March 10, 1936. W. T. WELLS ET AL 2,033,564

BYPASS PACKER

Filed Feb. 5, 1935 2 Sheets-Sheet 1

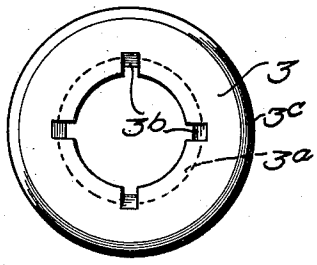


FIG. 3

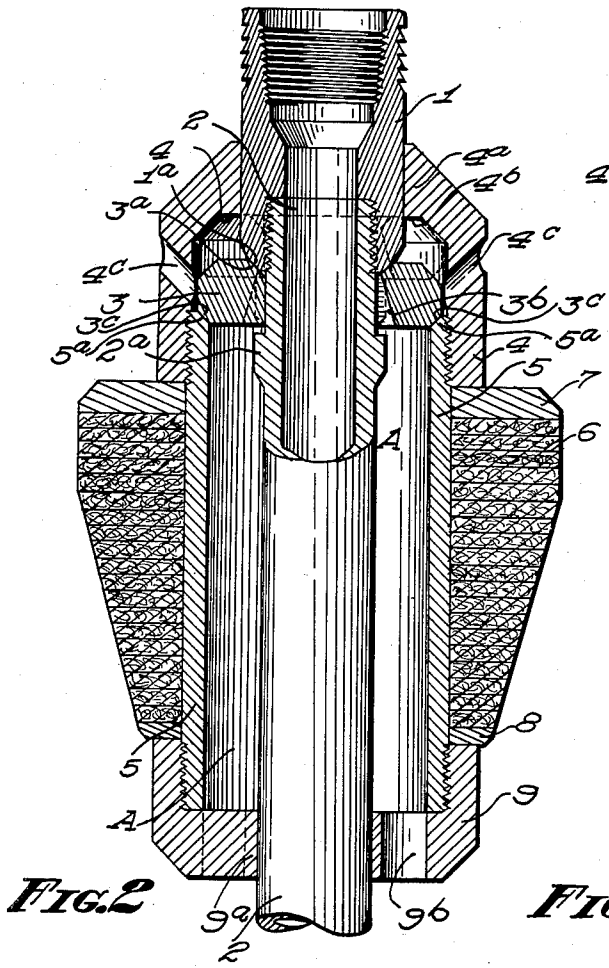


FIG. 2

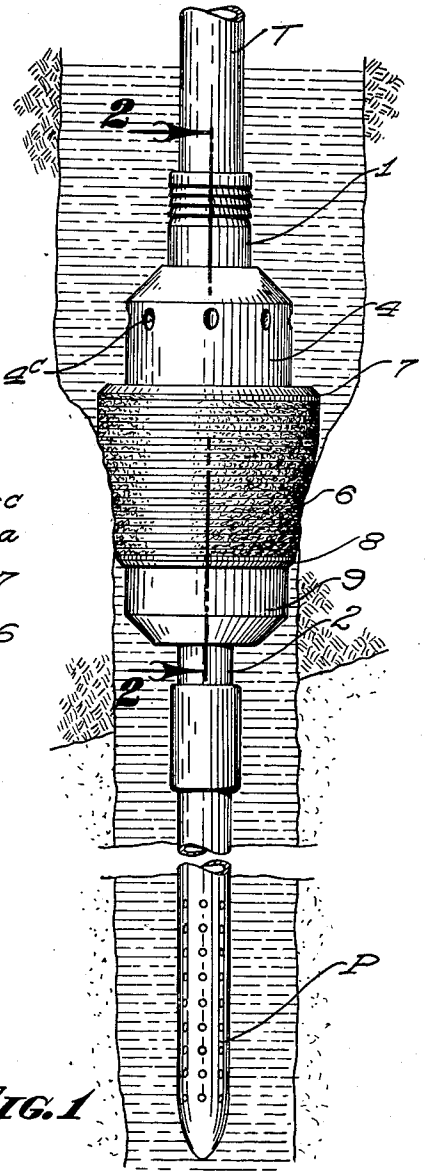


FIG. 1

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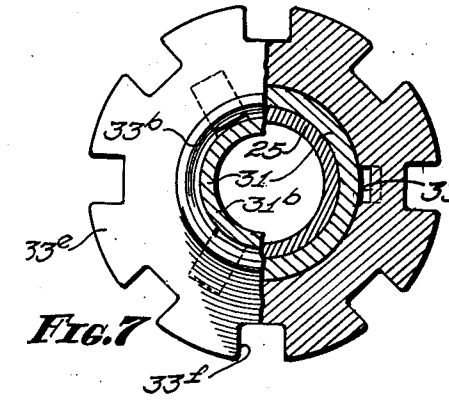


FIG. 7

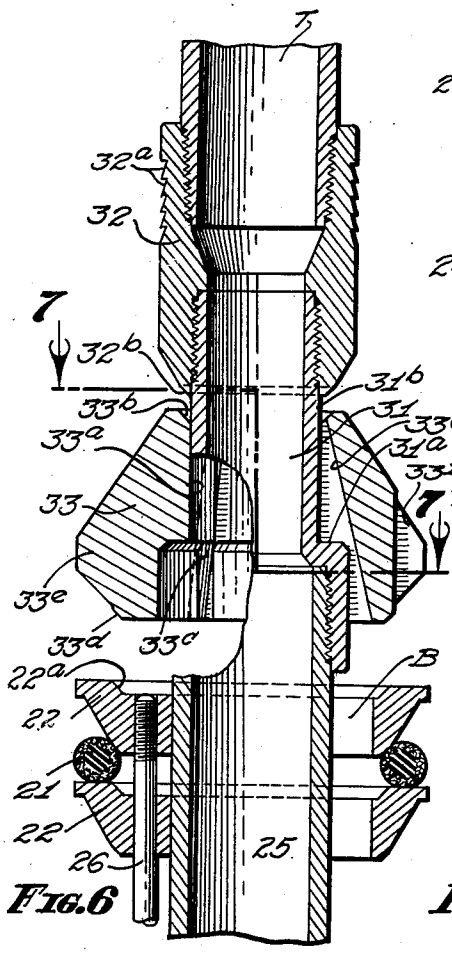


FIG. 6

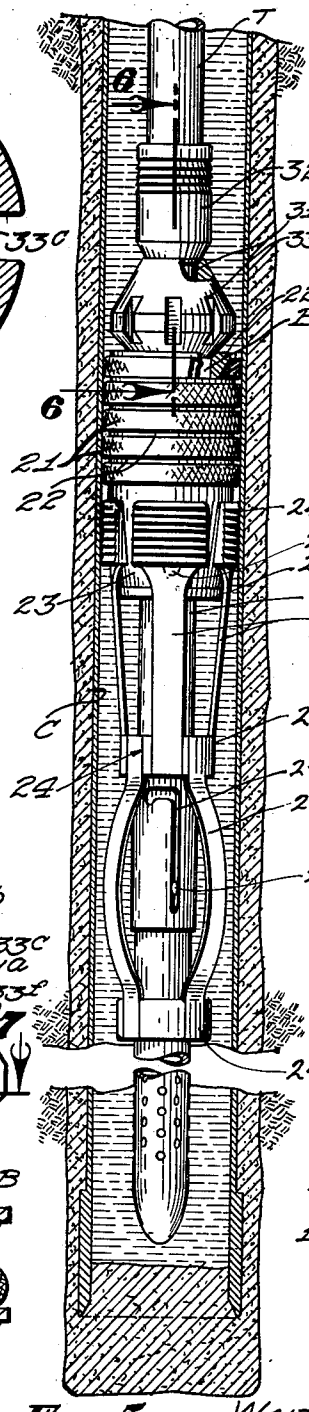


FIG 5

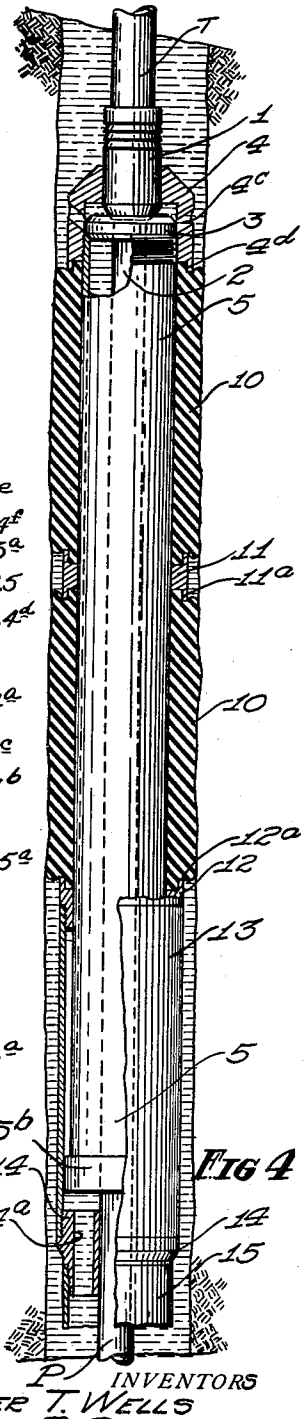


FIG 4

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BYPASS PACKER

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Application February 5, 1935, Serial No. 5,044

10 Claims. (Cl. 166—10)

Our invention relates to oil well packers and the objects of our invention are:

First.—To provide a novel by-pass packer which may be designed for use in casing or open hole and is particularly suitable for use in the larger well bores.

Second.—To provide a novel by-pass packer head which is provided with a by-passing or circulating valve of maximum area to facilitate running of the packer in heavy drilling fluid both into and out of the well while minimizing the strain on the packing elements.

Third.—To provide a novel by-pass packer which incorporates a circulating valve of maximum area and a relief valve of minimum area whereby the packer may be run rapidly both into and out of the well through heavy drilling fluid yet is readily unseated even though the pressure difference above and below the packer should reach several thousand pounds.

Fourth.—To provide a by-pass packer which may be inseated with no more effort than that required to lift the tubing string thereby minimizing the strain on the tubing string and draw works even when running packers in large casing.

Fifth.—To provide a packer of this character wherein the valve elements thereof are positive in action and in no manner interfere with the normal operation of the packer or tool used in conjunction with the packer.

Sixth.—To provide a packer which although incorporating both a circulating valve and a relief valve may be provided with a maximum size bore or passage therethrough for the circulation of fluid through the packer.

Seventh.—To provide a by-pass packer which by-passes the fluid between the packing elements and the body of the packer so that the body of the packer and the tubing string connected therewith may be run dry.

Eighth.—To provide a by-pass packer of this class which eliminates the need of a sliding or other relative movement between the tubing string and body of the packer, these parts being capable of rigid connection, thereby eliminating all packing glands or the like to seal the body.

Ninth.—To provide a packer which is particularly simple and economical of construction proportional to its functions, which may be readily and quickly installed, and which is particularly durable and efficient in its action.

With these and other objects in view as may appear hereinafter, attention is directed to the accompanying drawings in which:

Figure 1 is an elevational view of a formation or "rat hole" packer incorporating our novel by-pass means, showing the packer seated.

Figure 2 is an enlarged sectional view thereof taken through 2—2 of Figure 1 with the parts shown by solid lines in the positions assumed when the packer is seated, and the weight of the tubing string is applied, and showing by dotted lines their positions when the valves are opened and the packer is hanging or suspending from the tubing string.

Figure 3 is a bottom view of the floating valve ring.

Figure 4 is a partially sectional partially elevational view of a sleeve type formation packer incorporating our by-pass means.

Figure 5 is an elevational view of a casing or hook wall packer incorporating our by-pass means, showing the casing packer in position.

Figure 6 is an enlarged fragmentary sectional view thereof through 6—6 of Figure 5 showing the parts by solid line in the positions assumed when the packer is unseated and suspended from the tubing string.

Figure 7 is a transverse sectional view thereof taken through 7—7 of Figure 6.

Attention is first directed to Figures 1 to 3. Our packer here illustrated is connected with a tubing string T through a sub or coupling 1, the upper portion of which is internally threaded to receive the tubing string or an intermediate tool such as a formation tester, and the lower end is similarly threaded to receive a packer body member 2 in the form of a tube. The lower end of the coupling is provided with a frusto-conical valve face 1*a*, the diameter of which is only slightly greater than the packer body and need not be larger than the tubing string.

An annular shoulder 2*a* is provided around the packer body 2 a short distance below the coupling 1. Between the shoulder 2*a* and face 1*a* is mounted a floating ring valve 3. Said valve is provided with a valve seat 3*a* at the upper end of its inner periphery which coacts with the valve face 1*a*. The bore of the ring valve 3 is provided with longitudinally extending slots 3*b* which are sufficiently deep at their lower ends to provide passages from the top to the bottom of the ring valve when the valve is supported on the shoulder 2*a* as shown by dotted lines in Figure 2.

A top collar 4 surrounds the ring valve 3. Above the valve the collar is constricted as indicated by 4*a* and slidably fits the coupling 1. The underside of the constricted portion forms an abutment 4*b* which engages the upper side of the ring valve when the packer is suspended

from the tubing string and movement of the ring valve is limited by the shoulder 2a. The top collar clears the periphery of the ring valve and extends therebelow where it is internally threaded to receive a sleeve 5. Said sleeve is cylindrical and materially larger than the packer body to provide a large passage, designated A, therebetween. The sleeve is provided at its upper end with an internal valve seat 5a which is engaged by a valve face 3c formed around the outer periphery of the ring valve at its under side.

At a point above the sleeve 5, the collar 4 is provided with a plurality of relatively large apertures 4c which allow fluid to pass from above the packer into the passage A between the body member 2 and sleeve 5.

The sleeve receives a plurality of packing disks 6 formed of any suitable material and which vary in diameter to form a tapered plug adapted to fit a seat provided at the top of a "rat hole". The set of disks 6 is reinforced at its upper and lower extremities by plates 7 and 8 respectively. The disks and plates are held in place on the sleeve by a bottom collar 9 which is adapted to screw on the lower end of the sleeve 5. Said bottom collar 9 includes a constricted portion 9a which forms a sliding fit on the body member 2 and is provided with large apertures 9b which permit fluid to flow from the passage A.

The lower end of the body member 2 is adapted to receive a suitable perforated plug P.

The valve face 3c and valve seat 5a together form a valve which controls passage A and therefore functions as a by-passing or circulating valve to enable, when the packer is being raised and lowered, fluid to flow past the packer, particularly when the clearance between the packer and the well bore is at a minimum. This valve must necessarily be large in diameter; therefore, should the pressure below the packer, when the same is seated, be materially less than the pressure of the drilling fluid above the packer, the force required to lift the packer is apt to exceed the safe load that can be applied to the tubing string and draw works. It is the function of valve face 1a and valve seat 3a to overcome this difficulty, these elements forming a relief valve the diameter of which need not be materially greater than the tubing string and in fact may be smaller if desired. This being the case, there can be little or no hydrostatic head applied to the relief valve which would be effective in holding it closed by reason of a lower pressure below the packer; hence, no more effort is required to open the relief valve than is required to raise the tubing string itself.

The foregoing conditions are very apt to exist when the packer is used for formation testing in which case the packer is run on a dry tubing string together with a suitable testing tool mounted immediately above or below the packer. After the packer is seated and the formation thereby relieved of the hydrostatic pressure of the drilling fluid, the tubing string is opened to atmospheric pressure. Should the formation pressure be low, the pressure difference above and below the packer may reach several thousand pounds per square inch. With this in mind, the operation of the packer is as follows:

When the packer is being lowered, both the circulation and relief valve are open and the packer is suspended indirectly from the tubing string through the ring valve which rests on the shoulder 2a and in turn supports the top collar by means of the abutment 4b. Even though the packer is lowered through drilling mud, its weight is normally sufficient to maintain the circulation valve open against the upward thrust of the fluid through which it is descending. All circulation does not, of course, take place through the passage A, but a large amount of the fluid passes around the outside of the packer.

Upon seating of the packer in the upper end of a "rat-hole" as shown in Fig. 1, and the application of weight of the tubing string, the relief and circulation valves are closed, as shown in Fig. 2. After the necessary operations or tests are made, particularly should such operations or tests result in a lesser pressure below the packer than exists by reason of the hydrostatic head above the packer, such a hydrostatic head tends to hold the packer seated and inasmuch as this hydrostatic pressure is applied against the top of the ring valve through ports 4c, the ring valve is held against its seat 5a with considerable force because the area of the circulation valve incorporating the seat 5a is much larger than the tubing string. However, the relief valve formed by the confronting surfaces 1a and 3a may approximate the area of the tubing string and be in hydrostatic balance; therefore, with the condition of a materially lower pressure below the packer, the first upward movement of the tubing string opens the relief valve permitting equalizing of pressure through the relief valve. After the pressure becomes equalized, continued upward movement of the tubing string causes the shoulder 2a to engage the ring valve so as to open the circulation valve. In coming out of the well, the force of the fluid through which the packer passes is downward and therefore in a direction to maintain the circulation valve open, thereby minimizing any possibility of swabbing. In connection with formation packers, it is perhaps more essential that a maximum circulation be maintained when coming out of the hole than when going in for the reason that undue swabbing can cause the well to blow out of control; whereas, in going in, the rate at which the fluid can pass automatically controls the speed of descent.

Reference is now directed to Fig. 4 which discloses a packer of the anchor formation type incorporating our by-pass arrangement.

With this adaption of our packer, the top collar 4 is provided with an overhanging packing retaining bead 4d around its lower end and the sleeve 5 is elongated to receive one or more of sleeve-like packing elements 10 formed of rubber or other suitable material. If more than one packing element 10 is used, they are separated by rings 11 having axially directed lips or beads 11a to retain the ends of the packing elements. The lowermost packing element is retained by a bead 12a of a ring 12. A band 5b is provided at the bottom of the sleeve 5. The ring 12 is externally threaded to receive a shell 13 which fits over the band 5b and is in turn screwably connected to a bottom collar 14 similar to the collar 9 and which is provided with apertures 14a therethrough.

The collar 14 is also threaded to receive an anchor 15 which consists of a length of tubing, perforated at its lower end, not shown, and which engages the bottom of the well to force the shell 13 and ring 12 upwardly and thereby compress the packing elements against the formation. The packer body is, as in the first described structure, provided with a perforated plug P the length of which is, of course, shorter than the anchor 15. The operation of the relief

and circulation valves incorporated in this type of packer is similar to the first described structure. The packer itself however, operates in a different manner. When the anchor **15** engages the bottom of the well, further downward movement after closing the relief and circulating valves compresses the packing sleeves longitudinally causing them to expand radially against the formation as indicated by dotted lines in Figure 4. The sleeve type packer while likewise suspended indirectly from the tubing string is considerably heavier than the "rat-hole" packer and, therefore, may be run into the well with greater speed.

Attention is now directed to Figs. 5 to 7, the casing packer here shown is provided with a central tubular body **25** around which are slidably mounted a plurality of expansion rings **22** having substantially flat upper sides and conical lower sides, and between which are positioned annular expansible packing rings **21**. A downwardly tapering slip spreading cone **23** having a flat upper side similar to the expansion rings is provided below the lowermost expansion rings and its coacting packing ring. The cone **23** and expansion rings **22** are spaced from the body by means of lugs which define axially directed passages B. Tie bolts **26** extend between the cone and upper expansion ring in such a manner as to permit compression of the rings axially towards the cone but limit axial separation of the rings from the cone beyond a predetermined distance.

Below the cone **23** is mounted a slip assembly **24** including collars **24*a*** slidable upon the body **25** and connected by casing engaging springs **24*b***. Between the collars **24*a*** is a suitable catch or latch means **24*c***, such as a sleeve with J-slots therein, adapted to coact with a pin or pins **25*a*** protruding from the body member **25**. Turning of the body member, by reason of the frictional engagement of the springs **24*b***, enables the catch means **24*c*** to engage or disengage the pin **25*a***. Above the collar **24*a*** are upstanding spring reins **24*d*** which terminate in slips **24*e*** having serrated outer surfaces, and which are adapted to ride upon the cone **23**.

The cone **23** is provided around its lower or smaller end with a catch rib **23*a*** undercut on its upper side to engage lugs **24*f*** carried by the several slips so as to limit upward movement of the cone when the slip assembly is latched. The upper expansion ring is provided at its upper side with a seat **22*a*** which in the larger sizes of packers is materially larger than the tubing string upon which the packer is customarily run. The casing packer so far described is more particularly set forth in Patent No. 1,925,016 entitled, "Packer for oil wells", issued to Walter T. Wells, one of the co-inventors herein, and, except in so far as the structure thereof coacts with the hereinafter described by-pass means, constitutes no part of the present invention.

The equivalent of the valve seat **22*a*** disclosed in the above patent forms an element of a circulation valve which in the larger sizes of packers is materially larger than the tubing string on which such a packer is run, with the result that difficulty is sometimes experienced in unseating the packer whenever the hydrostatic pressure above materially exceeds the pressure below. As an example, this situation arises in conducting shoe tests for water shut-off to determine the efficacy of a cement job, for the packer is then run on a dry tubing string (as in formation testing), seated and the area below the packer opened to the atmosphere. If the cementing job is successful, the pressure below the packer will remain substantially atmospheric, but it will be necessary to raise the packer with the tubing string sealed in order to determine the success.

It is the purpose of our invention as illustrated in Figures 5 to 7 to equalize the pressure above and below the multiple ring casing packer as accomplished with the formation packer described hereinbefore. A sub **31** is screwed on the packer body **25**, said body being externally threaded to receive the sub. Above the packer body, the sub **31** is reduced in diameter forming a shoulder **31*a*** and thereabove a shank portion **31*b***. The upper end of the shank portion is externally threaded to receive a coupling **32** which may be provided with suitable wickers **32*a*** and is secured to the tubing string T in the conventional manner.

The lower end of the coupling **32** is provided with a valve face **32*b***. Slidably mounted on the shank portion **31*b*** between the valve face **32*b*** and the shoulder **31*a*** is the constricted portion **33*a*** of a ring valve **33**. The upper end of said constricted portion **33*a*** is provided with a valve seat **33*b*** which coacts with the valve face **32*a***. The bore of the ring valve **33** is provided with suitable passages **33*c*** communicating from the top to the bottom of the ring valve. The bottom portion of the ring valve overhangs the enlarged lower end of the sub **31** and is provided at its under side with a valve face **33*d*** which is adapted to coact with the valve seat **22*a*** provided on the uppermost expansion ring **22**. Between its ends the outer periphery of the ring valve **33** may be enlarged as indicated by **33*e*** to protect the expansion rings and packer rings, and if desired may be provided with channels **33*f*** to increase the available area for the flow of the well fluid as the packer is raised or lowered.

Operation of the by-pass means in conjunction with the multiple ring packer is as follows: The valve face **32*b*** and coacting valve seat **33*b*** form a relief valve while the valve face **33*d*** and valve seat **22*a*** form a circulating valve. It should be noted that the relief valve need not be larger than the tubing string T, hence the hydrostatic head above the packer cannot influence the operation of the relief valve. When the packer is lowered both the relief valve and the circulating valve are open as shown in Figure 6 being held so by reason of the latch connection of the slip assembly **24** with the packer body **25**, the interlocking arrangement of the slips **24*e*** and cone **23**, and the tie bolts **26**. Upon seating the packer, the valves are closed as shown in Figure 5. When the tubing string is raised subsequently, the relief valve opens first as described in connection with the "rat-hole" packer, permitting the pressure to equalize so that the circulating valve may open and the packer be withdrawn.

We claim:

1. In a packer: a packing structure, a body member therein, the body member and packing structure being capable of relative longitudinal movement and defining a circulation passage therebetween externally of the body member; a relief valve element defining one side of said circulation passage and moveable with said body member; a circulation valve element defining the opposite side of said passage and moveable with said packing structure; said elements being moveable towards or from each other upon relative

movement of said body member and packing structure; and a floating ring valve disposed between said elements incorporating relief and circulation valve parts arranged to coact with said relief and circulation valve elements respectively.

2. In a packer: a packing structure, a body structure defining therewith a circulation passage therebetween for permitting circulation of fluid through the packer externally of and sealed from the interior of said body structure, a ring valve slidably mounted around said body structure and forming therewith a bypass passage communicating with said circulation passage; stops above and below said ring valve for limiting movement of said ring valve with respect to said body structure; a relief valve means incorporating one of said stops and the portion of said ring valve engageable therewith for controlling said bypass passage, said ring valve engageable with said packing structure; and a circulating valve means incorporating the engaging portions of said ring valve and packing structure.

3. In a packer, a packing structure, a body structure mounted therein and spaced therefrom to form therewith a circulating pasage, a ring valve slidably mounted around the body structure, said body structure and said packing structure engageable with opposite axial sides of said ring valve whereby the ring valve limits axial movement of the body structure with respect to the packing structure, a circulating valve means formed by the engaging portions of said ring valve and packing structure, and a relief valve means formed by the engaging portions of said ring valve and body structures, both of said valve means controlling said circulation passage.

4. In a packer, an annular packing structure including a circulation valve seat around its inner periphery, a tubular body structure mounted within said packing structure and defining therewith a circulation passage, said body structure including an external relief valve seat; and a floating ring valve slidably mounted around said body structure and interposed between said valve seats and forming therewith duel valve means for controlling said circulation passage.

5. In a packer, a tubular body structure including means for connection with a tubing string, a section of reduced diameter defining an upper and a lower shoulder, the upper shoulder being a relief valve face having approximately the diameter of said tubing string; a ring member slidably mounted between said shoulders and including a relief valve seat engageable with said relief valve face, and a circulation valve face of larger diameter than said relief valve face; and a packing structure slidably mounted on said body structure forming therewith a circulating passage and including a circulating valve seat engagable with said circulating valve face to control said passage.

6. In a packer; a packing means, a body means forming therewith a circulation passage, a ring means for controlling said passage, each of said means being slidable with respect to the others, said ring means engageable with the packing means and the body means to limit their relative sliding movement in one direction; a relief valve formed by the portions of said ring means and body means so engaging; and a circulation valve formed by the portions of said ring means and packing means so engaging.

7. In a packer; a packing means, a body means forming therewith a circulation passage, a ring means for controlling said passage, each of said means being slidable with respect to the others, said ring means engageable with the packing means and the body means to limit their relative sliding movement in one direction, a relief valve formed by the portions of said ring means and body means so engaging, a circulation valve formed by the portions of said ring means and packing means so engaging, and other engaging portions between said ring means and said body means engageable subsequent to opening of said relief valve for opening said circulation valve.

8. In a packer: a body member; a sub connecting the body member with the tubing string, said sub having at its lower end a relief valve face of a diameter not exceeding the diameter of the tubing string; a packing structure forming with the body member a circulating passage and having a circulation valve seat of greater diameter than said tubing string; and a means interposed between said relief valve face and said circulation valve seat and including valve elements coacting with said relief valve face and circulating valve seat to form relief and circulation valves respectively.

9. In a packer: a body member; a sub connecting the body member with the tubing string, said sub having at its lower end a relief valve face of a diameter not exceeding the diameter of the tubing string; a packing structure forming with the body member a circulating passage and having a circulation valve seat of greater diameter than said tubing string; a means interposed between said relief valve face and said circulation valve seat and including valve elements coacting with said relief valve face and circulating valve seat to form relief and circulation valves respectively; and means for holding said circulating valves open during descent and ascent.

10. In a packer: a body member; a sub connecting the body member with the tubing string, said sub having at its lower end a relief valve face of a diamter not exceeding the diamter of the tubing string; a packing structure forming with the body member a circulating passage and having a circulation valve seat of greater diameter than said tubing string; a means interposed between said relief valve face and said circulation valve seat and including valve elements coacting with said relief valve face and circulating valve seat to form relief and circulation valves respectively; and a device engageable with said means upon opening of said relief valve to open said circulating valve.

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