March 17, 1953 R. H. BLOOD 2,631,672

HYDRAULIC WELL PACKER

Filed March 9, 1949 2 SHEETS—SHEET 1

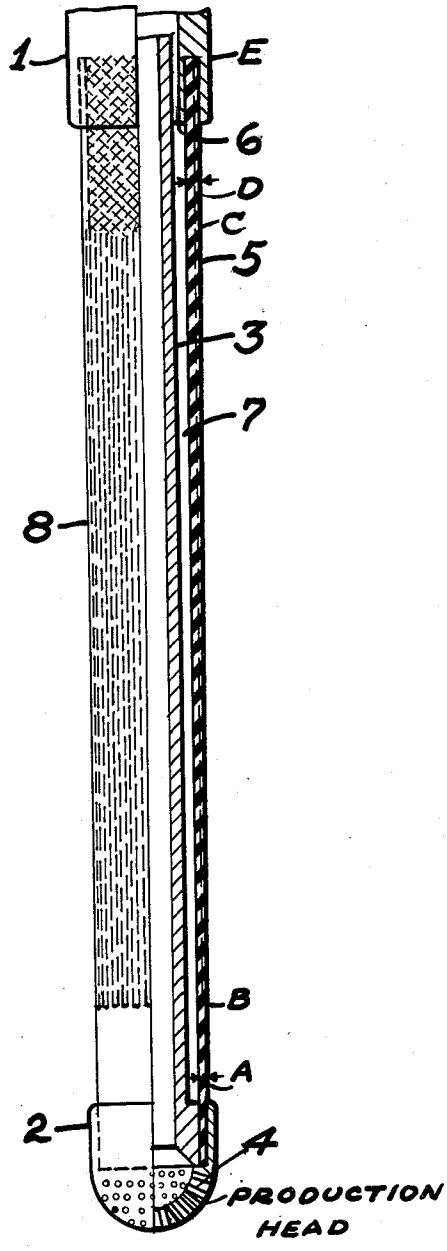


Fig. 1

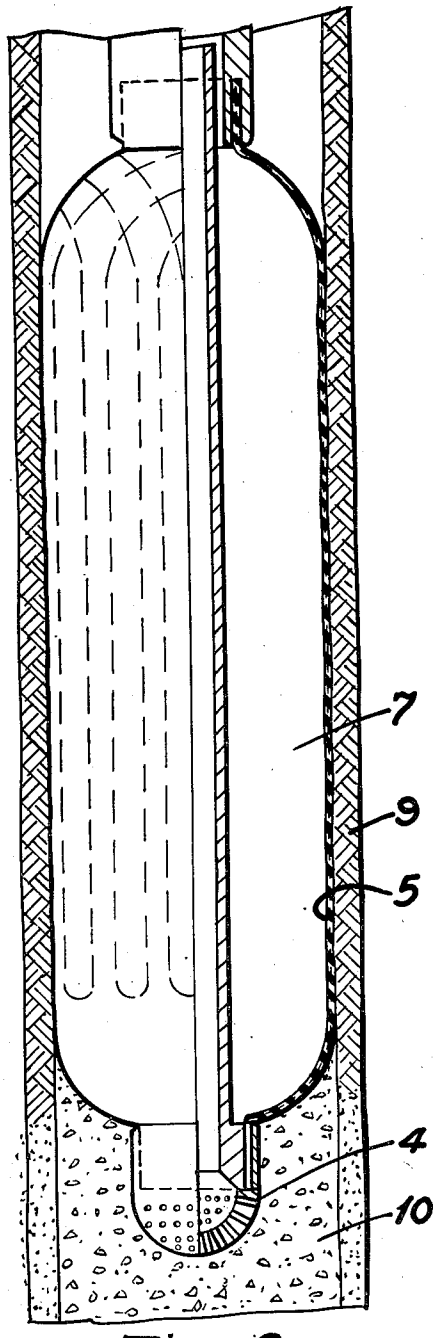


Fig. - 2

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HYDRAULIC WELL PACKER

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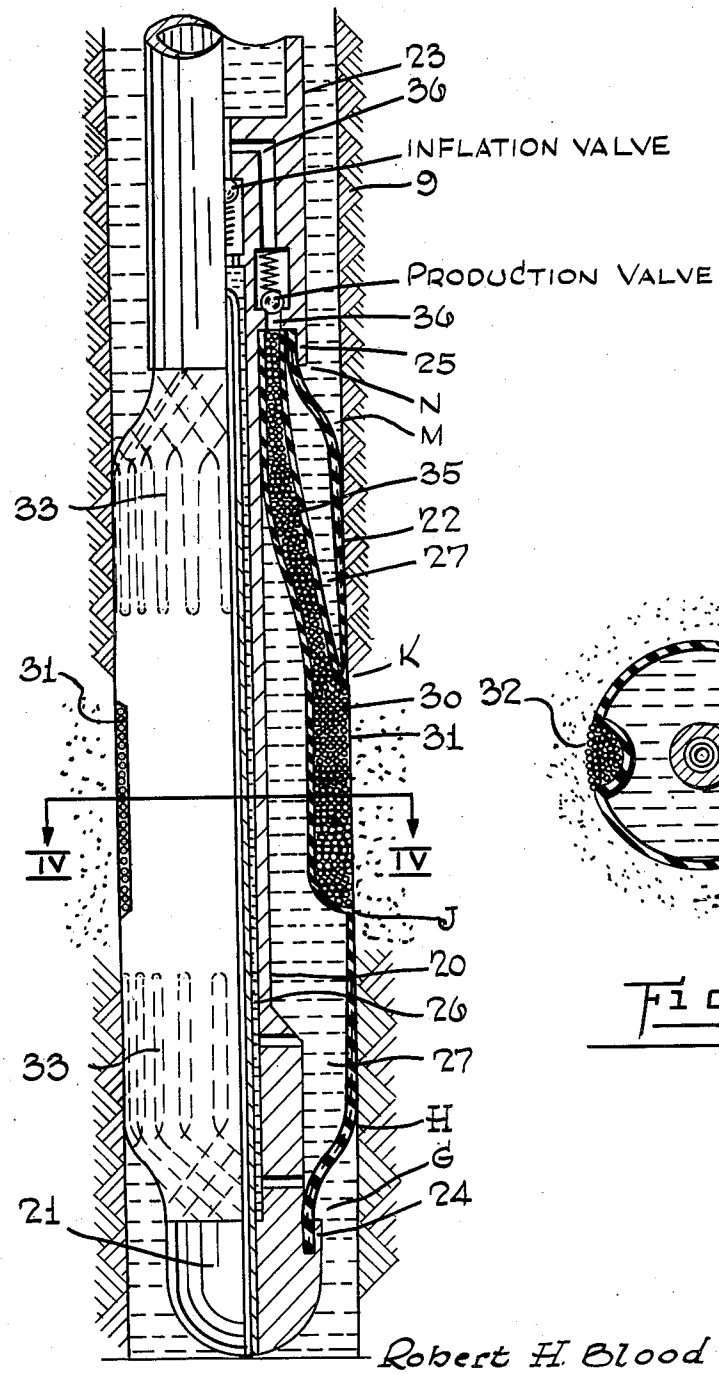


Fig.-3

Fig.-4

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2,631,672

HYDRAULIC WELL PACKER

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5 Claims. (Cl. 166—10)

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This invention relates to an improved method for sealing off portions of an oil well by means of an inflatable elastic packer. More particularly the invention relates to an improved device for sealing off a section of an oil well for various purposes such as for obtaining samples of fluids present in the well.

In conventional oil well drilling operations fluids known as drilling muds are employed to aid in carrying away cuttings and also to maintain a hydrostatic head in the well to prevent the uncontrolled escape of gases or fluids from various formations encountered during drilling. One disadvantage of drilling with a drilling mud is that the sampling of natural fluids occurring in various formations is thereby rendered difficult. To overcome this disadvantage various types of formation testers have been devised which are provided with means for reducing the hydrostatic pressure in the vicinity of the formation to be tested in order that a sample of the natural fluids can be taken.

Many of these formation testers are provided with elastic sleeves or packers for sealing off the portion of the well in which it is desired to reduce the hydrostatic pressure. The use of such elastic packers is particularly desirable since such a packer can be expanded to give a thorough seal and yet may be readily removed from the well after being deflated. Furthermore it is possible to position such an elastic packer at any desired point in the well with very little difficulty.

In order that an elastic packer may operate properly the progress of inflation of the packer must be controlled and the flow of fluid into the packer to bring about inflation must be stopped when the packer is fully inflated. When using a packer in a bottom hole tester for example, it is desirable to start expansion near the lower end of the packer in order to avoid trapping too much drilling mud below the packer. Likewise in an up-hole tester in which the sampling area is in the midsection of the packer it is desirable to have the expansion occur first at the midsection and then progress upwardly and downwardly from that section. The present invention is concerned with an improved design of packer in which the manner of expansion is carefully controlled.

Thus one object of the present invention is to provide for controlled expansion of elastic packers employed in oil wells and in oil well casing. It is a further object of this invention to provide for a thin-walled elastic inflatable packer having walls that have been designed so

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that the manner in which the packer inflates and deflates will be carefully controlled. Other and further objects of the invention will be apparent from the ensuing description and from the drawings. In the drawings Fig. 1 shows a vertical view partly in cross section of a bottom hole packer in a deflated position before being run into the well. Figure 2 shows the same packer in an inflated position in the well hole. A packer for use in up-hole formation testing is shown in its expanded position in Fig. 3, the view being in elevation, partly in cross section. A cross sectional view across the middle of the same packer is presented in Fig. 4.

Referring now to the drawing in more detail and referring particularly to Figs. 1 and 2, the body of the packer comprises the upper packer mount 1, the lower packer mount 2, and the production tube 3. Attached to the bottom of the lower packer mount is a production head 4 having perforations communicating with production tube 3 through which the sample to be collected may pass. It is usually desirable to have the production head rest on a layer of gravel or similar material 10 placed on the bottom of the hole at the point at which the test is made, in order to facilitate flow of formation fluids into the sampler, and to support the lower portion of the thin-walled packer. Surrounding production tube 3 and anchored to the lower and upper packer mounts is an elastic bag or sleeve 5 which may be made of rubber or other elastic material. The sleeve is of such diameter that an annular space 7 is formed between the sleeve and production tube 3. The sleeve is caused to expand by conducting drilling fluid into the annular space 7 through inflation channel 6.

The particular manner in which drilling mud or other inflating fluid is caused to flow into and out of annular space 7 does not form a part of this invention and hence is not described in detail here. A suitable system of valves for regulating such flow of fluid is described in co-pending application Serial No. 28,698 of Robert H. Blood and Ben W. Sewell, filed May 22, 1948.

Referring again to the elastic wall packer it will be seen that non-elastic cords 8 are embedded in the wall parallel to the longitudinal axis of the packer. These cords run parallel to each other from a section of the wall indicated by reference letter B near the lower extremity of the packer to a section indicated by reference letter C near the upper extremity of the packer. From point C up to point E at the top of sleeve 5 the cords are conducted upwardly in a spiral

manner, alternating strands being laid in opposite directions and overlapping each other in such a way as to give the effect of bias-woven fabric. The reinforcing cords are anchored to the upper end of sleeve 5 by upper packer mount 1. In addition the thickness of sleeve 5 increases gradually from the bottom of the packer to the top of the packer so that at point A the cross sectional thickness is appreciably less than at point D.

As the fluid is introduced into annular space 7 to expand the packer, expansion will begin first near the lower end of the packer in the region between points A and B. As more fluid is introduced the expansion progresses upwardly until the packer is fully inflated and wall 5 presses firmly against formation 9 as shown in Fig. 2. Such progressive upward expansion of the packer can occur merely by providing for a tapering thickness from bottom to top as shown. This feature constitutes one phase of the present invention. However as inflation progresses upwardly there is a tendency for slack elastic material to accumulate ahead of the inflation so that, finally, folds will appear at the top of the packer. Since such folds occur as a result of stretching of the elastic material in a longitudinal direction it is desirable to prevent longitudinal expansion as much as possible, hence a preferred embodiment of the invention consists in providing for longitudinal non-elastic cords in the manner shown. These reinforcing cords allow the packer to increase in circumference but not appreciably in length. By providing for spiral placement of the cords from point C up to the top of the packer the sleeve is given greater strength in this area in order that the sleeve will be restrained sufficiently to require a greater pressure for expansion here than in the rest of the wall.

The same principles can be applied to a packer used in an up-hole formation tester in which a sample is taken from a side wall of the packer. A formation tester of this type is shown in Figs. 3 and 4. Fig. 3 being a vertical elevation partly in cross section and Fig. 4 being a cross sectional view across the middle of the packer, along line IV—IV of Fig. 3.

In these figures, the packer bag 22 is attached to the supporting structure of the packer 20 which in turn is suitably fastened to the drill pipe 23. The lower end of packer bag 22 is firmly fastened to the lower end of structure 20 by suitable clamping means 24 and the upper end of the bag is similarly held by clamping means 25. Attached to the bottom of structure 20 is a rigid nose 21, designed to protect the packer as it is lowered into the bore hole or casing. At a plurality of points, preferably about two to four points, around the circumference of the packer bag as shown in Fig. 4 the bag is slightly indented to form pockets 30 which are covered with a permeable material such as closely woven fabric 31, which may be of metal or of heavy cloth made from natural or synthetic fibers. The pockets are preferably filled with pellets 32 or other suitable packing material made of glass, metal, plastic or the like in order to present a permeable medium through which the formation fluids may flow. Connected to each pocket is a flexible tube 35 leading to a production passage 36 for collecting the produced fluids. It is preferred that packing material 32 be used also in tube 35 to prevent its collapse under the pressure of the fluid used to expand the packer. As shown in Figure 3 the wall thickness of the packer bag increases gradually from the thinnest portion JK near the middle, i. e., in the region adjacent to pockets 30, to thicker portions at each end, i. e., at points G and N. Thus when the packer is expanded by forcing drilling mud into annular space 27 through inflation channel 26 the portion of the wall JK will expand first and expansion will then progress upwardly through portion KM and downwardly through portion JH. To permit still further control of the progress of inflation of the packer, cords 33 may be embedded in a cross-lacing fashion at each end of the bag, i. e., in sections GH and MN in a similar manner to that described in connection with the packer of Figs. 1 and 2. Further reinforcing may be desired in some cases, in which event the cords are continued in parallel fashion from point H to point J and from point M to point K or at least part way to points J and K respectively. If desired some of the cords may extend part way to points J and K and others may extend all of the distance.

Thus it will be seen that the present invention comprises, essentially, an improved inflatable elastic packer for sealing off a portion of an oil well in which the wall of the packer increases in cross sectional thickness from a section intermediate its ends to at least one end of the packer. If the packer is to be used in a bottom hole formation tester the wall thickness is at a minimum at a portion near the bottom and increases upwardly to the top so that the bottom portion of the wall will expand first when internal pressure is applied. For a packer to be used in an up-hole tester the wall thickness is at a minimum in the middle of the packer and increases upwardly and downwardly from the middle section.

A further feature of the invention involves the use of non-elastic cords embedded in the elastic wall of the packer in order to control the amount and direction of expansion of the packer wall. For a bottom hole tester it is preferred that these cords be laid in the wall parallel to the longitudinal axis of the packer, the cords running parallel to each other from a section near the bottom of the packer to a section near the top of the packer and then continuing up to the top of the packer in a spiral manner, alternate cords being wound in opposite directions. For an up-hole tester, the use of reinforcing cords is not quite so important although their use is sometimes desirable. The primary need for reinforcement in this case is at each end of the packer and thus the preferred reinforcement comprises non-elastic cords spirally wound around the bag at each end, interweaving alternate cords in opposite directions in the manner described for the packer for the bottom hole tester. If still greater reinforcement is desired, at least some of the cords can be extended longitudinally of the packer toward the middle of the packer.

It is to be understood that this invention is not to be limited to the exact description presented which has been by way of example only, but that the invention is to be limited only by the following claims.

What is claimed is:

1. An improved inflatable elastic packer for sealing off a portion of an oil well comprising a packer support, an expansible elastic bag fixed at both ends to said support, said bag having an elastic wall which increases in cross-sectional

thickness longitudinally from a section intermediate its ends to at least one end of the bag and non-elastic cords embedded in said wall adjacent at least one end thereof, said non-elastic cords being wound spirally around the circumference of the packer, alternate strands being wound in opposite directions.

2. Improved packer according to claim 1 in which the wall thickness increases upwardly from a portion near the bottom and in which said spirally wound cords are embedded in the upper end of the packer wall.

3. Improved packer according to claim 2 in which non-elastic cords are embedded in the wall parallel to the longitudinal axis of the packer over a large portion of its length.

4. Improved packer according to claim 1 in which the wall thickness increases both upwardly and downwardly from a section in the vicinity of the center of the packer and in which the spirally wound cords are embedded in the walls of the packer at each end thereof.

5. Improved packer according to claim 4 in which at least some of the cords extend longitudinally of the packer from each of said spirally wound portions toward a section adjacent to the middle of the packer.

ROBERT H. BLOOD.

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