April 9, 1940. R. C. BAKER ET AL 2,196,653

CEMENTING, WASHING, AND ACIDIZING RETAINER FOR PERFORATED WELL CASINGS

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Fig. 2.

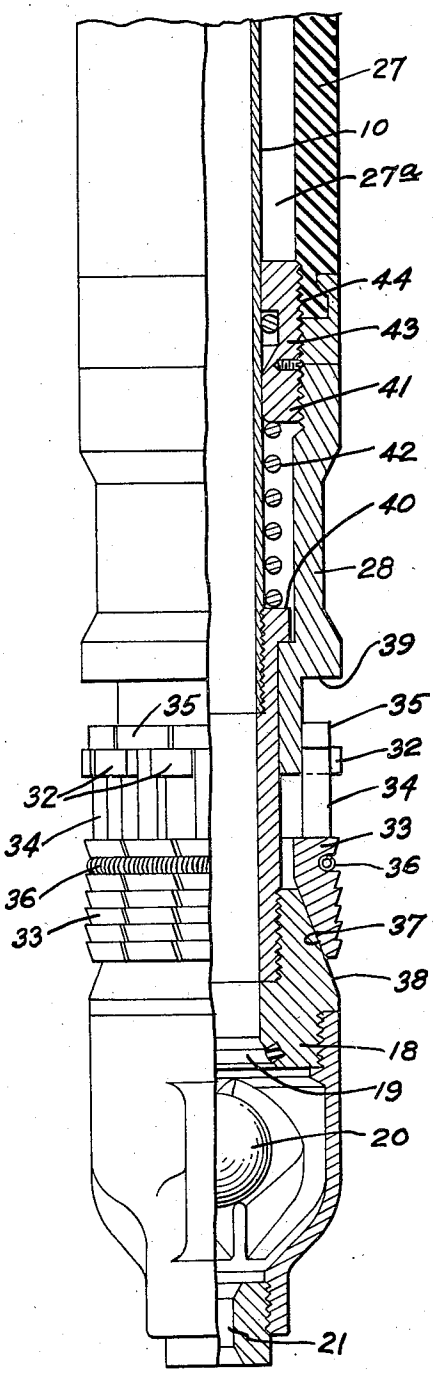
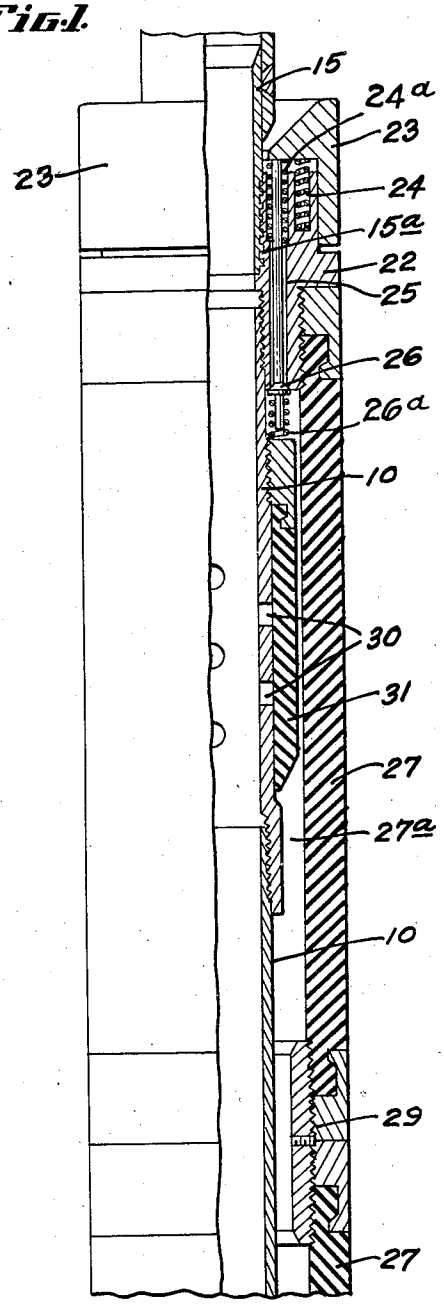


Fig. 1.



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Fig 4.

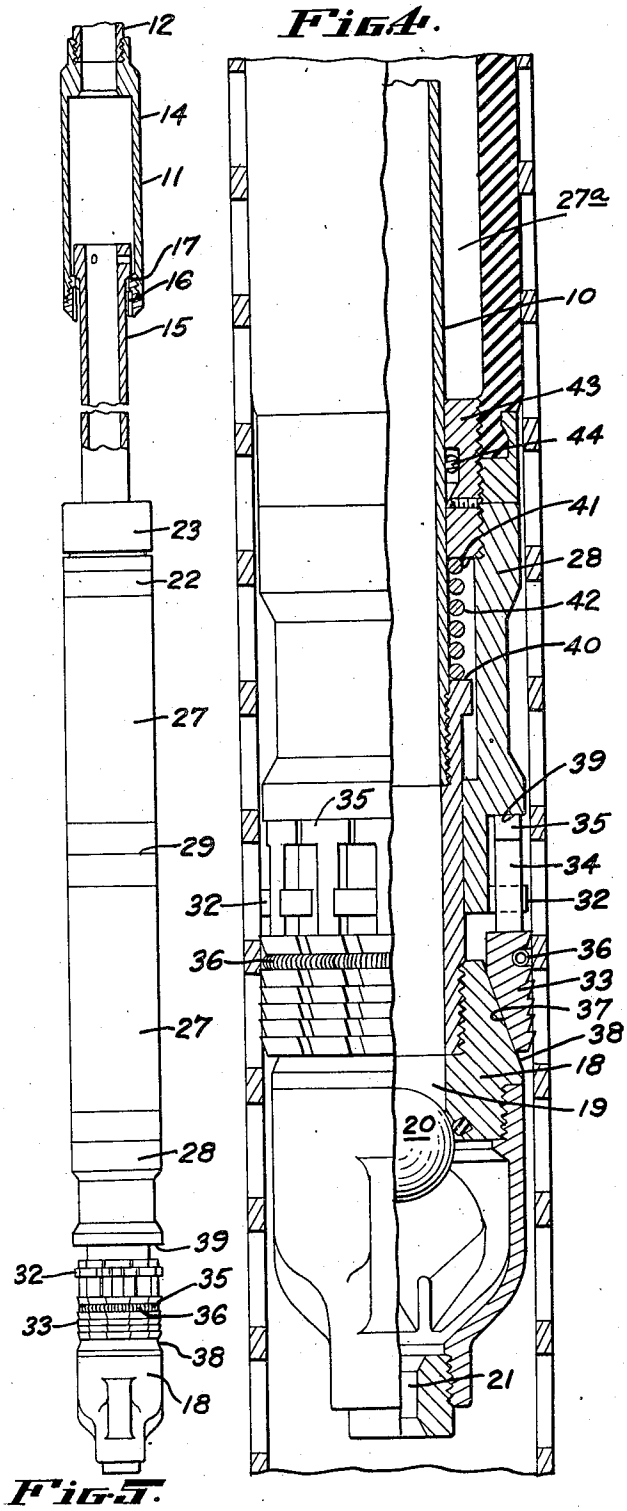
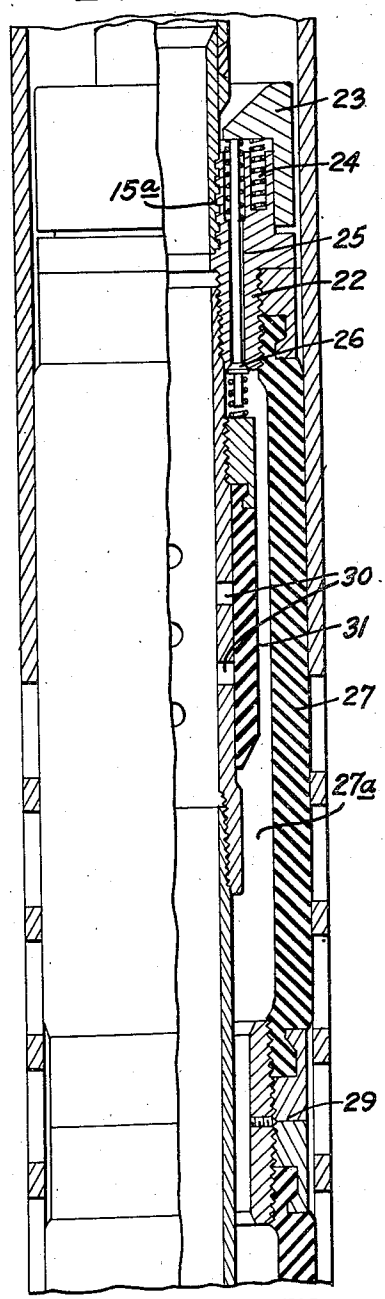


Fig 7.

Fig 3.



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Patented Apr. 9, 1940 2,196,653

UNITED STATES PATENT OFFICE

2,196,653

CEMENTING, WASHING, AND ACIDIZING RETAINER FOR PERFORATED WELL CASINGS

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Application May 5, 1939, Serial No. 271,939

11 Claims. (Cl. 166—13)

This invention relates generally to packers for oil wells, and specifically to the type of packers known as retainers for cementing, washing, acidizing and analogous operations in a well bore.

It is the principal object of our present invention to provide an improved packer capable of use in blanking off a desired length of perforated casing and then capable of use in cementing, washing or acidizing operations, and which may be entirely removed from the hole after it has performed its function.

In practicing our invention, we provide an elongated packer body which may be made up in a sectional form so that it may blank off any desired length of perforated casing into which it is lowered. This packer body is capable of expansion by fluid pressure into tight contact with the casing to blank the same off and to set slips for gripping the casing and anchoring the packer in place. After this operation, the packer may be used as a cement retainer for the purpose of cementing, washing, acidizing or analogous uses. Thereafter, through the medium of a simple operation, the packer may be contracted and the slips released and the entire packer removed from the hole at the end of the running in string of tubing.

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:

Figs. 1 and 2 are views of the upper and lower portions of a packer embodying the preferred form of my invention, shown in side by side relation for clearness, and disclosing the packer in the condition the parts assume when the device is to be lowered into or pulled from a well bore.

Figs. 3 and 4 are similar to Figs. 1 and 2 with the exception that the parts of the packer are shown in the condition they assume when the device has been set in a well casing for operation.

Fig. 5 is a view in side elevation of the entire apparatus embodying the invention, showing the packer in elevation and showing the circulating joint in central vertical section.

Referring more particularly to the accompanying drawings, we have there illustrated a packer or retainer capable of use in perforated or screen pipe for the purpose of cementing outside of the screen pipe and thereby blanking it off, or washing the outside of screen or perforated casing, or placing acid into the formation outside of the screen or perforated casing. We desire to point out here that this packer or retainer can be made in any desired length so as to simultaneously blank off any desired length of screen or perforated pipe.

Referring more particularly to Figs. 1 and 2 of the accompanying drawings, Fig. 1, of course, showing the upper half of the device and Fig. 2 the lower half, it will be seen that the device comprises an elongated center tube 10 of comparatively small diameter; that is, of a diameter which would coincide somewhat with the diameter of the running in tubing employed to run in the packer into the hole. On the upper end of this center tube 10 is fixed an upper head 22 which in turn is connected with a circulating joint 11 connected with the running in string of tubing 12. The circulating joint 11 is an article which is well known in the industry and which is in effect a telescoping type of valve.

The circulating joint 11 consists mainly of a cylinder 14 connected at its upper end to the lower end of the running in string 12 and telescoping over a hollow mandrel 15 which is connected by means of a left-hand thread 15a to the head 22 and connected thereby to the center tube 10 of the packer. The lower end of the cylinder 14 is splined as at 16 to the mandrel 15, there being sufficient play between the splines and the splineways to form fluid passages for the purpose that will be described. The end of the mandrel 15, which projects into the cylinder 14, is slightly enlarged as illustrated to constitute a valve to cooperate with a valve seat 17 arranged interiorly of the cylinder 14 adjacent its bottom.

It will be seen that when the telescopic joint is extended as illustrated in Fig. 5, that the valve seats on the seat 17 so that fluid may circulate only from the running in string downwardly through the mandrel 15 into the center tube 10. However, when the joint is telescoped, fluid from the running in string 12 may by-pass the valve and discharge between the lower end of the cylinder 14 and the mandrel 15 at the exterior of the latter. Therefore, by maintaining a tension on the running in string of tubing 12, the telescopic joint or valve 11 is closed so that fluid pressure may be built up in the center tube 10, but when the running in string is lowered with respect to the mandrel 15 and the center tube 10, the telescopic joint or valve 11 is opened so that fluid may be by-passed.

At its lower end the center tube 10 is rigidly connected to a back-pressure valve head 18 having a valve port 19 controlled by a buoyant type of back-pressure ball valve 20. The back-pressure valve head 18 is hollow and is provided at its lower end with a restricted orifice 21; that is,

restricted with respect to the diameter of the center tube 10 so that a fluid pressure may be built up in the center tube 10 as will be described. The back-pressure valve 20, of course, prevents the upflow of fluid into the center tube 10 for obvious reasons.

At the upper end of the center tube 10 is fixed the upper head 22 upon which is mounted a bleeder valve actuating collar 23 which may reciprocate to a limited degree on the head 22 against the action of springs 24 and 24a. Formed vertically through the head 22 are bleeder passageways or ports 25 controlled by bleeder valves 26 normally spring held in closed or shut condition by valve springs 26a. However, by depressing the bleeder valve actuating collar 23 with respect to the head 22, the bleeder valves 26 may be opened to render the bleeder ports or passageways effective and allow the by-pass of fluid upwardly through the head 22, as may be clearly seen from Figs. 1 and 3 of the drawings.

Fixed to the upper head 22 is a tubular packer body 27 which may be made up in units as will be described. The lower end of this tubular packer body 27 is fixed to a slip actuating head 28 slidably or telescopically mounted on the lower end of the center tube 10, as illustrated in Figs. 2 and 3. The tubular packer body 27 may be of a single length of rubber, or similar material, or may be made in sections or units of a length say not exceeding thirty feet, and connected by an internal collar in the manner indicated at 28 in Figs. 1 and 3.

Likewise, the center tube 10 may be made in sections so that the length of the entire packer may be as desired so as to blank off any length of perforated or screen casing as may be necessary. The function of the device, however, remains the same regardless of whether or not the packer body 27 is in a single length or made up of several lengths into one unit.

It will be noticed that the packer body 27 is of an internal diameter somewhat greater than the center tube 10 so as to form a pressure chamber 27a between the center tube 10 and the tubular packer body 27. It will also be noticed that the bleeder passageways 25 which extend vertically through the upper head 22 communicate with the pressure chamber at their lower ends and with the well bore at the upper end of the head.

Formed in the center tube 10 short of the upper head 22 are pressure ports 30, which are controlled by a valve 31 of the resilient sleeve-type mounted in the pressure chamber and secured to the center tube 10 in a position with its free end portion overlying the ports 30. When the pressure within the center tube 10 is greater than within the pressure chamber 27a, the fluid will pass through these ports 30 by opening the sleeve valve 31. However, when the pressure is greater in the pressure chamber than in the tube 10, the resilient sleeve valve 31 will maintain the ports 30 closed and thereby maintain the pressure in the pressure chamber.

Referring to Figs. 2 and 4, it will be noticed that the slip actuating head 28 includes a plurality of circumferentially spaced fingers 32 which project radially outward from the body of the head 28. Carried by the fingers 32 is a set of segmental slips 33, each slip having an upwardly extending shank 34 extending between fingers 32. Above the fingers 32, each shank 34 is formed with a T-head 35 to bear on the upper surfaces of adjacent fingers 32 so that upward movement of the fingers 32 will be accompanied by upward movement of the slips 33. The segmental slips forming the set of slips are embraced by a contractual means in the form of a circular coil spring 36 nesting in circumferential grooves formed in the outer surfaces of the slips 33, as most clearly illustrated in Figs. 2 and 4. The spring 36 normally urges the set of slips 33 into retracted and ineffective condition. However, it will be noticed that the slips are free to move radially outward if sufficient expanding force is exerted thereon due to the fact that the shanks 34 may move radially outward with respect to the fingers 32. The internal faces of the slips 33 are formed with conically curved faces 37, complemental with a cone face 38 formed on the valve head 18.

It is, therefore, seen that if the slips are moved downwardly relative to the valve head 18, the co-acting conical faces 37 and 38 will cause the slips to be moved radially outward or expanded into gripping engagement with a surrounding casing. It is likewise obvious that when the slips are in expanded or gripping position, should they be moved upwardly with respect to the valve head 18, the spring 36 will withdraw the slips from gripping position as their conical faces ride upwardly on the cone face 38.

It will be noticed that the slip actuating head 28 is provided with an external annular shoulder 39 overlying the T-heads 35 of the slips to force them downwardly with respect to the valve head 18 for the purpose of tightly setting them into gripping relationship with a surrounding casing.

We also desire to point out, and we refer particularly to Figs. 2 and 3, that the center tube 10 has a surrounding annular shoulder 40 at a point just above its lower end, and between which shoulder and an internal annular shoulder 41 secured to the slip actuating head 28 is interposed a comparatively strong coil spring 42. The internal annular shoulder 41 on the slip actuating head 28 is actually the lower edge of an internal collar 43 secured to the slip actuating head 28, which collar is bored to telescopically or slidably receive the center tube 10, suitable packing means 44 being provided to prevent the by-pass of fluid between the center tube 10 and the internal collar 43.

We desire to point out that when the apparatus is assembled, the spacing of the circulating joint 11 above the bleeder valve actuating collar 23 is such that when the circulating joint is telescoped, the lower end of the cylinder 14 thereof may engage the bleeder valve actuating collar 23 and depresses the same relative to the upper head 22 sufficiently to open the bleeder valves 26 and bleed the pressure chamber which is, as previously described, disposed between the tubular packing body 27 and the center tube 10.

In operation of the device, it is assembled as shown in the drawings with the parts in the condition illustrated in Figs. 1, 2 and 5, and it is lowered into the well bore on the lower end of the running in string 12. When it reaches the predetermined position in the casing, the circulation pumps are started, causing the circulation fluid to be pumped downwardly under pressure into the center tube 10. Due to the restricted orifice 21 at the lower end of the valve head 18, which communicates with the center tube 10, pressure will be built up in the center tube 10 and fluid will by-pass through the pressure ports 30 by expanding the sleeve valve 31 and build

up a fluid pressure in the pressure chamber between the tubular packer body 27 and the center tube 10. This will cause the packer body 27 to expand into tight contact with the casing.

As the pressure continues to build up in the pressure chamber 27a, the tubular rubber packer body 27, being restricted from further expansion by engagement with the casing, elongates, moving the slip actuating head 28 downwardly against the action of the spring 42. This downward movement continues until the external annular shoulder 39 on the head 28 engages the T-heads 35 of the slips 33, moving the latter downwardly with respect to the cone face 38 on the valve head 18, thus causing the slips to move radially outward into casing engaging position.

While the circulating pumps are maintained in operation, the running in string is then raised until the indicator shows a weight of three or four points, which indicates that the tool is set and a pack-off has been accomplished and the tool is now ready for operation. It is desired to point out that the highest pressure that is reached in any of the foregoing operations is that of the fluid trapped in the pressure chamber 27a between the tubular packing body 27 and the center tube 10, and that due to the provision of the resilient sleeve valve 31, reduction in pressure in the center tube 10 will not effect reduction of pressure in the pressure chamber.

Cementing, washing or acidizing operations may then be carried on by pumping the cement slurry, or the washing fluid, or the acid, downwardly through the running in string, unseating the back-pressure valve 20 and discharging through the restricted orifice 21. It is seen that if a cementing operation is carried on, that the cement will discharge through the perforations in the casing below the packer and will travel upwardly around the casing in the space between it and the well bore, blanking the same off. Similarly, washing fluid will travel and wash the exterior of the screen casing.

After the operation has been completed and it is desired to retrieve or remove the packer from the casing, the weight is taken off of the running in string 12 and the same permitted to slightly lower so as to telescope the circulating joint 11, relieving the pressure in the center tube 10, and when the lower end of the cylinder 14 of the circulating joint 11 engages and bears on the bleeder valve actuating collar 23, the latter will move downwardly relative to the upper head 22 and open the bleeder valves 26, by depressing the stems thereof, relieving the pressure in the pressure chamber by permitting the fluid therein to by-pass upwardly through the upper head 22 and into the space above the packer through the bleeder passageways 25.

When the pressure in the pressure chamber is relieved, the rubber packer body 27 will contract, which will result in the shortening of the same and permit the spring 42 to move the slip actuating head 28 upwardly relative to the back-pressure valve head 18. This upward movement of the slip actuating head 28 will cause the fingers 32 to engage the T-heads 35 of the slips 33 and move the slips upwardly with respect to the cone face 38, and as they move upwardly, the spring 36 will contract the set of slips by withdrawing them radially inward as fast as permitted by the taper of the complemental cone surfaces 37 and 38. The running in string may then be pulled from the hole and as it is removed, it will withdraw the packer in its entirety from the bore.

In the event, however, that something should happen so that the packer cannot be loosened or freed from the casing, the entire running in string may be turned to the right, which will disconnect the mandrel 15 from the upper head 22. As previously described, the mandrel is connected to the head 22 by means of the left-handed thread 15a.

From the foregoing it is obvious that we have provided a very efficient and very practical apparatus which may be run into a well bore for the purpose of packing off any desired length of screen or perforated casing, and thereafter to permit a fluid to be pumped downwardly into the casing below the packed off area, as described. As pointed out hereinbefore, after the device has performed its function, it may be quickly and easily removed from the well bore in its entirety.

While we have shown the preferred form of our 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 our invention, what we claim and desire to secure by Letters Patent is:

1. An apparatus of the character described comprising a tubular member having an open upper end, a closure member for the lower end of said tubular member, said closure member having a restricted discharge orifice therein, a tubular expansible packer body surrounding the tubular member and fixed thereto at one end and slidably mounted thereon at its opposite end in fluid-tight relationship therewith, said tubular member having ports formed therein intermediate the ends of said packer body whereby fluid pressure built up in the tubular member will be exerted to expand said packer body.

2. An apparatus of the character described comprising a tubular member having an open upper end, a closure member for the lower end of said tubular member, said closure member having a restricted orifice to enable pressure to be built up in said tubular member, a back-pressure valve means interposed between the tubular member and said orifice to prevent the back flow of fluid upwardly into said tubular member from said orifice, a tubular expansible packer body surrounding the tubular member and connected therewith at its opposite ends in fluid-tight relationship to prevent the by-pass of fluid between the tubular member and the packer body, and valve controlled ports in the tubular member to enable fluid pressure built up in the tubular member to be exerted between the tubular member and the packer body to expand the latter.

3. An apparatus of the character described comprising a sectional tubular member having an open upper end, a closure for the lower end of said tubular member having a restricted discharge orifice formed therein, a sectional tubular expansible packer body surrounding the tubular member and fixed thereto at one end and slidably mounted thereon at its opposite end in fluid-tight relationship therewith, said tubular member having ports formed therein at a point between the ends of the packer body to enable fluid pressure built up in the tubular member to be exerted between the tubular member and the packer body to expand the same.

4. An apparatus of the character described comprising a sectional tubular member having

an open upper end, a closure for the lower end of said tubular member having a restricted discharge orifice formed therein, a sectional tubular expansible packer body surrounding the tubular member and connected therewith at opposite ends, said connections being fluid-tight, said tubular member having ports formed therein at a point between the ends of the packer body to enable fluid pressure built up in the tubular member to be exerted between the tubular member and the packer body to expand the same, and check valve means controlling said ports to prevent reduction of pressure between the tubular member and the packer body through said ports.

5. An apparatus of the character described comprising a sectional tubular member having an open upper end adapted to be connected with a string of running in tubing, a closure for the lower end of said tubular member having a restricted discharge orifice, a back-pressure valve means interposed between said orifice and the lower end of said tubular member to control the up-flow of fluid from said orifice into said tubular member, a sectional tubular expansible packer body surrounding the tubular member and connected at its opposite ends to said tubular member, said connections being fluid-tight, said tubular member having valve controlled ports formed therein at a point between the ends of the packer body to enable fluid pressure built up in the tubular member to be exerted between the same and the packer body to expand the latter, said valve controlled ports preventing the relief of pressure from between said tubular member and said packer body when the pressure in the tubular member is less than the pressure between the tubular member and the packer body.

6. An apparatus of the character described comprising a tubular member having an open upper end adapted to be connected to a string of running in tubing, a closure member for the lower end of said tubular member having a restricted orifice, a tubular expansible packer body surrounding the tubular member and fixed thereto at one end, a telescopic connection between the other end of the packer body and said tubular member to enable elongation and retraction of the packer body under pressure conditions, means for exerting fluid pressure against said packer body through the tubular member to expand and elongate the same, a set of slips operatively connected to the telescopic connection between the tubular member and the packer body to be operated by the elongation and contraction thereof, and cooperating cone faces on said tubular member and on said slips whereby elongation of the packer body will move said slips radially outwardly and contraction of said packer body will withdraw said slips radially inwardly.

7. An apparatus of the character described comprising a tubular member having an open upper end adapted to be connected to a string of running in tubing, a closure member for the lower end of said tubular member having a restricted orifice, a tubular expansible packer body surrounding the tubular member and fixed thereto at one end, a telescopic connection between the other end of the packer body and said tubular member to enable elongation and retraction of the packer body under pressure conditions, means for exerting fluid pressure against said packer body through the tubular member to expand and elongate the same, a set of slips operatively connected to the telescopic connection between the tubular member and the packer body to be operated by the elongation and contraction thereof, cooperating cone faces on said tubular member and on said slips whereby elongation of the packer body will move said slips radially outwardly and contraction of said packer body will withdraw said slips radially inwardly, and spring means constantly tending to withdraw said slips radially inward to an ineffective position.

8. An apparatus of the character described comprising a tubular member having an open upper end, an upper head member connected with said tubular member, a slip operating member reciprocably mounted on the tubular member adjacent the opposite end thereof and in fluid-tight relationship thereto, a tubular packer body connected at its upper end to said upper head member and at its lower end to said slip operating member, slips carried by the slip operating member, cooperating cone faces on the tubular member and on said slips whereby movement of said slip operating member in one direction will move said slips radially outward and movement in the opposite direction will move said slips radially inward, said packer body being capable of elongation under fluid pressure and contraction when said pressure is relieved whereby to reciprocate said slip operating member, a closure for the lower end of said tubular member, said closure having a restricted orifice to enable pressure to be built up in said tubular member, said tubular member having valve controlled ports formed therein between the ends of said packer body to enable fluid pressure built up in the tubular member to be exerted against said packer body to expand and elongate the same, and independently operable means for relieving the fluid pressure exerted to expand and elongate said packer body.

9. An apparatus of the character described comprising a tubular member having an open upper end, a tubular expansible packer body, an upper head member connected to said tubular member and to the upper end of said packer body, a means connecting the lower end of said packer body to said tubular member, a closure for the lower end of said tubular member having a restricted orifice, valve controlled ports formed in the tubular member intermediate the ends of the packer body to enable fluid pressure built up in the tubular member to be exerted between the packer body and the tubular member, said upper head member having relief ports formed therethrough, relief valve means controlling said ports, and a reciprocable relief valve operating member carried by said upper head member and capable upon depression to open said relief valve means.

10. An apparatus of the character described comprising a tubular member having an open upper end, an upper head member secured on the upper end of said tubular member, a tubular packer body surrounding the tubular member and secured to the upper head member at its upper end, a slip operating member reciprocably mounted on the tubular member and connected with the lower end of the packer body, a set of slips associated with the slip operating member, cooperating cone faces on the tubular member and on the slips whereby longitudinal movement of the slips in one direction will move the same radially outward and longitudinal movement in the opposite direction will move the same radially inward, said tubular packer body being capable of elongation under pressure and being in-

herently resilient so that it will contract when said pressure is relieved, the said elongation and contraction of the packer body causing actuation of the slips, a closure for the lower end of the tubular member having a restricted discharge orifice to enable pressure to be built up in said tubular member, said tubular member having valve controlled ports formed therein intermediate the ends of the packer body to enable fluid pressure built up in the tubular member to be exerted against the packer body to expand and elongate the same, said upper head member having relief passageways formed therethrough, relief valves controlling said passageways, a depressible member carried by the upper head member for engaging and opening said relief valves.

11. An apparatus of the character described comprising a tubular member having an open upper end, an upper head member connected with said tubular member, a tubular packer body surrounding the tubular member and connected at its upper end to the upper head member, means for creating fluid pressure between the tubular member and the packer body to expand the latter, said upper head member having relief ports formed therethrough to relieve the pressure between the tubular member and the packer body, relief valves controlling said ports, a depressible member carried by the upper head member and capable upon depression to open said relief valves, a mandrel detachably connected to said upper head member, a telescoping joint connecting said mandrel to a string of running in tubing and positioned so that when it is telescoped a part thereof engages said depressible member to open said relief valves.

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