

Jan. 16, 1940.

R. C. BAKER ET AL

2,187,482

CEMENT RETAINER

Filed Dec. 12, 1938

3 Sheets-Sheet 1

Fig. 1.

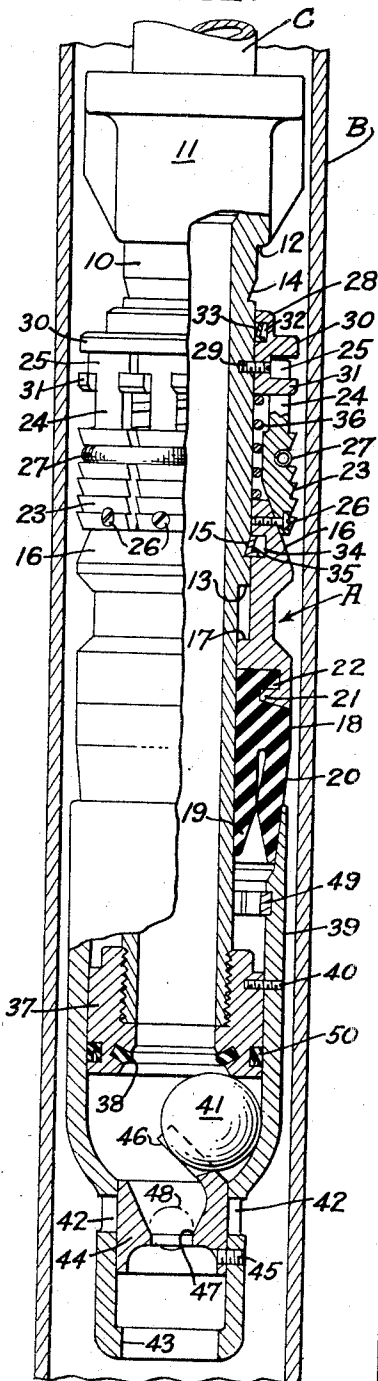
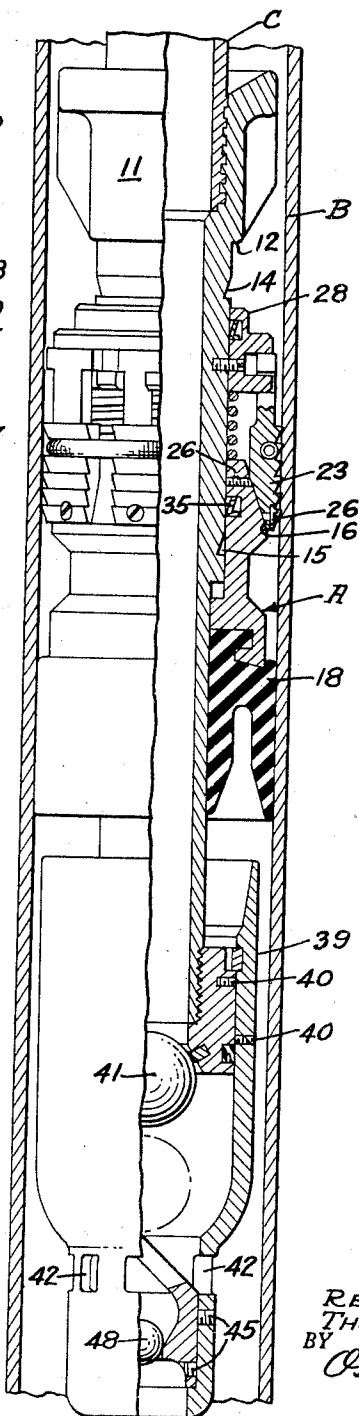


Fig. 2.



INVENTORS
REUBEN C. BAKER
THOMAS M. RAGAN
BY
Oscar A. Mellin
ATTORNEY

Jan. 16, 1940.

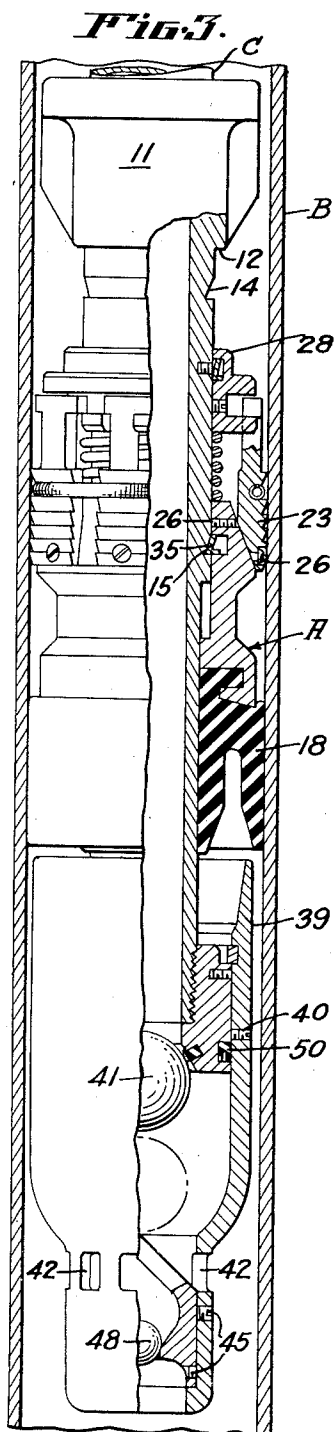
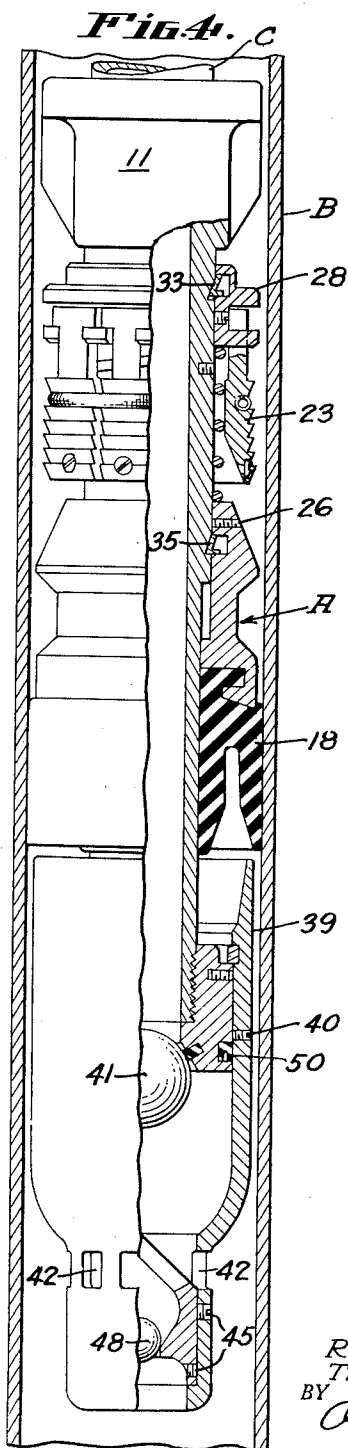
R. C. BAKER ET AL

2,187,482

CEMENT RETAINER

Filed Dec. 12, 1938

3 Sheets-Sheet 2



INVENTORS
REUBEN C. BAKER
THOMAS M. RAGAN
BY *Oscar A. Mellin*
ATTORNEY

Jan. 16, 1940.

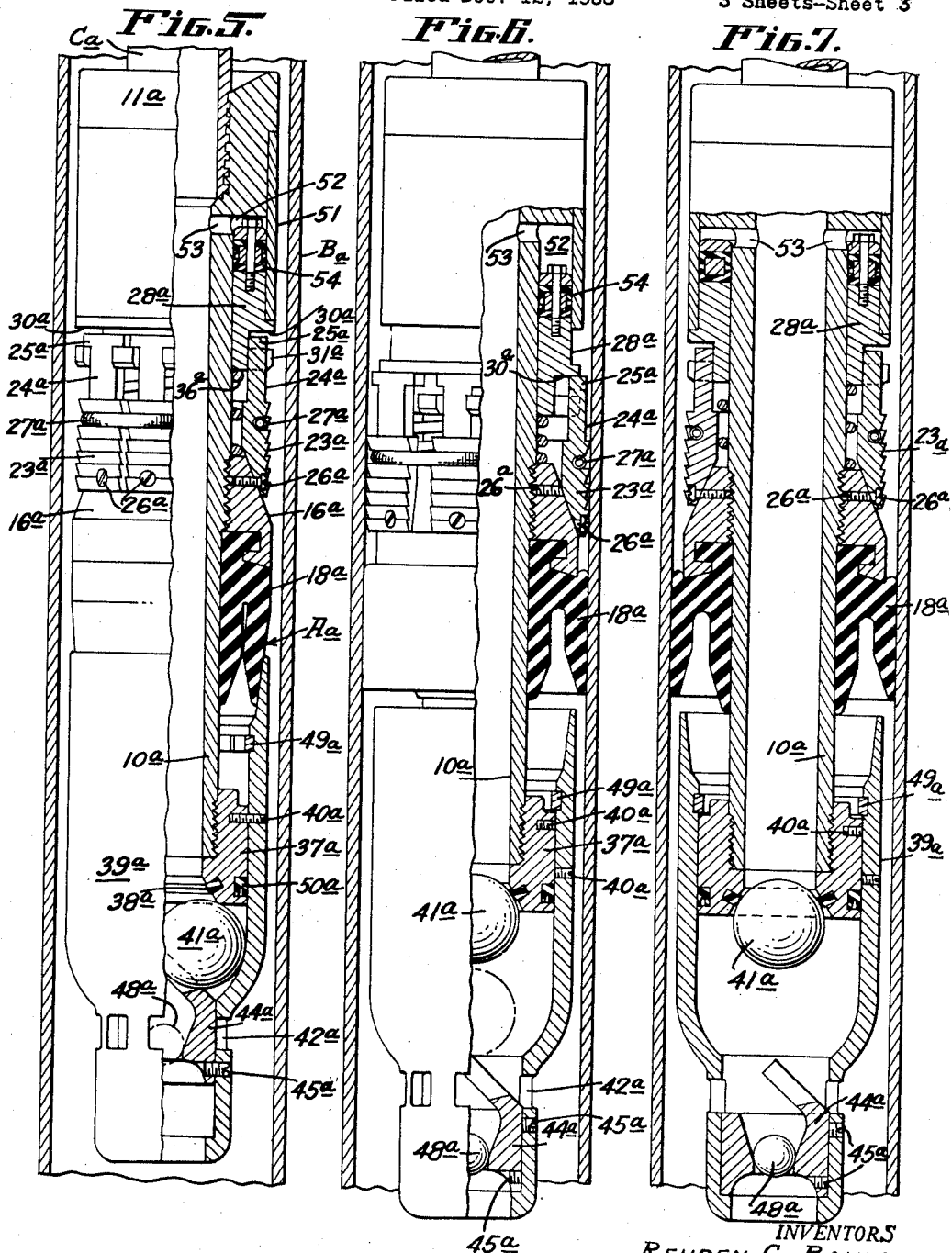
R. C. BAKER ET AL

2,187,482

CEMENT RETAINER

Filed Dec. 12, 1938

3 Sheets-Sheet 3



INVENTORS
REUBEN C. BAKER
THOMAS M. RAGAN
BY
Oscar A. Mellin
ATTORNEY.

UNITED STATES PATENT OFFICE

2,187,482

CEMENT RETAINER

Reuben C. Baker, Coalinga, and Thomas M. Ragan, Los Angeles, Calif., assignors to Baker Oil Tools, Inc., Huntington Park, Calif., a corporation of California

Application December 12, 1938, Serial No. 245,240

19 Claims. (Cl. 166—12)

This invention relates to that general type of well devices commonly known as cement retainers which are utilized in the cementing, packing off, and repressuring of oil wells.

5 It is the principal object of the present invention to provide an improved device of the character referred to which may be detachably connected to the lower end of a string of tubing or the like and be safely and properly run-in and set at any desired point in a well casing in such a manner as to resist dislodgment by pressures to which it may be subjected, and which may thereafter be released and withdrawn from the well by the tubing string, or which may be left in set position in the well casing by disconnecting and withdrawing only the tubing string; the apparatus being utilized in cementing operations to cement off water formations at one or more predetermined levels or to form a cement seal and reinforcement between the well casing and bore throughout the entire length of the casing, and being capable of efficient use in packing off the well casing at any desired elevation for purposes such as packing off a high pressure gas strata located below an oil sand or packing off the well casing preparatory to a repressuring operation.

15 In general, the cement retainer comprises a tubular packing device adapted to be run-in a well casing at the lower end of a string of tubing by which it may be manipulated by an operator at the derrick floor, and it includes in its structure operable slips for anchoring the retainer firmly in the surrounding casing at a desired location and an expansible packing means or sealing element for sealing off the annular space between the exterior of the retainer and the wall of the well casing, the slips and the packing means being operated by fluid pressure and by manipulation of the tubing string.

20 In cementing operations, the tubing method may be practiced; that is, the cement slurry is pumped down through the run-in string of tubing and through the cement retainer into the space below said retainer and back up around the casing to form a seal between the casing and the well bore, the cement being prevented from returning into the cement retainer by a back-pressure valve.

25 As this device can be set at any desired point in a well casing, it is capable of use in connection with stage or series cementing operations, and when employed purely as a packer for sealing off the casing at any predetermined point, it may be effectively used above an oil sand in

repressuring operations, or below a productive strata for shutting off troublesome high pressure gas of a lower formation.

The packing element with which the device is provided comprises an inherently expansive cup packing and for the purpose of preventing undesirable wear thereof and to insure its safe and proper passage down a well casing, the device is provided with means for normally protecting and for maintaining said packing cup contracted during the running-in of the device and arranged to later be operated by fluid pressure to release the packing cup for engagement with the casing wall.

15 The device also includes an arrangement for effecting a release thereof from its gripping engagement with the casing wall so that it may be moved or withdrawn from the well if desired.

20 Further, the device is so connected to the run-in string of tubing that after it is set in the well casing, said run-in string may be disconnected therefrom and withdrawn from the well, leaving the cement retaining device in its set position in the well casing to be later drilled up in a subsequent drilling operation. The device, for this reason, is constructed of readily drillable materials.

The invention is exemplified in the following description and illustrated by way of example in the accompanying drawings, in which:

25 Fig. 1 is a longitudinal sectional view through a portion of a well casing and disclosing one form of embodiment of my improved device positioned therein with the parts in the position they assume when the device is being run-in the casing.

Fig. 2 is a view similar to Fig. 1, showing the device in a tripped condition with the packing and the slips in engagement with the casing wall.

30 Fig. 3 is a view similar to Fig. 2, but showing the parts of the device in the position they assume when the device is completely set and firmly anchored in place in the casing, the slips being conditioned for subsequent automatic disengagement from the casing.

35 Fig. 4 is a view similar to Fig. 3, but showing the slips in the position they assume after having been released and automatically disengaged from the casing preparatory to a removal of the device from the well.

40 Fig. 5 is a longitudinal sectional view through a portion of a well casing and disclosing a second embodiment of our invention positioned

therein with the parts in the position they assume when the device is being run-in the casing.

Fig. 6 is a view similar to Fig. 5, but showing the device in its fully set condition.

Fig. 7 is a view similar to Fig. 6, but showing the device with the parts in the position they assume after the slips have been released from gripping engagement with the casing wall preparatory to withdrawal of the device from the well.

Referring to the drawings (particularly to Figs. 1 to 4 inclusive) A designates a packer or what is commonly known as a cement retainer, and in Fig. 1 this packer is shown in its normal condition as it is run-in a well casing B, it being noted that the device is of a general tubular character, cylindrical in cross-section, and of normal overall external diameter just slightly less than the internal diameter of the well casing in which it is to be run and set.

The packer or cement retainer A includes a tubular body 10 adapted for attachment to the lower end of a run-in string of tubing C, and in the structure shown we prefer a means of attachment which comprises a relatively coarse screw-thread connection, preferably a square left-hand screw-thread so that the tubing string C may be rotated in a right-hand direction to disconnect it from the set retainer without danger of disconnecting any of the usual right-hand screw-thread connections between the several lengths of tubing which comprise the relatively long tubing string.

The body 10 has a head 11 providing an upper annular jarring shoulder 12 and the lower portion of said body is reduced in external diameter to provide a lower annular jarring shoulder 13. Between these shoulders the body is provided with upper and lower annular one-way latch grooves 14 and 15 respectively.

A slip expanding cone 16 is mounted on the body 10 to slide longitudinally, partly on the body above the jarring shoulder 13 and partly on the reduced portion of said body below said shoulder, and having an annular internal abutment shoulder 17 disposed in position to be engaged by said jarring shoulder.

The cone 16 has secured to its lower end a cylindrical resilient packing element 18 longitudinally slidable with said cone on the reduced portion of the body 10, said packing element being of cup form and having an inner annular depending lip 19 engaging the body and an outer annular depending marginal lip 20 spaced from said inner lip. It is desired that the cup 18 be connected to the cone 16 by interlocking means and to this end the upper end of the cup and the lower end of the cone are of companion contour, the cone being provided with an internal annular flange 21 defining an adjacent internal groove, and the cup having an external annular bead 22 disposed in said groove and defining an adjacent external groove accommodating said bead. This packing cup is preferably formed of relatively tough rubber or of other suitable material of a nature having sufficient resiliency to cause the outer marginal lip 20, when released from restraint, to flex outwardly and engage the casing wall.

The means for anchoring the device in set position in the well casing comprises a plurality of circularly spaced slips 23, each of which is of wedge form and is provided with an upwardly extended shank 24 having a T-head 25. Each slip 23 is, in its normal condition as shown in

Fig. 1, secured to the cone 16 by a shear screw 26 and is provided with external horizontally disposed wickers or teeth formed to have an upward gripping engagement with the casing wall.

The several slips are embraced by a contractile means in the form of a circular coil spring 27 which is disposed in exterior companion grooves formed therein. 28 designates a retractor ring which surrounds the upper portion of the body 10 and is normally secured in place thereon by one or more shear screws 29, as shown in Figs. 1 and 2, said shear screws 29 being of such diameter as to have a greater shear value than the several shear screws 26 of the slips. The retractor ring 28 has an external annular flange 30 extending over the T-heads 25 of the several slips and is provided with radial fingers 31, each extending between the shanks 24 of two adjacent slips beneath the lateral arms of their respective T-heads.

In the inner wall surface of the ring 28 is formed a groove 32 in which is disposed a ratchet latch in the form of a contractile split ring 33 of substantially saw-tooth cross-sectional contour with its inner face angled upwardly and outwardly and its lower face disposed transverse to the longitudinal axis of the device, this split ring forming a one-way ratchet latch which will cooperate with the upper one-way latch groove 14 of the body 10, as will later be explained.

The slip expanding cone 16 has a like internal groove 34 in which is disposed a one-way ratchet latch comprising a contractile split ring 35, of the same character as the ring 33, and so disposed as to engage in the lower latch groove 15 of the body 10 when said body and said cone are in normal relative relationship, as shown in Figs. 1, 3 and 4.

A slip elevating compression spring 36 surrounds the body 10 behind the several slips and is disposed between the slip retractor ring 28 and the top of the slip expanding cone 16, the purpose of which will later be explained.

Attached to the lower end of the body 10, by screw-threads or by other desired means, is a tubular piston 37 having its bore aligned with the bore of the body and its lower end formed to provide a valve seat, the preferred form of valve seat herein disclosed being a seat ring insert 38 of rubber or any other material suitable for the purpose. Slidable in relation to this piston is a tubular packing restraining and protecting means comprising a cylindrical housing or shoe 39 which also serves as a means for discharging fluid or cement from the packer or cement retainer as well as serving as a means for properly guiding the device down the well casing to its position of use.

The cylindrical housing 39 normally is retained in the upper position shown in Fig. 1, by a shear screw 40, with its upper lip portion engaged over the outer lip 20 of the packing cup 18 to restrain said lip 20 in collapsed position and protect the packing against damage before use and during its descent into a well casing. Thus, the housing or shoe 39 is in fact an extensible continuation of the body structure which may be said to comprise two telescopically disposed tubular members normally rigidly connected by means subsequently to be disabled to permit relative axial extension of said members.

Disposed within the housing 39 immediately below the piston 37 is a buoyant back-pressure ball valve 41 adapted to engage the valve seat 38, when released from restraint. Below the ball valve 41, the housing 39 has a cylindrical portion

of reduced diameter provided with lateral discharge ports 42 and an internal stop flange 43, and mounted within said reduced portion is a tripping slide valve 44 which normally closes the discharge ports 42 and is held in such normal position by a shear screw 45, which has a substantially greater shear value than does the shear screw 40 of the housing 39. Said tripping valve 44 has an upwardly extended forked arm 46 which normally engages and holds the back-pressure ball valve 41 crowded to one side of the axis of the device and in restraint against the bottom of the piston 37 and the side wall of the housing 39. The tripping valve 44 has an axial bore which forms a continuation of the fluid passage through the device and which is formed to provide a seat 47 adapted to be engaged by a tripping ball 48 which will be sent down the tubing string to close said fluid passage when the device has reached its position of use.

To limit the downward movement of the housing 39, there is provided a stop 49 which, in the preferred form illustrated, comprises an internal snap ring engaged in a companion groove formed in the wall of said housing and adapted to abut against the upper surface of the piston 37, and to prevent leakage of fluid or cement past said piston it is provided with a suitable packing ring 50 disposed within a groove therein and engaging the wall of the housing.

In practicing our invention, the device will be constructed and assembled as shown in Fig. 1. In this condition the slip retractor ring 28 is secured to the body 10 by its shear screws 29, the several slips 23 are secured on the cone 16 by their respective shear screws 26, the packing cup 18 is held in collapsed condition and is protected by the housing member 39, while said housing member is secured on the piston 37 (of the body 10) by the shear screw 40. Also the tripping valve 44 will be maintained in its normal upper position by the shear screw 45, to close the discharge ports 42 and restrain the back-pressure ball 41 in an inactive position.

With the device thus normally conditioned, it is screwed on the lower end of the running-in tubing and lowered into the well casing as the tubing string is made up in the usual manner, it being obvious that since the back-pressure ball is restrained in an inactive position and since the tripping ball 48 has not as yet been sent or pumped down the tubing string, the fluid passage through the device remains open, thus permitting the device to be freely lowered or raised without causing a swabbing action.

When the device has been positioned at the desired point, circulation may be established to clear the well, particularly the zones to be cemented, of heavy mud, drilling detritus and the like. When the operator is satisfied that the proper condition for effective cementing has been attained, the tripping ball 48 will be dropped in the tubing string C and pumped down to its seat 47 in the tripping valve 44, said tripping ball passing around the restrained back-pressure ball 41. With the circulation thus blocked by the seating of the trip ball 48, fluid pressure will be built up in the tubing line and in the device above said trip ball until such fluid pressure becomes sufficient to first shear the screw 40 and drive the packing restraining housing 39 downwardly to release said packing and at the same time free the back-pressure ball 41. Continued building up of the fluid pressure will next shear the screw 45 and drive the tripping valve 44

down to the stop flange 43, thus opening the discharge ports 42 and reestablishing the circulation through the device, the pressure of this reestablished circulation now being exerted to further expand the released packing cup 18 and drive the slip expanding cone 16 upwardly to shear the slip screws 26 and wedge the several slips into gripping engagement with the casing wall to set the device, as shown in Fig. 2. The several slips are restrained against upward movement by the annular flange 30 of the slip retractor ring 28 which at this time is held against movement on the body by its shear screw 29. This upward movement of the cone 16 in relation to the slips 23 will compress the slip elevating spring 36, the stored energy of which may subsequently be employed in releasing the device.

Having in this manner set the device at the desired location in the well casing, the operator will put an upward strain on the tubing string C sufficient to shear the screw 29 of the slip retractor ring 28, thus freeing said ring from the body 10. The body 10 is thus elevated in relation to the slip expanding cone 16 until its contractile ratchet latch 35 automatically snaps into engagement with the lower latch groove 15, as shown in Fig. 3. The upward strain on the tubing string will now be exerted through the engaged latch 35 to wedge the cone 16 more firmly within the several slips and further embed their wickers or teeth into the casing wall.

While the device may be effectively set in this manner, it will be stated that we prefer to use in connection with the device a circulating jar or joint of any preferred type, which may be employed to jar the body 10 during the shearing of the screw 29 and the final wedging of the cone 16 within the several slips.

It will be obvious from the above description and from the drawings that any pressure built up in the casing below the device will tend to more closely press the packing against the body 10 and the casing wall and to more forcefully urge the cone 16 upwardly to cause the several slips 23 to take a deeper bite into the casing wall. Therefore, it should be evident that the packing efficiency of the device and its resistance against dislodgment will increase with any increase in the up-pressure to which it is subjected.

The device in the set condition shown in Fig. 3 is then ready for cementing operations, and cement slurry may be pumped downwardly through the tubing string C, thence through the body 10 of the cement retainer A, to open and flow past the back-pressure valve 41 and discharge through the discharge ports 42 into the well casing below the retainer A. When the cementing operation is completed, the back-pressure of the cement will close the valve 41 to prevent return flow of the cement back into the body 10.

After completion of the cementing operation, the cement retainer may be left anchored in the well casing to be subsequently drilled up, or it may be released and withdrawn from the well after the cement is set sufficiently to become stable and before it has become so hardened as to freeze the retainer against removal.

If the cement retainer is to be left in the casing, the tubing string C will be rotated in a right-hand direction and disconnected from the body 10, due to the left-hand screw-thread connection between the two. The tubing string C may then be pulled from the well.

In the event it is desired to remove the retainer after the cement is set and before it hard-

ens, such removal may be accomplished in the following manner. By lowering the body 10 and jarring downwardly, the jarring shoulder 13 will strike the abutment shoulder 17 of the slip expanding cone 16 to drive said cone downwardly to release the several slips 23. The slips being thus released will be compressed to collapsed position by the encircling coil spring 27 and will be immediately elevated, through the associated retractor ring 28, by the stored energy of the slip elevating spring 36, as shown in Fig. 4.

Since the wickers or teeth of the slips may in some instances become so embedded in the casing wall that the slip encircling spring 27 cannot loosen the slips, we provide the upper jarring shoulder 12 which, by striking downwardly on the top of the slip retractor ring 28, will jar the slips loose from the casing so that they may then be elevated by the slip elevating spring 36 as above explained.

With an upward withdrawing movement of the tubing string and the body of the retainer, the ratchet latches 33 and 35 will automatically snap into their companion latch grooves 14 and 15, as shown in Fig. 4, so that a withdrawal of the several parts of the retainer from the well will be assured.

From the foregoing it will be evident that we have provided a device which may be set in a well casing at any desired point to provide a fluid-tight seal for cementing and other operations and which will be securely anchored in set position against dislodgment by such pressures as may be present in the well below said device, and it will also be evident that our invention contemplates a device which may be disconnected from its run-in string and left in set position in the well casing and subsequently drilled up to clear the casing, or which may, through proper manipulation of the run-in string, be released from the well casing and withdrawn from the well.

As before stated, the device may also be employed purely as a packer for a repressuring operation. In repressuring an oil sand an exhausted well which taps said sand is selected and the packer positioned therein just above the perforated section of the well casing. The trip ball is then dropped down the run-in tubing and gas under high pressure is forced down said tubing to trip and expand the packer and set the slips and to open the discharge ports in the manner above described. Continued pumping of the gas into the casing below the set packer will force the gas into the oil sand to create therein a gas pressure sufficient to drive additional oil into adjacent wells from which it may be pumped to the surface.

Referring to the second embodiment of our invention and particularly to Figs. 5 to 7, inclusive, of the drawings, the device Aa therein disclosed includes a tubular body 10a, the lower end of which is provided with a piston 37a, an associated housing 39a having discharge ports 42a and containing a tripping valve 44a adapted to receive a trip ball 48a, a back-pressure ball valve 41a, shear screws 40a and 45a, stop ring 49a, packing ring 50a and valve seat 38a, all of like construction to the similar parts of the previously described device of Figs. 1 to 4.

In this second embodiment, the slip expanding cone 16a is secured on the body 10a by screw-threads, thus maintaining said cone and the expansible packing 18a fixed in relation to said body. The several slips 23a and their embracing contractile spring 27a are the same as the slips 23 and spring 27 of the device A, the several slips

23a each being normally secured to the cone 16a by a shear screw 26a. The upper end of the body 10a has an enlarged head 11a which is provided with a fixed depending tubular skirt 51 spaced from the body to form an annular open end chamber 52 in which is slidably mounted an annular piston-like slip actuating and retracting ring 28a having a shoulder 30a adapted to engage the T-heads 25a of the several slips and radial fingers 31a, each extending between the shanks 24a of two adjacent slips beneath the lateral arms of their respective T-heads. The body 10a has one or more lateral ports 53 leading from the bore of the body to the upper end of the chamber 52, and the upper end of the annular slip operating ring 28a is provided with packing means 54 of any desired type suitable to prevent leakage of fluid past said ring. A compression spring 36a surrounds the body 10a behind the several slips and is disposed between the top of the cone 16a and the lower end of the slip actuating ring 28a. The tubing string Ca by which the device is run-in the well casing Ba has a left-hand screw-thread connection with the body 10a, preferably of the square thread type, as in the device A.

The device Aa is lowered into the well casing Ba in the normal condition, as shown in Fig. 5, with the packing cup 18a restrained in collapsed position and protected by the housing 39a, the back-pressure ball 41a restrained in inactive position, and the slip actuating ring 28a in its upper position. When the device reaches its predetermined position of use, the trip ball 48a will be pumped down the run-in string Ca to its seat in the tripping valve 44a to block the circulation and cause pressure to be built up within the device and the run-in tubing. Such increase of fluid pressure will first be effective through the ports 53 and chamber 52 to drive the slip actuating ring 28a downwardly to engage the T-heads of the several slips 23a, and will then drive said slips downwardly on the stationary cone 16a, shearing the several slip screws 26a and expanding the slips to gripping engagement with the casing wall, while at the same time compressing the compression spring 36a, as shown in Fig. 6.

Continued building up of the fluid pressure within the device will effect a successive shearing of the respective shear screws 40a and 45a, the pressure translating the housing 39a to free the packing cup 18a from restraint and then translating the tripping valve 44a to open the discharge ports 42a. The circulation through the device thus being reestablished, a continued pumping of the circulation into the well casing below the device will build up therein sufficient pressure to expand the packing cup 18a to closely engage the body 10a and the casing wall.

After completion of the cementing operation, the run-in tubing string Ca may be disconnected from the set device and removed from the well, as explained in connection with the device A, or the device Aa may be released from its gripping engagement with the casing wall and removed from the well with said tubing string. This is accomplished by first jarring downwardly to release the expanding cone 16a from its wedging engagement with the several slips 23a, whereupon the compression spring will immediately become effective to elevate the slip actuating ring 28a which will carry upwardly with it the several released slips, as shown in Fig. 7, the device then being in condition for withdrawal from the well casing by the tubing string.

While we have disclosed herein two preferred

embodiments of our invention, it is to be understood that various changes may be made therein by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

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

1. In a device of the character disclosed, the combination of a body providing an axial flow passage and adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup carried by said body and having an expansible longitudinally extended marginal lip, a packing restraining means normally surrounding and removably engaged over said lip to restrain it against expansion, and means including means cooperable with said flow passage to enable an increase in the pressure of fluid therein whereby to effect a separation of said packing and said packing restraining means to release said lip for engagement with the casing wall.

2. In a device of the character disclosed, the combination of a tubular body providing an axial flow passage and adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup carried by said body and having an expansible longitudinally extended marginal lip, a packing restraining means normally surrounding and removably engaged over said lip to restrain it against expansion, and hydraulically actuated means including means adapted to be sent down said tubing string to close said flow passage and operable to effect a separation of said packing and said packing restraining means to release said lip for engagement with the casing wall.

3. In a device of the character disclosed, the combination of a body providing an axial flow passage and adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup carried by said body and formed of a resilient material to provide an inherently expansible longitudinally extended marginal lip, a packing restraining means normally surrounding and removably engaged over said lip to restrain it against expansion, and means including means adapted to be sent down said tubing string to close said flow passage and operable to effect a separation of said packing and said packing restraining means to release said lip for engagement with the casing wall.

4. In a device of the character disclosed, the combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup carried by said body and having an expansible longitudinally extended marginal lip, a packing restraining means normally surrounding and engaged over said lip to restrain it against expansion, retaining means capable of being disabled normally maintaining the coengaging relationship between the packing and the packing restraining means, and means operative to disable said retaining means and effect a separation of said packing and said packing restraining means to release said lip for engagement with the casing wall.

5. In a packing device adapted to be attached to and lowered into a well casing by a string of tubing and having a normally open fluid passage for receiving fluid pumped through said tubing and for discharging said fluid into said casing, a tubular member carrying an annular packing cup having an expansible longitudinally extended

marginal lip, a packing restraining means normally surrounding and engaged over said lip to restrain it against expansion, said means being provided with a lateral discharge port, a slide valve normally closing said port and having a bore forming a portion of said fluid passage, and a closure adapted to be sent down said tubing string to close said bore to cause a build up of the fluid pressure in said fluid passage above said closure, such pressure being effective to separate the packing and the packing restraining means to release the packing lip for engagement with the casing wall and to subsequently cause said valve to uncover said discharge port.

6. In a packing device adapted to be attached to and lowered into a well casing by a string of tubing and having a normally open fluid passage for receiving fluid pumped through said tubing and for discharging said fluid into said casing, a tubular member carrying an annular packing cup having an expansible longitudinally extended marginal lip, a packing restraining means normally surrounding and engaged over said lip to restrain it against expansion, said means being provided with a lateral discharge port, a slide valve normally closing said port and having a bore forming a portion of said fluid passage, connecting means maintaining said packing restraining means in normal position and capable of being released by a predetermined applied force, a second connecting means normally maintaining said slide valve in closed position and capable of being released by a predetermined greater applied force, and a closure adapted to be sent down said tubing string to close said bore to cause a build up of the fluid pressure in said fluid passage above said closure, such fluid pressure being effective to release said first named connecting means and cause a separation of the packing and the packing restraining means to release the packing lip for engagement with the casing wall and to subsequently release said second named connecting means and open said slide valve.

7. In a device of the character disclosed, the combination of a tubular body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup surrounding said body and having an expansible longitudinally extended marginal lip, a tubular housing slidably mounted on said body and having an end normally surrounding and engaged over said lip to restrain it against expansion, the opposite end of said housing being extended beyond said body to form a valve chamber and being provided with a lateral discharge port, a slide valve normally closing said discharge port and having an axial bore, and a trip ball adapted to be sent down the tubing string and tubular body to close said bore.

8. In a device of the character disclosed, the combination of a tubular body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup surrounding said body and having an expansible longitudinally extended marginal lip, a tubular housing slidably mounted on said body and having an end normally surrounding and engaged over said lip to restrain it against expansion, the opposite end of said housing being extended beyond said body to form a valve chamber and being provided with a lateral discharge port, a slide valve normally closing said discharge port and having an axial bore, a back-pressure valve disposed in said valve chamber above said

slide valve, said slide valve being provided with means normally holding said back-pressure valve in an open position, and a trip ball adapted to be sent down the tubing string and tubular body and past the open back-pressure valve to close the bore of said slide valve.

9. In a device of the character disclosed, the combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup carried by said body and having an expansible longitudinally extended marginal lip, a packing restraining means normally surrounding and removably engaged over said lip to restrain it against expansion, slips mounted on said body, a slip expanding means connected to said packing cup and having a wedge engagement with the said slips, connecting means capable of being released normally connecting the slips to said expanding means in ineffective positions, and means operable to cause relative axial movement between said slips and said expanding means to disable said connecting means and expand the slips radially to gripping engagement with the casing wall.

10. In a device of the character disclosed, the combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup carried by said body and having an expansible longitudinally extended marginal lip, a packing restraining means normally surrounding and removably engaged over said lip to restrain it against expansion, slips mounted on said body, a slip expanding means connected to said packing cup and having a wedge engagement with the said slips, connecting means capable of being released normally connecting the slips to said expanding means in ineffective positions, and hydraulically actuated means operable to cause relative axial movement between said slips and said expanding means to disable said connecting means and expand the slips radially to gripping engagement with the casing wall.

11. In a device of the character disclosed, the combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, an annular packing cup carried by said body and having an expansible longitudinally extended marginal lip, a packing restraining means normally surrounding and removably engaged over said lip to restrain it against expansion, slips mounted on said body, a slip expanding means connected to said packing cup and having a wedge engagement with the said slips, connecting means capable of being released normally connecting the slips to said expanding means in ineffective positions, complementary jarring means on the body and on said slip expanding means engageable to break the wedge engagement of said expanding means with the several slips, and tension means for automatically collapsing said slips when released from said gripping engagement with the casing.

12. In a device of the character disclosed, the combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, slips associated with said body, a slip expanding means mounted on said body and having a wedge engagement with said slips, connecting means capable of being released normally connecting the slips to said expanding means in ineffective positions, means operable to cause relative axial movement between said slips and said expanding means to disable said connect-

ing means and expand the slips radially to gripping engagement with the casing wall, and tension means tending to automatically collapse said slips when released from said gripping engagement to permit withdrawal of the device from the well casing.

13. In a device of the character disclosed, the combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, slips associated with said body, a slip expanding means mounted on said body and having a wedge engagement with said slips, connecting means capable of being released normally connecting the slips to said expanding means in ineffective positions, means operable to cause relative axial movement between said slips and said expanding means to disable said connecting means and expand the slips radially to gripping engagement with the casing wall, complementary means on the body and on said expanding means engageable to break the wedge engagement of said expanding means with the several slips, and tension means tending to automatically collapse said slips when released from said gripping engagement to permit withdrawal of the device from the well casing.

14. In a device of the character disclosed, the combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, slips associated with said body, a slip expanding means mounted on said body and having a wedge engagement with said slips, connecting means capable of being released normally connecting the slips to said expanding means in ineffective positions, means operable to cause relative axial movement between said slips and said expanding means to disable said connecting means and expand the slips radially to gripping engagement with the casing wall, slip retracting means, tension means compressible during the expanding of the slips to store energy tending to retract the slips axially in relation to the body, yieldable contractile means tending to collapse the slips inwardly, and complementary jarring means on the body and on the slip expanding means engageable to break the wedge engagement of said expanding means with the several slips to permit said tension means and said contractile means to automatically cooperate to move the released slips axially and inwardly to collapsed positions for withdrawal with the body from the well casing.

15. In a device of the character disclosed, the combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, slips associated with said body, a slip expanding means mounted on said body and having a wedge engagement with said slips, connecting means capable of being released normally connecting the slips to said expanding means in ineffective positions, means operable to cause relative axial movement between said slips and said expanding means to disable said connecting means and expand the slips radially to gripping engagement with the casing wall, slip retracting means, tension means compressible during the expanding of the slips to store energy tending to retract the slips axially in relation to the body, yieldable contractile means tending to collapse the slips inwardly, and complementary one-way ratchet means on said body and said slip expanding means and on said body and said slip retracting means operative to insure withdrawal thereof with the body.

16. In a device of the character disclosed, the

combination of a body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, slips associated with said body, a slip expanding cone mounted on said body, means operable to cause relative axial movement between said slips and said expanding cone to expand the slips radially to gripping engagement with the casing wall, a slip retracting means mounted on the body and engaging the ends of the several slips, said retracting means being provided with means disposed to engage an under surface of each of the several slips, tension means between said retracting means and said cone compressible during the expanding of the slips to store energy, and yieldable contractile means tending to collapse said slips inwardly, said tension means and said contractile means automatically cooperating to move the slips axially and inwardly to collapsed positions when the expanding cone is released from wedging engagement with said slips.

17. In a device of the character disclosed, the combination of a tubular body adapted to be attached to the lower end of a string of tubing and lowered into a well casing, slips associated with said body, a slip expanding cone mounted on said body, hydraulically actuated means operable to cause relative axial movement between said slips and said expanding cone to expand the slips radially to gripping engagement with the casing wall, a slip retracting means mounted on the body and engaging the ends of the several slips, said retracting means being provided with means disposed to engage an under surface of each of the several slips, tension means between said retracting means and said cone compressible during the expanding of the slips to store energy, and yieldable contractile means tending to collapse said slips inwardly, said tension means and said contractile means automatically cooperating to move the slips axially and inwardly to collapsed positions when the expanding cone is released from wedging engagement with said slips.

18. In a device of the character disclosed, the combination of a tubular body, slips associated therewith, slips expanding means mounted on the body and having a wedge engagement with said slips, connecting means capable of being released connecting the slips to said expanding means, slip retracting means mounted on said

body to engage the upper ends of the several slips and being formed to engage an under surface of each of said slips, a second connecting means connecting said slip retracting means to the body during an expansion of the slips and capable of subsequently being released by a translation of the body relative to the set slips, tension means disposed between said retracting means and said expanding means, hydraulic means operable to translate said expanding means to release the slip connecting means and expand said slips radially to gripping engagement with the casing wall, and to compress said tension means, yieldable contractile means tending to urge the slips inwardly, and complementary jarring means on the body and on said expanding means engageable to break the wedge engagement of said expanding means with the several slips to permit said tension means and said contractile means to automatically elevate the released slip retracting means and to move the said slips upwardly and inwardly to collapsed positions for withdrawal thereof with the body from the well casing.

19. In a device of the character disclosed, the combination of a tubular body, slips associated therewith, slip expanding means on said body and having a wedge engagement with said slips, connecting means capable of being released connecting the slips to said expanding means, hydraulically actuated slip translating means, tension means between said slip actuating means and said slip expanding means, and yieldable contractile means tending to urge the slips inwardly, said slip translating means being slidable on the body to engage and translate said slips on the slip expanding means to release said slip connecting means and expand said slips to gripping engagement with the casing wall, and to compress said tension means, said slip translating means also being formed to engage an under surface of each of said slips, whereby, upon jarring of the body to break the wedge engagement between the slip expanding means and the several slips, said tension means and said contractile means will automatically cooperate to move the slips upwardly and inwardly to collapsed positions for withdrawal thereof with the body from the well casing.

REUBEN C. BAKER.
THOMAS M. RAGAN.