June 21, 1938. T. M. RAGAN ET AL 2,121,050

HYDRAULICALLY (NTROLLED CEMENT RETAINER

Original led March 26, 1935 2 Sheets-Sheet 1

Fig. 1.

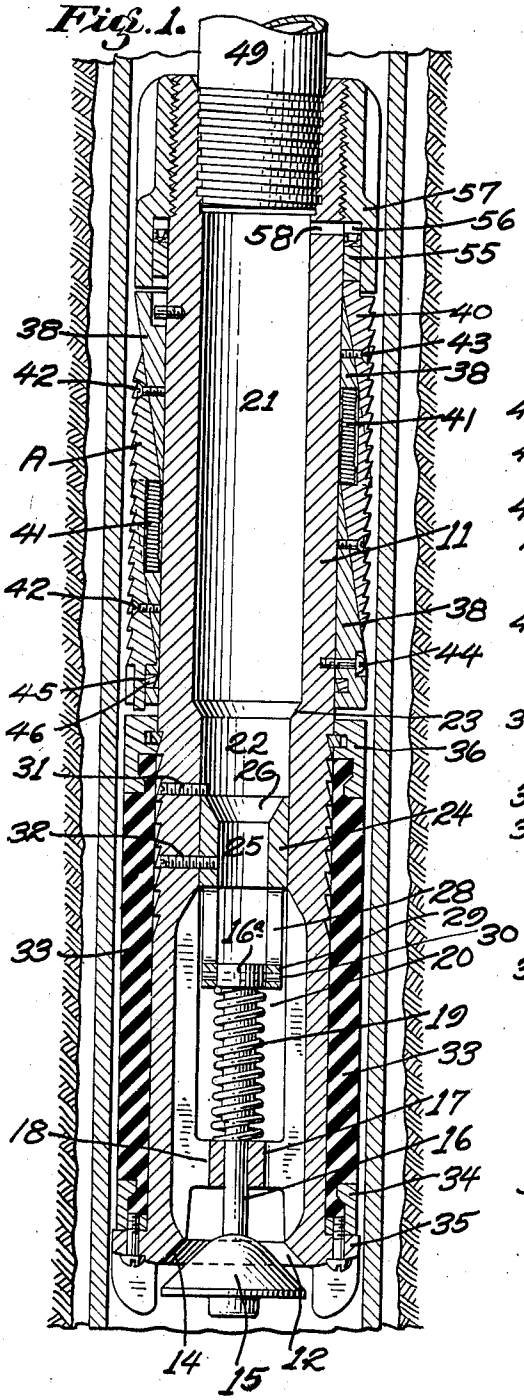
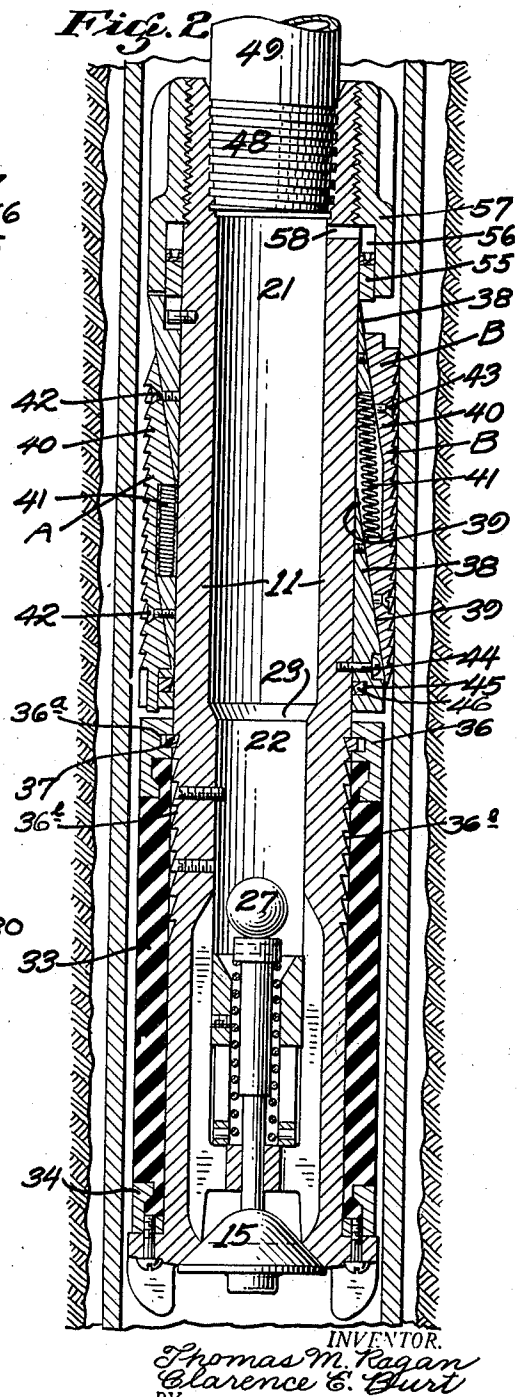


Fig. 2.



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HYDRAULICALLY CONTROLLED CEMENT RETAINER

Original Filed March 26, 1935 2 Sheets-Sheet 2

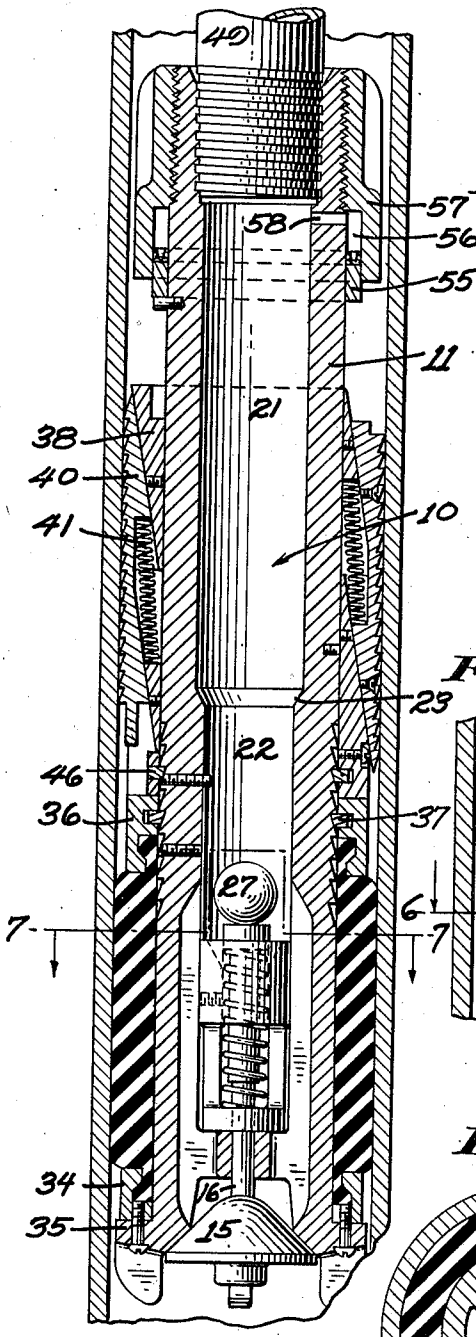


Fig. 3

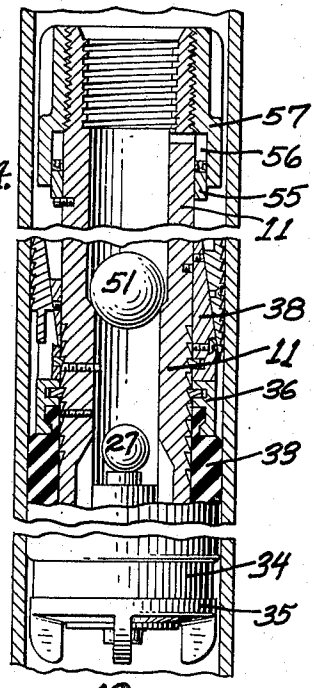


Fig. 4.

Fig. 5.

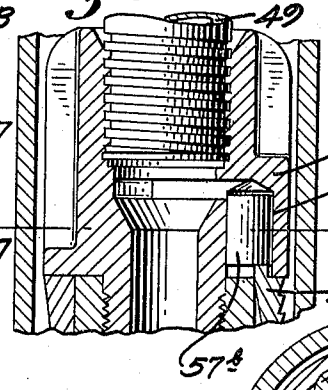


Fig. 6.

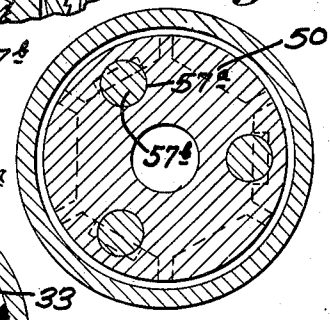
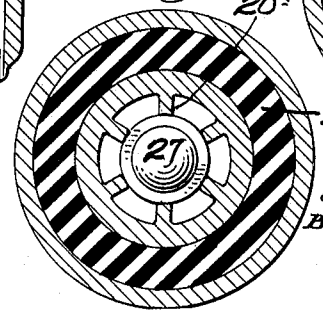


Fig. 7.



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2,121,050

HYDRAULICALLY CONTROLLED CEMENT RETAINER

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Application March 26, 1935, Serial No. 13,064
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32 Claims. (Cl. 166—13)

This invention relates to appliances commonly known as cement retainers which are utilized in packing off, cementing and repressuring operations in deep oil wells.

It is the principal object of the present invention to provide an efficient tool of the character referred to which may be safely run-in and the casing of a deep well and so set at any desired point therein that it will resist dislodgment by pressures in the casing either above or below the device; which tool may be quickly set in the casing by a minimum of operations.

In general, the device consists of a packer-like device which may be run-in the hole at the lower end of a string of tubing. This packer is fitted with operative slips for firmly anchoring it to the surrounding casing so that it will resist dislodgement either from pressures above or pressures below. The packer is fitted with an expansible packing or sealing element for sealing off the space between the exterior of the device and the casing wall. The slips or anchoring means and the packing element are operated by fluid pressure and by manipulating the running-in tubing at the derrick floor. The tool may be utilized in cementing-off a water formation at any level above the bottom of the bore or form a cement seal between the bore and casing throughout the entire length of the casing. The tool is also capable of efficient use in packing-off or bridging the casing at any point therealong.

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

Figure 1 is a longitudinal sectional view through a portion of a well casing and disclosing our improved apparatus positioned therein with the parts in the positions they assume when the device is being run-in in the casing.

Figure 2 is a view similar to Figure 1 but disclosing one set of slips in tripped position.

Figure 3 is a view similar to Figure 1 but showing the parts of the packer in the position they assume when the packer is fully set in the casing.

Figure 4 is a view the same as Figure 3 except the bridge ball valve is shown in position so that the device will act as a bridge plug.

Figure 5 is a fragmentary view in section disclosing a modified form of actuating mechanism for tripping one set of slips.

Figure 6 is a transverse sectional view taken on line 6—6 of Figure 5.

Figure 7 is a transverse sectional view taken on line 7—7 of Figure 3.

Referring more particularly to the accompanying drawings, 10 indicates a packer or what is commonly known as a cement retainer. This device is generally cylindrical in cross section and of an overall external diameter just slightly less, when its parts are in unset position, than the internal diameter of the well casing into which it is to be run and set. The packer or cement retainer 10 includes an elongated hollow cylindrical body 11, the lower end of which is formed with a concentric main circulating port 12 surrounded by a valve seat 14.

Cooperating with this valve seat to control the flow of fluid upwardly into the body 11 from below the same is a downwardly opening back pressure valve 15 of the poppet type. This valve is fitted with a valve stem 16 which extends vertically upward into the body 11 and is reciprocably mounted in a guide 17 formed centrally of a spider 18 formed integrally with or secured within the body 11. An expansion spring 19 is arranged between the guide 17 and an enlarged head 16a formed on the upper extremity of the valve stem 16. The spring 19 normally tends to maintain the valve 15 seated on the seat 14, thereby closing the main circulating port 12. It is obvious, however, that the valve 15 may be opened by fluid pressure from within the body when the same exceeds the pressure in the casing below the packer 10.

It will be noticed that the body 11 is hollow and is formed with a lower bore 20 and an upper bore 21. These two are connected by an intermediate bore 22 which is reduced in diameter with respect to the upper and lower bores 21 and 20. A bridging valve seat 23 is formed at the junction between the upper bore 21 and the intermediate bore 22, the purpose of this seat will be hereinafter described.

Reciprocably mounted in the intermediate bore 22 is a sleeve 24 which has a passageway 25 formed co-axially therethrough. At its upper end the sleeve 24 is formed with a trip valve seat 26 to receive a ball trip valve 27 as shown in Figure 2. Depending from the lower end of the sleeve 24 are spaced legs 28 which connect the sleeve 24 to a circular trunnion 29. This trunnion 29 is connected to the head 16a by means of a shear pin 30. Due to the connection between the sleeve 24 and the valve stem 16, the valve spring 19 constantly tends to maintain the sleeve 24 in its uppermost position.

When the packer is assembled for running-in, it is desirable to hold the valve 15 open so that fluid may pass freely upwardly through the body

11. To maintain the valve in this open position we provide a stop pin 31 which is secured in the body 11 and against which the upper end of the sleeve 24 abuts. Such engagement prevents the valve 15 from entirely closing so that when the plug is run-in the casing, it may be moved up and down therein without causing a swabbing action. The sleeve 24 is also secured to the body 11 by a shear pin 32 which is sheared to release the sleeve and render it ineffective to hold the valve 15 open after the packer has been set in the casing.

A packer sleeve 33 formed of rubber or any other suitable pliable material is arranged exteriorly on the body 11 and is anchored at its lower end to a fixed ring 34 which is bolted or otherwise secured to an annular flange 35 circumscribing the lower end of the body 11. The upper end of the packer sleeve 33 is anchored to a sliding ring 36 slidably fitting the exterior of the body 11. This sliding ring 36 is formed with an interior annular groove 36*a* into which is fitted a spring latch ring 37. When the packing sleeve 33 is compressed into sealing position as shown in Figure 3, this latch ring engages annular latching grooves 36*b* on the body 11 to latch the sleeve 33 in sealing position.

Referring particularly to Figures 1 to 3 inclusive, it will be seen that above the packer sleeve 33 the body 11 is provided with a slip sleeve 38. This slip sleeve is bored so that it is capable of reciprocation on the exterior surface of the body 11. The exterior of the slip sleeve 38 is formed with a plurality of vertically arranged slip sockets 39 which are spaced equal distances apart about the periphery of the slip sleeve 38. There are two sets of these sockets, one set to receive what we prefer to term "down-pressure slips", which are provided to resist dislodgement of the plug or packer from pressures above it, the other set of slips we prefer to term "up-pressure slips" which are provided to resist dislodgement of the device from pressures below the packer.

The inner surface of each socket 38 is formed with two parallel surfaces arranged one above the other and which are inclined with respect to the vertical axis of the slip sleeve. The inner surfaces of adjacent sockets are oppositely inclined so that the up-pressure and down-pressure slips will be arranged alternately about the slip sleeve 38. A slip 40 is provided for each socket 39, and in this instance there are three up-pressure slips and three down-pressure slips, there being six sockets formed in the slip sleeve 38. It is to be understood, however, that we may provide a greater or lesser number of slips if found desirable.

The inner surface of each slip is formed with parallel inclined surfaces which coincide with and are complemental to the inner surfaces of its socket so that relative vertical movement between the slips and the slip sleeve 38 will result in radial movement of the slips.

At the junction between the inclined surfaces of the slip socket, there is a lateral shoulder which coincides with a similar lateral shoulder between the inclined surfaces of the slip fitting the socket. Each socket is formed with a keyway 39*a* which is engaged by a key 40*a* formed on the slip. An expansion spring 41 is arranged in each socket and it abuts against the end of the keyway 39*a* at one end and against the lateral shoulder on the slip 40 at the other end so that when the slip is detached from the slip sleeve 38, the spring 41 will move the slip relative to the slip sleeve 38 and consequently cause the slip to move radially outward. In the case of the down-pressure slips which we have indicated at A, the springs 41 will move the slips upwardly relative to the slip sleeve 38 and in the case of the up-pressure slips B, the springs 41 will move the slips downwardly relative to the slip sleeve 38. This movement of the slips causes them to move radially outward and into engagement with the casing.

Referring to Figure 1 where the parts are shown in the position which they assume when the device is run into the casing, it will be noticed that the slips are arranged in their innermost position and that the down-pressure slips are secured to the slip sleeve 38 by a shear pin 42 while the up-pressure slips B are secured to the slip sleeve 38 by shear pins 43. It will also be seen from Figure 1 that when the parts are in run-in condition of an assembly, that the springs 41 are under full compression.

When the slip sleeve 38 is assembled on the body 11 prior to running the tool into the casing, it is secured to the body 11 by a shear pin 44. It will also be noticed that within its lower end, the slip sleeve 38 is formed with an annular groove 45 which receives a spring latch ring 46. This latch ring is adapted to engage the annular latch grooves 36*b* formed about the exterior surface of the body 11 to latch the sleeve 38 in position on the body 11 when the tool has been run-in the casing and set.

For the purpose of running the tool into the casing, the upper end of the upper bore 21 is formed with a left-hand female thread to receive the left-hand male thread 48 formed on the lower end of running-in tubing 49. The purpose of the left-hand thread is to enable the tubing 49 to be unscrewed from the body 11 after the tool has been tripped and set in the casing.

To trip the up-pressure slips B we provide an annular piston 55 mounted for reciprocation coaxially of the body 11 in an annular cylinder 56 formed between the body 11 and a cylinder head 57. The lower end of this piston when sufficient fluid pressure is exerted thereon, engages the upper ends of the up-pressure slips B and forces them downwardly relative to the slip sleeve 38 shearing the pins 43 and enabling the springs to move the slips B downwardly relative to the sleeve 38 and consequently outwardly into engagement with the casing. A port 58 forms a communication between the upper chamber 21 and the cylinder 56.

In operation of the device it is constructed and assembled as shown in Figure 1. In this condition the valve 15 will be unseated, the two sets of slips A and B will be in their innermost position, and the packer sleeve 33 will be fully contracted. The tool is then threaded on the lower end of the running-in tubing 49 and lowered into the casing.

It is obvious that due to the fact that the valve 15 is open, the device can be moved up and down in the casing without causing a swabbing action.

When the device has been positioned at the desired point, the trip ball valve 27 is dropped through the tubing 49 and it will find its seat on the seat 26 on the sleeve 24. Fluid pressure is then created in the tubing 49 and in the interior of the body of body 11 above the sleeve 24. This pump pressure is insufficient to shear the pin 32 and move the trip ball valve 27 and the sleeve 24 downwardly so as to permit the fluid to pass through the body. This fluid pressure, however,

is sufficient to move the piston 55 downwardly in the cylinder 56, engage the slips B and shear the pins 43 so that the springs 41 will place the slips into engagement with the casing. This pressure is insufficient to shear the pins of the slip sleeve 38.

The pump pressure in the body 11 is then relieved and an upward strain is taken on the running-in tubing 49. The moment that the body 11 commences to move upwardly, the complemental faces between the sockets and the up-pressure slips B will jamb the up-pressure slips into firm gripping engagement with the casing. Thereafter this upward movement of the body 11 is continued to a point where the engagement between the up-pressure slips B and the casing prevents further upward movement of the slip sleeve 38 so that continued upward movement of the body will shear the slip sleeve shear pins 44. The sliding ring 36, which will be moving upwardly together with the body 11, will then engage the projecting lower ends of the down-pressure slips A and will shear the down-pressure slip shear pins 42. The springs 41 will then immediately move the down-pressure slips A upwardly relative to the slip sleeve 38, placing them in engagement with the casing.

The sliding ring 36 then engages the lower end of the slip sleeve 38 and as this slip sleeve is then stationary, further upward movement of the sliding ring 36 will be prevented. However, the lower end of the packer sleeve will continue to move upwardly with the body 11, shortening the distance between the sliding ring 36 and the stationary ring and consequently compressing the packer sleeve 33 into tight sealing position between the exterior of the body 11 and the interior of the casing.

When this packer sleeve 33 has been fully compressed, the latch ring 37 in the sliding ring 36 will engage the proper latch groove 35a in the body 11 and latch the packer sleeve in compressed sealing position. At the same time the latch ring 46 in the lower end of the slip sleeve 38 will engage the proper latch groove 36a in the body 11 and latch the slip sleeve from upward movement relative to the body 11. It is obvious that at this time the parts of the packer or retainer will be in the positions shown in Figure 3 with the slips in firm gripping engagement with the casing and with the packer sleeve 33 compressed and forming a seal between the exterior of the body 11 and the casing.

It is obvious from the previous description and from the drawings that any up-pressure built up in the casing below the retainer or packer will tend to more tightly press the up-pressure slips into contact with the casing due to the inclined surfaces of the slip sockets. It is likewise apparent that any considerable pressures built up in the casing above the packer or retainer will tend to more tightly press the down-pressure slips into contact with the casing. Therefore, the packer will resist dislodgement either from pressures above or pressures below. It will be noticed that the down-pressure slips are provided with downwardly extending wickers and that the up-pressure slips are provided with upwardly directed wickers for gripping purposes.

We wish to call attention at this time to Figures 5 and 6 of the drawings wherein we show a modified form of hydraulic medium for tripping the up-pressure slips. In Figures 5 and 6 we show an individual cylinder and piston for each up-pressure slip instead of an annular piston which engages all of the slips. Reference being had to these figures, it will be seen that head 57 is formed with a vertical cylinder 57a in vertical alignment with each up-pressure slip. A piston 57b is mounted in each cylinder 57a so that when fluid pressure is created through the tubing 49, this pressure will bear against the upper ends of the pistons 57b forcing them downwardly. This downward movement shears the pins of the up-pressure slips and trips the slips in the same manner as does the annular piston shown in the other figures of the drawings.

After the packer or retainer has been fully set as previously described, fluid pressure is again created in the interior of the body 11 through the tubing 49. This pressure is considerably more than the fluid pressure first created and is sufficient to shear the pin 24a connecting the sleeve 24 to the body 11 and is also sufficient to shear the pin 30 which connects the trunnion 29 to the valve stem head 16a. The sleeve 24 will then drop to an ineffective position within the lower chamber 20 where it will be held in such ineffective position by radial ribs 20a in such chamber. The moment that the sleeve 24 is disconnected from the body 11 and from the valve stem 16, the trip ball 27 becomes ineffective to prevent the passage downwardly though the body 11 to the valve port 12. Likewise the valve 15 is then free to seat on the seat 14. The device is then ready for cementing or repressuring operations.

In cementing, cement slurry may be pumped downwardly through the running-in tubing 49, thence through the body 11 opening the valve 15 and discharging into the casing below the packer or retainer 10. In most instances, the casing is perforated below the packer or retainer 10 so that the cement may discharge outwardly through these perforations and upwardly around the casing to effect a seal between it and the wall of the hole. After the cementing operation has been completed, the back pressure of the cement will close the valve 15 which acts to prevent the cement from passing upwardly into the body 11 and into the casing or tubing above the body. When the cementing operation has been completed, the running-in tubing 49 may be disconnected from the body 11 due to the left-hand screw connection between the two. The running-in tubing may then be pulled from the hole. We may prefer to use in connection with this cement retainer or packer a circulating jar of any preferred type or design.

If, for any reason, it is desired to use this device as a bridge plug to prevent the passage of fluid either upwardly through the casing or downwardly therethrough, a bridge ball 51 is provided. This ball may be dropped through the running-in tubing 49 so that it will seat on the bridging valve seat 23. This will prevent fluid from being pumped downwardly through the casing past the packer 10 or upwardly through the casing past the packer 10.

From the foregoing it is obvious that we have provided a very efficient cement retainer which may be set in a casing with a minimum of operation and which will resist dislodgement either by pressures in the casing above it or by pressures in the casing below it. We desire to point out here that the device has many uses and may be employed not only in various kinds of cementing operations but may likewise be used as a bridge plug or packer.

Another use to which the device may be put

is that of repressuring oil sands. In such use, the packer is set in a casing which taps the oil sands to be repressured just above the perforated section of the casing. Gas under high pressure is then forced downwardly through the running-in tubing 49 so that it will discharge through the port 12 by opening the back pressure valve 14. The gas will then pass into the oil sands through the perforated section of the casing raising the pressure therein and driving the oil into adjoining wells which also tap the sands.

While we have shown the preferred form of our device, it is to be understood that various changes may be made in its construction and in the combination of its parts 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. An apparatus of the character described comprising a hollow body adapted to be secured to the lower end of a string of tubing and lowered into a well casing, slips mounted on said member, means capable of being released connecting said slips to said member and maintaining them in an ineffective position, hydraulically actuated means incorporated in said body and operative to release said means and thereby release said slips so that they may move to an effective position.

2. An apparatus of the character described comprising a member to be secured to the lower end of a string of tubing and slips mounted on said member, cooperating means on the slips and member whereby relative axial movement between the slips and said member will cause said slips to move radially outward, means capable of being sheared connecting said slips to said member and maintaining them in an ineffective position, hydraulically actuated means incorporated in said body and operative to shear said means and release said slips to permit them to move axially relative to said member to an effective position.

3. An apparatus of the character described comprising a hollow member to be secured to the lower end of a string of tubing, slips mounted on said member, cooperative means on the slips and member whereby relative axial movement between the slips and said member will move said slips radially outward, shear means capable of being sheared connecting said slips to said member and maintaining them in an ineffective position, spring means constantly tending to move said slips to an effective position and hydraulically actuated means carried by said member operative to shear said shear means and release said slips so that said spring means may move said slips axially relative to said member.

4. An apparatus of the character described comprising a member adapted to be detachably connected to the lower end of a string of tubing, said member having a passageway formed longitudinally therethrough and in communication with said tubing, a back pressure valve mounted in said member to control the passage of fluid through the lower end thereof, spring means constantly tending to maintain said valve closed, shear means normally maintaining said valve open and hydraulic pressure actuated means for shearing said shear means to release the valve so as to enable the same to close.

5. An apparatus of the character described comprising a member adapted to be connected to the lower end of a string of tubing and lowered thereby into a well casing, means carried by said member and operative to secure said member to the casing, said member having a fluid conducting passageway extending from its upper end through its lower end and in communication with the interior of said tubing, a valve carried by said member and capable of interrupting the upward flow of fluid through said passageway, means normally maintaining said valve in open position, and fluid pressure actuated means for rendering the last named means ineffective.

6. A device of the character described comprising a member to be detachably connected to the lower end of a string of tubing, means carried by said member and operative to secure said member in position within a well casing, said member being hollow whereby fluid discharged therein through said tubing may pass downwardly through said member, a spring pressed valve adapted to interrupt the flow of fluid upwardly through the lower end of said member, said valve constantly tending to seat, holding means normally holding said valve in open position, and fluid pressure actuated means for rendering said holding means ineffective and permitting said valve to close.

7. A device of the character described comprising a hollow member adapted to be connected to the lower end of a string of tubing, slips mounted on said member, cooperative means on said slips and member whereby relative axial movement between slips and member will cause said slips to move radially outward with respect to said member, shear means connecting said slips to said member in ineffective positions, a back-pressure valve carried by said member capable of preventing the flow of fluid upwardly through the lower end thereof, said valve constantly tending to seat, shear means normally holding said valve in open position, hydraulically actuated means for shearing said shear means and releasing said valve so that the same may close, and hydraulically actuated means for shearing said shear means and releasing said slips so that the same may move axially relative to said member, the last named hydraulic means requiring lesser hydraulic pressure to release said slips than the pressure required to release said valve.

8. An apparatus of the character described comprising a hollow member to be connected to the lower end of a string of tubing, a first set of slips mounted on said member, a second set of slips mounted on said member, cooperative means between said slips and on said member whereby relative axial movement between said member and said slips will move said slips radially outward, shear means connecting said slips to said member in ineffective positions, hydraulically actuated means operative to shear said means of the first set of slips so that they may move to an effective position, and means operative upon subsequent movement of said member upwardly to shear the shear means of the second named slips to release the same.

9. An apparatus of the character described comprising a hollow member adapted to be detachably connected to the lower end of a string of tubing, a first set of slips mounted on said member and a second set of slips mounted on said member, spring means associated with said means and said member and constantly tending to move said slips axially relative to said slips to move radially outward upon relative movement between the same and said member, shear means

connecting said slips to said member, hydraulically actuated means for shearing said shear means of the first set of slips, and means on said member and operative upon upward movement of said member subsequent to the shearing of the shear means on the first set of slips to engage the second set of slips and shear the shear means thereof to release the same.

10. An apparatus of the character described comprising a hollow member to be connected to the lower end of a string of tubing, a first set of slips mounted on said member, a second set of slips mounted on said member, cooperative means between said slips and on said member whereby relative axial movement between said member and said slips will move said slips radially outward, shear means connecting said slips to said member in ineffective positions, hydraulically actuated means operated to shear said means of the first set of slips so that they may move to an effective position, and means operative upon subsequent movement of said member upwardly to shear the shear means of the second named slips to release the same, the lower end of said member being formed with a valve port, a valve cooperating with said port to close the same, means normally maintaining said valve in open position and hydraulicaly actuated means for rendering said means ineffective.

11. An apparatus of the character described comprising a hollow cylindrical member adapted to be connected at its upper end to the lower end of a string of tubing and lowered thereby into a string of well casing, a set of slips at the exterior of said member, coinciding angular faces on said slips and member whereby relative axial movement between said member and slips will move said slips radially outward into engagement with the casing, means for detachably connecting said slips to the member to maintain the slips in ineffective position and hydraulic pressure actuated means for detaching said slips from the member, and spring means associated with the slips and member constantly tending to cause relative axial movement between the slips and said member thereby causing said slips to move radially outward into engagement with the casing.

12. An apparatus of the character described comprising a hollow cylindrical member adapted to be connected at its upper end to the lower end of a string of tubing and lowered thereby into a string of well casing, a set of slips at the exterior of said member, coinciding angular faces on said slips and member whereby relative axial movement between said member and slips will move said slips radially outward into engagement with the casing, means for detachably connecting said slips to the member to maintain the slips in ineffective position and hydraulic pressure actuated means incorporated in said member for detaching said slips from the member, and spring means associated with the slips and member constantly tending to cause relative axial movement between the slips and said member thereby causing said slips to move radially outward into engagement with the casing, normally ineffective packing means mounted on the member and capable of being expanded into packing engagement with the interior of the well casing subsequent to the releasing of said slips.

13. An apparatus of the character described comprising a hollow cylindrical member adapted to be connected at its upper end to the lower end of a string of tubing and lowered thereby into a string of well casing, a set of slips at the exterior of said member, coinciding angular faces on said slips and member whereby relative axial movement between said member and slips will move said slips radially outward into engagement with the casing, means for detachably connecting said slips to the member to maintain the slips in ineffective position and hydraulically actuated means incorporated in said member for detaching said slips from the member, and spring means associated with the slips and member constantly tending to cause relative axial movement between the slips and said member thereby causing said slips to move radially outward into engagement with the casing, and a packing sleeve mounted on the member and means causing axial compression of said packing sleeve to expand the same into packing position upon upward movement of said member after said slips have been released.

14. An apparatus of the character described comprising a hollow body adapted to be lowered into a cased well bore, first casing gripping means mounted at the exterior of the body and normally retained in an ineffective position, a piston carried by the body and operatively associated with said first gripping means and operative in response to fluid pressure built up in said body to move said first gripping means to operative position, second gripping means carried by the body and normally held in an ineffective position, means carried by the body and associated with said second gripping means to cause the same to move to an effective position upon axial movement of the body in the casing subsequent to the first gripping means being moved to an effective position, and means carried by the body and associated with both of said gripping means to move both of said gripping means radially outward with respect to the casing upon axial movement of the body in the casing.

15. An apparatus of the character described comprising a hollow body adapted to be lowered into a well bore, up-pressure slips carried by the body, complemental means formed on said slips and body whereby relative longitudinal movement between the body and slips will move said slips radially outward with respect to said body, a piston carried by the body and operatively associated with the slips and operative in response to fluid pressure built up in a body to move said up-pressure slips longitudinally relative to the body into operative position, said body being axially moved thereafter to set said up-pressure slips, down-pressure slips carried by the body, complemental means formed on said down-pressure slips and on the body whereby relative longitudinal movement between the body and said down-pressure slips will move the latter radially outward with respect to the body, means normally retaining said down-pressure slips in an ineffective position, said means being capable of being released by axial movement of the body to set said up-pressure slips, radial movement of the down-pressure slips with respect to the body being effected by axial movement of the body in a direction opposite that required to set the up-pressure slips.

16. An apparatus of the character described comprising a hollow body adapted to be lowered into a well bore at the end of a drill stem, a plurality of slips arranged about the perimeter of the body, shear means normally holding said slips in an ineffective position, complemental means on the slips and body whereby movement of said slips longitudinally relative to the body will move said slips radially outward with respect to the body, a cylinder formed in the body, a piston therein, said piston being operatively associated

with the slips to move the same relative to the body in response to fluid pressure built up within the body.

17. An apparatus of the character described comprising a hollow body adapted to be lowered into a well bore at the end of a drill stem, a plurality of slips arranged about the perimeter of the body, shear means normally holding said slips in an ineffective position, complemental means on the slips and body whereby movement of said slips longitudinal relative to the body will move said slips radially outward with respect to the body, a cylinder formed in the body, a piston therein, said piston being operatively associated with the slips to move the same relative to the body in response to fluid pressure built up within the body, said piston and cylinder being of annular shape, and a packing member carried by the body and capable of being expanded subsequent to the setting of the slips.

18. An apparatus of the character described comprising a hollow body adapted to be secured to the lower end of a string of tubing and lowered into a well casing, gripping means carried by said member, means normally holding said gripping means in an ineffective position, hydraulically actuated means incorporated in said body and operative to release said casing gripping means so that the same may assume an effective position, said body having a fluid passageway formed therethrough, a valve seat formed in said passageway, and a valve member adapted to be positioned after the said body has been positioned in a well casing to seat on said seat and prevent the flow of fluid downwardly through said passageway.

19. An apparatus of the character described comprising a hollow body adapted to be secured to the lower end of a string of tubing and lowered into a well casing, a plurality of slips mounted on said body at the exterior thereof, means capable of being released connecting said slips to said body and maintaining them in an ineffective position, complemental means on said slips and said body whereby relative movement between the slips and said body will cause said slips to move radially outward wit respect to the body, hydraulically actuated means incorporated in said body and operative to release said means and thereby release said slips so that they may move relative to the body, said body having a fluid conducting passageway formed longitudinally therethrough, a valve seat in said passageway, a valve member adapted to be positioned after said body has been lowered into a well casing to seat on said seat and prevent the flow of fluid downwardly through said passageway.

20. An apparatus of the character described comprising a hollow body adapted to be lowered into a cased well bore, first casing gripping means mounted at the exterior of the body and normally retained in an ineffective position, a piston carried by the body and operatively associated with said first gripping means and operative in response to fluid pressure built up in said body to move said first gripping means to operative position, second gripping means carried by the body and normally held in an ineffective position, means carried by the body and associated with said second gripping means to cause the same to move to an effective position upon axial movement of the body in the casing subsequent to the first gripping means being moved to an effective position, and means carried by the body and associated with both of said gripping means to move both of said gripping means radially outward with respect to the casing upon axial movement of the body in the casing, and normally ineffective packing means carried by the body, said packing means being adapted to become effective to form a seal between the body and the casing during the axial movement of the body, expanding said first-named gripping means and moving said second-named gripping means to effective position.

21. An apparatus of the character described comprising a hollow body adapted to be lowered into a well bore, up-pressure slips carried by the body, complemental means formed on said slips and body whereby relative longitudinal movement between the body and slips will move said slips radially outward with respect to said body, a piston carried by the body and operatively associated with the slips and operative in response to fluid pressure built up in a body to move said up-pressure slips longitudinally relative to the body into operative position, said body being axially moved thereafter to set said up-pressure slips, down-pressure slips carried by the body, complemental means formed on said down-pressure slips and on the body whereby relative longitudinal movement between the body and said down-pressure slips will move the latter radially outward with respect to the body, means normally retaining said down-pressure slips in an ineffective position, said means being capable of being released by axial movement of the body to set said up-pressure slips, radial movement of the down-pressure slips with respect to the body being effected by axial movement of the body in a direction opposite that required to set the up-pressure slips, and normally ineffective packing means carried by the body capable of being rendered effective to create a seal between the exterior of the body and the well casing upon the axial movement of the body utilized to set said up-pressure slips.

22. An apparatus of the character described comprising a hollow body adapted to be lowered into a cased well bore at the end of a string of tubing, a plurality of slips arranged about the perimeter of the body, means normally holding said slips in an ineffective position, complemental means on the slips and body whereby movement of said slips longitudinally relative to the body will move said slips radially outward with respect to the body, a cylinder formed in the body, a piston therein, said piston being operatively associated with the slips to release said means normally holding said slips in an ineffective position in response to fluid pressure built up within the body, said complemental means acting upon the release of the slips to position the same in an effective position whereupon upward movement of the body will set said slips, a normally ineffective packing member carried by the body and adapted to be rendered effective to form a seal between the body and the casing upon the axial upward movement of the body utilized to set said slips.

23. A device of the character described including a body adapted to communicate with and to be connected to the lower end of a string of tubing and lowered into a well bore, a member slidably mounted on the exterior of said body for movement longitudinally thereof, slips arranged about the exterior of said member, complementary means on said slips and said member whereby relative movement therebetween in one direction will move said slips radially outward, an expan-

sible chamber supported by said body and communicating therewith, said member being responsive to fluid pressure built up in said chamber and body by pressure of the drilling fluid within the string of tubing to move longitudinally relative to the body and slips to move the latter radially outward.

24. A device of the character described including a rigid body adapted to communicate with and to be connected to the lower end of a string of running-in tubing and lowered into a well bore, a cone member slidably mounted on the exterior of said body and capable of movement longitudinally with respect thereto, segmental slips arranged at the exterior of said cone member and having cone faces complementary to the conical face of said cone member, whereby longitudinal movement of the cone member relative to the slips will move the latter radially outward, said cone member being responsive to fluid pressure built up in the body by the pressure of the drilling fluid within the running-in tubing to move longitudinally relative thereto and to the slips to move the latter radially outward.

25. A device of the character described comprising a body adapted to be connected to the lower end of a string of tubing and lowered into a well bore, tapered means presenting oppositely inclined external surfaces on the exterior of said body, releasably retracted slip means relatively movable with respect to said tapered means, and said slip means having surfaces complementary to those of said tapered means whereby relative movement therebetween will urge said slip means outward, an expansible chamber for actuating one of said means supported by said body in communication with said tubing, one of said means being movable into engagement with the wall of said bore upon expansion of said chamber and means for directing fluid pressure from within said tubing to expand said chamber to effect relative movement between said tapered means and said slip means to move the latter radially outward.

26. A device of the character described including a body adapted to communicate with and to be connected to the lower end of a string of tubing and lowered into a well bore, tapered means mounted on the exterior of said body, slip means having complementary tapered surfaces arranged about the exterior of said tapered means whereby relative movement therebetween in one direction will move said slip means radially outward, shear means holding said slip means in normally retracted position, an expansible chamber for actuating one of said means supported by said body and communicating therewith, and means for directing fluid pressure from within said tubing into said expansible chamber to fracture said shear means and move said slip means outward.

27. An apparatus of the character described comprising a body having a passage continuous throughout its length adapted to be lowered into a well bore, gripping means mounted on the exterior of the body longitudinally and radially movable with respect thereto, means normally retaining said gripping means in an ineffective position, a piston carried by the body for actuating said gripping means, the passage in the body being unobstructed to permit fluid to pass therethrough, and means for directing fluid pressure built up in said body to said piston to move said gripping means to operative position.

28. An apparatus of the character described comprising a hollow body having an unobstructed passage continuous throughout its length adapted to be lowered into a well bore, gripping means mounted on the exterior of the body longitudinally and radially movable with respect thereto, means normally retaining said gripping means in an ineffective position, a piston carried by said body and having its active surface offset from the axis of said body, said piston being operatively associated with said gripping means and operative in response to fluid pressure built up in said body to move said gripping means to operative position, and mean for directing fluid under pressure from said body to said piston.

29. An apparatus of the character described comprising a hollow body having a continuous passage extending therethrough adapted to be lowered into a well bore, a plurality of slips carried by the body, complemental means formed on the slips and body whereby relative longitudinal movement between the body and slips will move said slips radially outward with respect to said body, a piston carried by said body having its active surface radially spaced from the axis of said body and operatively associated with the slips and operative in response to fluid pressure built up in the body to move said slips longitudinally relative to the body, and means for directing fluid under pressure from said body to said piston.

30. An apparatus of the character described comprising a body having a continuous passage extending therethrough adapted to be lowered into a well bore, a plurality of slips carried by the body, complemental means formed on the slips and body whereby relative longitudinal movement between the body and slips will move said slips radially outward with respect to said body, a piston carried by the body for actuating said slips, the passage in the body being unobstructed to permit fluid to pass therethrough, and means for directing fluid under pressure built up in said body to said piston to move said slips longitudinally relative to the body.

31. An apparatus of the character described comprising a hollow body having a continuous passage extending therethrough adapted to be secured to the lower end of a string of tubing and lowered into a well casing, releasably retracted slip means adapted for radial movement mounted on said body, normally retracted packer means adapted for radial movement mounted on said body in cooperation with said slip means and means for building up fluid pressure within said body for actuation of one of said means adapted for radial movement.

32. An apparatus of the character described comprising a hollow body adapted to be secured to the lower end of a running-in line and lowered into a well bore, slips mounted on said body in normally retracted position and longitudinally and radially movable with respect thereto, a fluid actuated annular member movably carried by said body for actuation of said slips, and means for directing fluid under pressure from said body to a surface of said member to move said member and actuate said slips.

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