Cement Retainer and Bridge Plug for Well Casings

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Fig. 3.

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CEMENT RETAINER AND BRIDGE PLUG FOR WELL CASINGS

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This invention relates to devices commonly termed "cement retainers" and "bridge plugs" which are utilized in packing off, cementing and other analogous operations in deep oil wells.

It is the principal object of my present invention to provide an improved and simplified apparatus of the character referred to which may be expeditiously run in the casing of a deep oil well bore and set at a desired point therein, and efficiently employed in bridging, cementing and analogous operations.

In practicing my invention, I provide a packer body which may be detachably connected to the lower end of a string of tubing and run in the well bore. This packer body is fitted with operative slips for firmly anchoring it to the surrounding casing so that it will resist dislodgement either from pressures above or pressure below it in the casing. The packer body is also fitted with an expandable packing or sealing element for sealing off the space between the exterior of the body 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 bridging the casing and in cementing through the casing at any level above the bottom of the bore. The tool may also be used in various other operations, such as repressuring, if so desired.

One form which the invention may assume is exemplified in the following description and illustrated by way of example in the accompanying drawings, in which:

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

Fig. 2 is a view similar to Fig. 1 with the exception that the up-pressure slips are shown as tripped and ready for firm setting.

Fig. 3 is a view similar to Fig. 2 but showing the parts in the position they assume when the device has been completely set in the casing.

Referring more particularly to the accompanying drawings, 10 indicates a packer or what is commonly known as a cement retainer and bridge plug. This device is cylindrical in cross section and of an overall external diameter 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 con-centric 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 constantly 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.

For the purpose of running the body 11 into the casing, the upper end of the body is interiorly threaded with a left-hand female thread to receive a left-hand male thread formed on the lower end of a tubular sub 11a, which may be threadedly connected to the lower end of running in tubing 49. The purpose of the left-hand thread is to enable the sub 11a and the tubing 49 to be unscrewed from the body 11 after the tool has been tripped and set in the casing.

It will be noticed that the body 11 is hollow and cylindrical 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 being hereinafter described.

Slidably fitting the intermediate bore 22 is a trip sleeve 24 which has a passageway 25 formed coaxially 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 Fig. 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 15a by means of a shear pin 30.

When the packer is assembled for running-in, it is desirable to hold the valve 15 open so that no fluid may pass freely upwardly through the body 11. To maintain the valve in this open position, I secure the sleeve 24 to the body 11 by a shear pin 33 which is sheared as will be described 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 surrounding 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 annular groove 38 into which is fitted a spring latch ring 37. When the packing sleeve 33 is compressed into sealing position as shown in Fig. 15, this latch ring engages annular latch grooves 36b on the body 11 to latch the sleeve 33 against longitudinal expansion.

Referring particularly to Figs. 1 to 3, inclusive, it will be seen that above the packer sleeve 33 the body 11 is provided with a lower cone 38. This lower cone is bored so that it is capable of reciprocation on the exterior surface of the body 11. The exterior of the lower cone 38 is formed with a frusto-conical face with its smaller diameter lowermost.

Arranged about the exterior of the conical surface of the lower cone is a set of down-pressure slips A which are segmental in form and the interior faces of which are frusto-conical to complement the cone with and be complementary to the conical face of the lower cone member 38. Obviously, any relative longitudinal movement of the cone 38 and slips A will be accompanied by radial movement of the slips relative to the body 11.

Referring to Fig. 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 A are arranged in their innermost position and that each is secured to the lower cone 38 by a shear pin 42.

When the lower cone 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 lower cone 38 is formed with an annular groove 48 which receives a spring latch ring 49. This latch ring is adapted to engage the annular latch grooves 36b formed about the exterior surface of the body 11 to latch the lower cone 38 in position on the body 11 when the tool has been run in the casing and set as will be described.

Reciprocally mounted on the body above the lower cone 38 is an upper cone member 50 which has a frusto-conical face 51 arranged with its smaller diameter uppermost. Arranged about the conical face 51 of the upper cone 50 is a set of up-pressure slips B which are likewise segmental and which are formed with an interior conical face coinciding with and complementary to the conical face 51 of the upper cone member 50.

The up-pressure slips B are each connected to the cone member 50 by a shear pin 53.

I desire to point out here that when the device is assembled for lowering into the well casing, the down-pressure set of slips A and the up-pressure sets of slips B are so connected by the shear pins 42 and 53 to the lower and upper cones that they will be in contracted position, and will not interfere with the lowering of the device into the well casing.

Secured on the sub 11a and positioned just above the upper end of the body 11 is an annular flange 11b of a diameter sufficient so that it will be engaged by the slips B in any attempt of the latter to move longitudinally upward relative to the body 11.

Referring more particularly to Fig. 1, it will be noticed that the lower cone member is formed with an upwardly extending annular cylinder 54 within which an annular piston 55, depending from the upper cone member 50, extends and is reciprocable. These telescoping parts of the lower cone forms an annular pressure chamber 56 between them and said packing rings 57 are provided and fitted to both the cylinder and the piston to prevent fluid leakage. This pressure chamber 56 communicates with the interior of the packer body 11 through suitable ports 58. It is intended that when fluid pressure be built up within the packer body 11, that this pressure be exerted in the pressure chamber 56, tending to move the cones 38 and 50 in opposite directions longitudinally of the packer body.

To produce this internal pressure in the packer body 11 the ball valve 21 is permitted to seat in the seat 20 of the sleeve 24, shutting off further circulation downwardly through the body 11. Fluid pressure may then be built up within the body 11, and which pressure will build up in the pressure chamber 56 through the ports 58. This pressure will be insufficient to shear the slips 44 connecting the lower cone to the body, but is sufficient to move the upper cone 50 upwardly against the body and to the lower cone. This movement will be resisted by engagement of the slips B with the flange 11b, but the pressure will be sufficient to shear the pins 53, detaching the slips B from the upper cone 50. Obviously, continued upward movement of the upper cone 50 on the body 11 and relative to the slips B will be accompanied by radial outward movement of the slips B until they tightly engage the casing as shown in Fig. 2.

The pump pressure in the body 11 is then relieved and an upward strain is taken on the running-in tubing 48. The moment that the body 11 commences to move upwardly, it will do so relative to the upper cone 50 due to the fact that the latter will be held stationary relative to the casing due to the contact of the slips B with the casing. This upward movement of the body 11 will continue until the upper end of the cylinder 54 engages the annular abutment on the upper cone 50 at the junction between the conical face and the piston 55. Thereafter continued upward movement will move the upper cone 50 sufficiently upward to tightly jam the slips B into the wall of the casing, at which time further upward movement of the upper cone 50 will be prevented.

As the body 11 continues to move upwardly, the strain will be sufficient to shear the pin 44, releasing the lower cone from the body 11. As this upward movement of the body 11 continues, the ring 36 at the upper end of the packing element 33 will engage the lower ends of the segmental slips A, moving them upwardly relative to the lower cone and shearing the pins 42. Obviously, further upward movement of the body 11 will move the slips into contact with the casing due to the complementary conical faces of the lower cone and the slips.

As the body 11 continues to move upwardly, the ring 36 will remain stationary because of being blocked from further upward movement by the slips, but the lower ring 34 of the packing element will continue to move upwardly with the body 11. This will shorten the distance between the sliding
ring 38 and the fixed ring 34, and consequently compress the packer sleeve 33 into tight contact with the casing and effect a seal between the exterior of the body 11 and the casing. The packer sleeve 33 will maintain this position thereafter due to the engagement of the latch ring 37 with the annular grooves 56, as illustrated in Fig. 3.

The device is then set and ready for further operation. Pump pressure is again built up within the device, and as the pin 32 is sheared, the sleeve 24 will move downwardly, which downward movement will be accompanied by shearing of the pin 36 connecting the sleeve 24 to the valve stem 16. This will release the valve stem and enable the sleeve 15 to seat on the seat 14. The sleeve 24 will drop to an ineffective position within the lower chamber 20 as illustrated in Fig. 3.

If the device is to be used in cementing, cement slurry may then be pumped downwardly through the running-in tubing 43, thence longitudinally through the body 11, opening the valve 15 and discharging through the port 12. In most instances the casing is perforated below the device so that the cement may discharge outwardly through the casing.

After the cementing operation has been completed, the back pressure of the cement and the spring 19 will close the back pressure valve 16 and prevent the cement from passing upwardly through the body 11. The seal effected by the sleeve 33 will prevent the cement from passing upwardly around the body between it and the casing.

Upon completion of the cementing operation, the running-in tubing 45 may be disconnected from the body 11 due to the left-hand screw connection between the sub 11a and the body 11. I may prefer to use in connection with this device a suitable circulating jar of any preferred type or design.

If it is desired to use the apparatus here disclosed as a bridge plug, a ball 60 shown in dotted lines in Fig. 3 is dropped through the tubing after the device is set as previously described. This bridging ball 60 will seat on the seat 23 and prevent fluid from being pumped downwardly through the body 11. The back pressure valve 16 will prevent fluid from passing upwardly through the body so consequently an effective bridge will be provided.

All of the major parts of the device here shown are constructed preferably of cast iron or other material which can be readily drilled out so that after the device's usefulness has ended, it may be drilled up so as to leave the casing unobstructed.

Although the device has been described for use in bridging a casing and for cementing operations, it is obvious that it has various other uses and that it may be put to other uses without departing from the present invention.

While I have shown the preferred form of my invention, it is to be understood that various changes may be made in its construction by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

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

1. A device of the character described including a cylindrical rigid body member adapted to communicate with and to be connected to the lower end of a string of tubing and lowered into a well bore, a cone member slidably mounted on the exterior of said body and having a conical face, segmental slips arranged about the outer edge of said conical member and having an interior conical face complementary to the conical face of said member, shear means connecting said slips to said cone member with the slips in a contracted position, said cone member being responsive to fluid pressure built up in said body by the pressure of the drilling fluid within the string of tubing to move longitudinally of the body in a direction causing said complementary conical faces to move said slips radially outward with respect to the body, and means on the body preventing said slips from moving longitudinally relative thereto in the direction of movement of said cone member.

2. A device of the character described including a hollow cylindrical body adapted to be connected to the lower end of the string of running-in tubing and lowered into a well bore, a cylindrical cone member slidably mounted on the exterior of the body and having a cone face with its smaller diameter uppermost, a plurality of segmental slips arranged about the exterior of said cone face, fragile means connecting said slips to said cone member and normally securing the slips in a retracted position, an annular abutment rigid with respect to the body and preventing upward movement of said slips relative to the body, said cone member being responsive to fluid pressure built up in said body by the pressure of the drilling fluid within the running-in tubing to move longitudinally upward with respect to the body and the slips and disrupt said fragile means and move said slips radially outward with respect to the body.

3. A device of the character described including a hollow cylindrical body adapted to be connected to the lower end of a string of running-in tubing and lowered into a well bore, a cylindrical cone member slidably mounted on the exterior of the body and having a cone face with its smaller diameter uppermost, a plurality of segmental slips arranged about the exterior of said cone face, fragile means connecting said slips to said cone member and normally securing the slips in a retracted position, an annular abutment rigid with respect to the body and preventing upward movement of said slips relative to the body, said cone member being responsive to fluid pressure built up in said body by the pressure of the drilling fluid within the running-in tubing to move longitudinally upward with respect to the body and the slips and disrupt said fragile means and move said slips radially outward with respect to the body.

4. A device of the character described comprising a hollow cylindrical body adapted to be secured to the lower end of a string of running-in tubing and lowered into a well bore, a first cone member slidably mounted on the exterior of the body and having a conical face, segmental slips arranged about the exterior of said conical face and having faces complementary to said conical face, whereby relative longitudinal movement between said slips and said first cone member in one direction will result in radial outward movement of said slips, a second cone member having a conical face arranged in opposed relation to the conical face of the first cone member, segmental slips arranged about the exterior of said second cone member and fragile means connecting said slips to said second cone member, whereby relative movement of said second cone member will result in said slips moving outwardly with respect to said second cone member.
4. the second conical member and having conical faces complementary to the conical face thereon, one of said cone members being responsive to fluid pressure built up in said body to move longitudinally thereof and move its cooperative slips radially outward into engaging position, and means responsive to longitudinal movement of the body after operation of the first cone member to move the slips associated with the second cone member longitudinally relative thereto in a direction moving the same radially outward with respect to the body.

5. A device of the character described comprising a hollow cylindrical body adapted to be secured to the lower end of a string of running-in tubing and lowered into a well bore, a first cone member slidably mounted on the exterior of the body and having a conical face, segmental slips arranged about the exterior of said conical face, and having faces complementary to said conical face, whereby relative longitudinal movement between said slips and said first cone member in one direction will result in radial outward movement of said slips, a second cone member having a conical face arranged in opposed relation to the conical face of the first cone member, segmental slips arranged about the exterior of the second conical member and having conical faces complementary to the conical face thereon, one of said cone members being responsive to fluid pressure built up in said body to move longitudinally thereof and move its cooperative slips radially outward into engaging position, an annular abutment on said body adapted to engage the slips of the second cone member to move the same longitudinally with respect to the second cone after the first cone member has been operated whereby to move said slips radially outward into engaging position.

6. A device of the character described comprising a hollow cylindrical body adapted to be secured to the lower end of a string of running-in tubing and lowered into a well bore, a first cone member slidably mounted on the exterior of the body and having a conical face, segmental slips arranged about the exterior of said conical face, and having faces complementary to said conical face, whereby relative longitudinal movement between said slips and said first cone member in one direction will result in radial outward movement of said slips, a second cone member having a conical face arranged in opposed relation to the conical face of the first cone member, segmental slips arranged about the exterior of the second conical member and having conical faces complementary to the conical face thereon, one of said cone members being responsive to fluid pressure built up in said body to move longitudinally thereof and move its cooperative slips radially outward into engaging position, a packer sleeve surrounding said body and fixed thereto at one end, the other end being adjacent the slips associated with the second cone member the casing, said second cone member being adapted to engage said slips when said body is moved longitudinally with respect to the first cone member after the same has been operated to move said slips relative to said second cone member to cause the same to move radially outward and grip the casing, said packer sleeve being longitudinally compressed upon continued longitudinal movement of the body after said latter named slips have been placed in engaging position.

7. In a device of the character described, a hollow cylindrical body adapted to be connected to the lower end of a string of running-in tubing and lowered into a well casing, an upper cone member reciprocally mounted on the body and having a conical face with its smallest diameter uppermost, a set of segmental slips arranged about said upper cone member and having conical faces coinciding with the conical face thereof, means on said body for preventing upward movement of the slips relative thereto, a lower cone member attached to said body below said upper cone member and having a conical face opposed to that of the upper cone member, means whereby fluid pressure exerted between the contiguous ends of said cone members will move said upper cone member upwardly relative to the body and move its associated slips radially outward into engagement with the casing, a set of segmental slips arranged about the conical face of the lower cone member and having conical faces complementary thereto, an annular abutment on the body below the lower cone member and adapted to engage the slips of the lower cone member upon continued upward movement of the body member and to move the same upwardly relative to said lower cone member into engaging position with respect to the casing.

8. In a device of the character described, a hollow cylindrical body adapted to be connected to the lower end of a string of running-in tubing and lowered into a well casing, an upper cone member reciprocally mounted on the body and having a conical face with its smaller diameter uppermost, a set of segmental slips arranged about said upper cone member and having conical faces coinciding with the conical face thereof, means on said body for preventing upward movement of the slips relative thereto, a lower cone member attached to said body below said upper cone member and having a conical face opposed to that of the upper cone member, means whereby fluid pressure exerted between the contiguous ends of said cone members will move said upper cone member upwardly relative to the body and move its associated slips radially outward into engagement with the casing, a set of segmental slips arranged about the conical face of the lower cone member and having conical faces complementary thereto, said lower cone member being adapted to be prevented from upward movement by said upper cone member after a predetermined amount of upward movement of the body member and to become detached from the body member upon continued upward movement thereof, an annular abutment on the body below the lower cone member and adapted to engage the slips of the lower cone member upon continued upward movement of the body member and to move the same vertically with respect to the lower cone member into engaging position with the casing, said continued upward movement of the body member resulting in axial compression and radial expansion of said packer sleeve.

9. A device of the character described including a body adapted to be connected to the lower end of a string of tubing and lowered into a well.
bore, a conical 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 members whereby relative movement therebetween in one direction will move said slips laterally outward, said member being responsive to fluid pressure built up in said body by pressure of the drilling fluid within the string of tubing to move said member longitudinally relative to the body and slips to move the latter laterally outward, a second cone member having a conical face arranged in opposed relation to the conical face of the first cone member, slips arranged about the exterior of the second conical member and having conical faces complementary to the conical face thereon, a packer sleeve surrounding said body and fixed thereto at one end, the other end being adjacent the slips associated with the second cone member, said second mentioned end being adapted to engage said slips when said body is moved longitudinally with respect to the first cone member; after the same has been operated to move said slips relative to said second cone member to cause the same to move radially outward and grip the casing, said packer slip being longitudinally expanded upon continued longitudinal movement of the body after said latter named slips have been placed in engaging position.

10. 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, spaced slip means with oppositely directed serrations carried by said body and adapted for radial movement, fluid actuated means carried by said body intermediate said slip means and actuable to actuate said slip means, and means for directing fluid pressure from said body to said fluid actuated means to actuate the same.

11. 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, slip means slidably mounted on the exterior of said body, tapered means carried by said body and said slip means whereby relative movement therebetween will move said slip means radially outward, an expandable chamber being responsive to fluid pressure built up in said chamber and body to actuate said slip means.

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