Feb. 5, 1957 G. L. LOOMIS 2,780,294

PACKER ASSEMBLY

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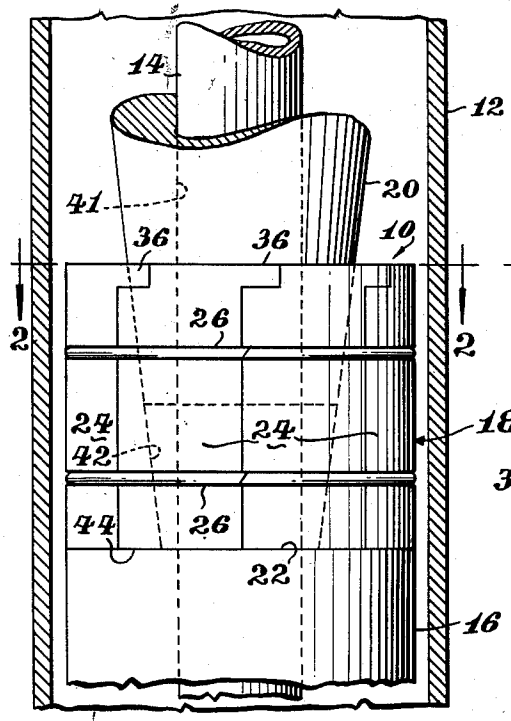


FIG. 1.

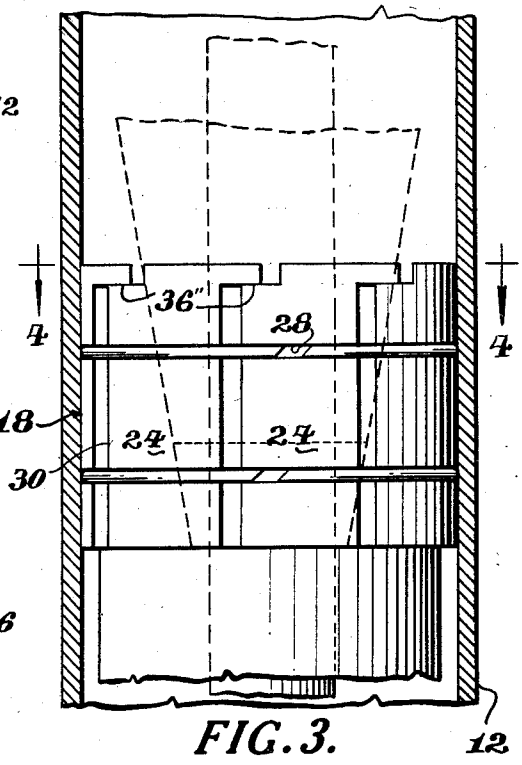


FIG. 3.

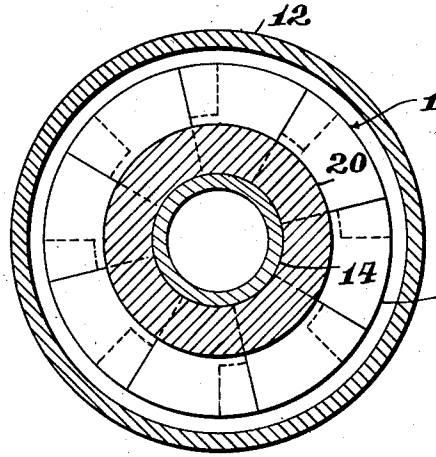


FIG. 2.

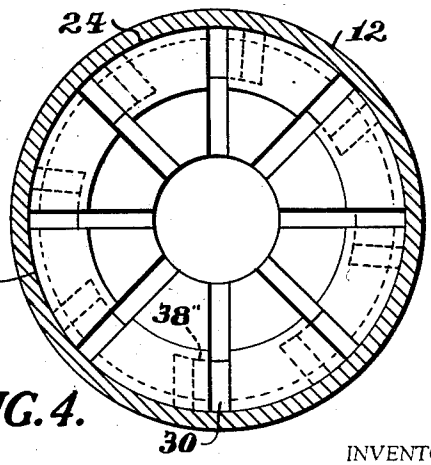


FIG. 4.

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FIG.5.

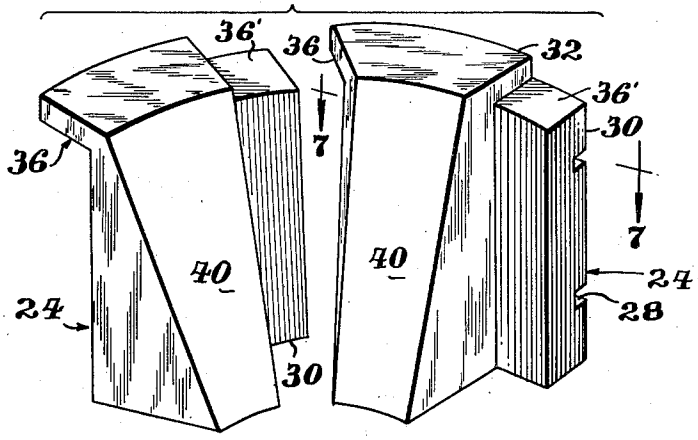


FIG.6.

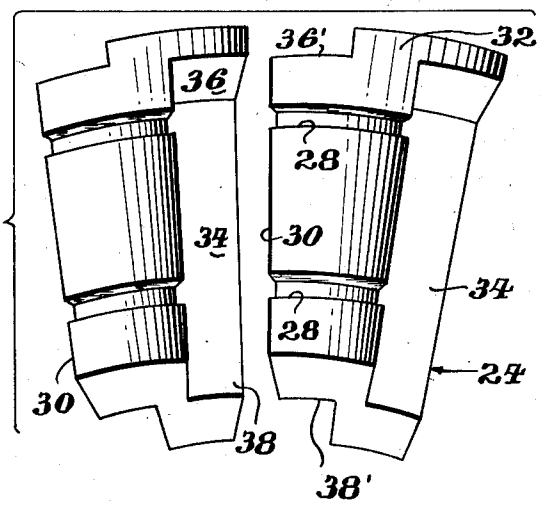
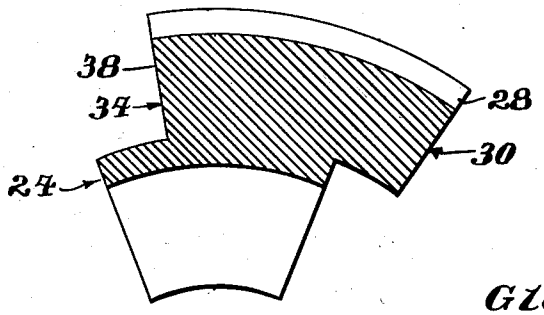


FIG.7.



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PACKER ASSEMBLY

Glenn L. Loomis, McAllen, Tex., assignor of one-sixteenth to John Stahl, one-sixteenth to Robert T. Elmore, one-twelfth to J. P. King, Sr., one-twelfth to J. P. King, Jr., one-twelfth to W. F. King, and one-eighth to the estate of Florence L. Stahl, deceased.

Application May 2, 1955, Serial No. 505,133

2 Claims. (Cl. 166—203)

The present invention relates to a packer assembly including a packing made of an inert substantially rigid material for use in a confined closure such as in a string of casings or flow tubing in oil wells or the like. More particularly, the present invention relates to a packer assembly having a packing which may be set in a deep oil well or the like and which may then be withdrawn when the necessity arises and reused.

The present application is a continuation-in-part of my co-pending United States application, Serial No. 383,577, filed October 1, 1953, now abandoned.

In the prior art, packers for use in oil wells or the like usually included a sleeve-type packing made of rubber or similar resilient deformable compositions and materials. These types of packings have been used in various stages of drilling in an oil well by expanding them into sealing engagement with a casing and providing a seal between the casing and a packer head. Also, packers have been used with packings made of malleable lead sleeves which are pressed or deformed into sealing engagement with the wall of a casing by the weight of the well flow tubing on which they are mounted or by some other suitable means.

In the present-day drilling of oil wells and the like, the wells may often go into the ground to depths of 15,000 to 20,000 feet where very high pressures up to approximately 20,000 p. s. i. and temperatures up to approximately 400° F. are encountered. Difficulties arise in the use of a rubber or composition type of packings in a packer assembly in that the rubber or composition cannot withstand the high pressures utilized or encountered in modern-day drilling, nor, can they withstand the high temperatures now experienced. Under certain pressure and temperature conditions, the rubber or composition packing will have a tendency to adhere or vulcanize to the casing wall or will extrude past the packer head. Consequently, it is almost impossible to maintain a good seal or to remove such a packing from the well, and if it is removed further use of the packing is impossible.

Therefore, an object of the present invention is to provide a packer assembly for use in deep wells or the like and having a packing which can withstand high temperature and pressure conditions throughout its continuous use in the well.

Another object of the present invention is to provide a packer assembly for use in deep wells having a packing made from an inert material which is substantially rigid at temperatures and pressures encountered in the well.

Further, an object of the present invention is to provide a packer assembly having a packing made of a metal or alloy which may be set in a casing or the like and, when the necessity arises, may be retracted and withdrawn from the casing and reused. Various types of lead sleeves have been used in the past as packings for packer assemblies, but these packer assemblies are not retrievable once the packings have been expanded in the well casing as they will not regain their original shape for removal.

Still another object of the present invention is to provide a packer assembly having a synthetic resin packing

for use in deep wells or the like which can withstand high temperature and pressure conditions throughout its continuous use in the well.

A still further object of the present invention is to provide a packer assembly which will not be deteriorated by chemicals used in the drilling mud. Ancillary to the preceding object, it is also an object of the present invention to provide a packing for a packer assembly which will not be deteriorated by the high temperatures found in deep wells nor will extrude past the packer head due to the extreme pressure within the well. By having the packer assembly and its associated parts made entirely of metal, metal alloys, and synthetic resins or the like, temperature and pressure conditions are not critical to its use as a fluid-tight seal.

A still further object of the present invention is to provide a packer assembly which will have greater annular clearance between it and the outer well casing, thereby facilitating the entry and removal of the assembly into the casing.

These and other objects of the invention will appear more clearly in the specification, claims and drawings in which:

Figure 1 is an elevational view partly in section of the metal, metal alloy, or synthetic resin, e. g., Teflon, packing and disclosing the packer assembly positioned in a casing with the packing in the retracted non-sealing position;

Figure 2 is a view of the packer assembly in the casing taken on the line **2—2** of Figure 1;

Figure 3 is an elevational view of the packer assembly partially in section similar to Figure 1 but showing the packing in the expanded and sealing position;

Figure 4 is a view similar to Figure 2 but taken on the line **4—4** of Figure 3, the mandrel and well flow tubing having been omitted for the purpose of clarity;

Figure 5 is a perspective view of two of the arcuate segments of the packing as viewed toward their interior;

Figure 6 is a perspective view of two of the segments of the packing as viewed toward their exterior; and

Figure 7 is a cross sectional view of one of the segments of the packing taken on the line **7—7** of Figure 5.

Referring specifically to the drawings wherein like character or reference numerals represent like or similar parts, the present invention includes a packer assembly generally designated by the numeral **10**, the packer assembly being adapted to be lowered into a casing **12** of an oil well or the like in any suitable manner, such as on a tubing anchor of the type disclosed in the Charles H. Barnes United States Patent No. 2,603,294, issued July 15, 1952. The packer assembly **10** includes a packer head **16** which may form the upper portion of a tubing anchor, such as disclosed in the aforementioned Barnes patent, an abutting segmental expansible packing member **18**, a mandrel **20**, and oil well flow tubing **14** on which the mandrel is supported. Packing **18** and packer head **16** are made of an inert material which is substantially rigid at temperatures and pressures encountered in the well, as will be described in more detail later in the specification. After the packer assembly **10** has been positioned in the well, at a desired location, the mandrel **20** is then moved into engagement with the packing **18** to expand the packing into sealing engagement with the wall of casing **12**. Removal of the packer assembly **10** from the well is accomplished by first relieving the pressure of mandrel **12** against the packing **18** to retract the same from engagement with the wall of the casing and then removing the packer assembly by removal of the tubing anchor or the like from the well.

Packer head **16**, which is of a diameter substantially smaller than the inside diameter of casing **12**, is polished, lapped or smoothed, so that its surface **22**, which engages

or abuts the packer **18**, will provide a fluid-tight seal therewith. Further, packer head **16** has sufficient clearance between it and the casing wall so that it may be easily inserted into the casing **12**. As shown in Figure 1, packer head **16** is utilized when the well is provided with the flow tubing **14** and therefore must have a longitudinal bore throughout so that it may be received on the flow tubing. Since the packer head **16** may be supported on the flow tubing **14** by a tubing anchor of the type disclosed in the aforementioned Barnes patent, the bore through the packer head must be of such a diameter as to form a fluid seal with the flow tubing **14** so that when packing **18** is expanded into sealing engagement with the wall of casing **12** to form a fluid seal therewith, the packer head also forms a fluid seal with the lower end surface of packing **18** and the outside of flow tubing **14**.

Packing **18** is comprised of a plurality of arcuate segments **24** held together as a cylindrical unit by means of one or more snap rings **26** which circumscribe the same. Segments **24** are made of an inert material which is substantially rigid at temperatures and pressures encountered in the well, such material being metals, metal alloys, or synthetic resins and the like. Snap rings **26** are received in grooves **28** on the outer surface of each of the segments **24** and, therefore, do not interfere with the sealing action of these surfaces against the wall of casing **12**. As previously stated, snap rings **26** hold packing **18** in a retracted position, enabling the packer assembly to be inserted into the casing. When a fluid-tight seal is desired, the packing **18** is expanded against the sides of the casing and snap rings **26** will consequently be expanded. When pressure is released from packing **18**, snap rings **26** will return the segments to their abutting retracted position enabling the packer assembly **10** to be removed.

As previously mentioned, the packer assembly **10** including the mandrel **20**, the packer head **16** and packing **18** can be made of any metal or metal alloy capable of withstanding a particular condition occurring at the point of use of the assembly in the well. In other words, wells utilizing high caustc muds would require that the packer assembly be made of copper, copper alloys, stainless steel, titanium or the like. In wells utilizing an oil base or asphalt drilling fluid, the packer assemblies could be made of metal or metal alloys such as aluminum, aluminum alloys, or the like. In all instances the metal or metal alloy used in the packer assembly must have a higher melting point than the temperature encountered in the well and must also be able to withstand the pressure encountered in the well. In modern-day drilling of wells, it has been found that temperatures up to approximately 400° F. and pressures up to 20,000 p. s. i. are encountered.

In place of metals or metal alloys the packer assembly can be made of synthetic resins which are inert under the conditions of the oil well and are substantially rigid at temperatures up to about 400° F. and preferably up to about 425° F. or 450° F.

An outstanding example of such a material is polytetrafluoroethylene (Teflon). The use of polytetrafluoroethylene has several advantages over metal or rubber packer assemblies. It has been found that Teflon is ductile enough to make a good seal against the wall of the pipe. It is not affected by any of the chemicals encountered in an oil well, and in this respect is superior to any known metal or rubber. It is very resistant to extrusion and will not vulcanize to the casing wall while being resistant to a considerable amount of heat. Although Teflon is not ductile enough to be utilized as a packing in a conventional sleeve form in the manner of rubber, unexpectedly it has been found ideally suited to be used in the packing of the segmented form of the packer assembly of the present invention.

While Teflon is the preferred synthetic resin, other chemically inert, heat resistant and extrusion resistant resins can be employed in some types of wells. Among

such resins is polychlorotrifluoroethylene (Kel-F). This resin possesses similar properties to those of Teflon, but not to the same degree. That is, Kel-F is less resistant to heat and chemicals and is not as resistant to extrusion although it is somewhat more ductile than Teflon. It is considerably lower in cost than Teflon, and, hence, may be used as a substitute therefor wherever the condition of the oil well is not too drastic.

There can also be used other heat resistant synthetic resins such as asbestos filled polyethylenically unsaturated polyesters, e. g., asbestos filled polymerized diallyl phthalate.

Another synthetic resin which can be employed is an unfilled copolymer of a polyalkyleneglycol bisallyl carbonate and an allyl substituted 1, 3, 5 triazine, more especially a copolymer of diethylene glycol bisallyl carbonate with 10, 25 or 41.7% of triallyl cyanurate. Such a copolymer shows substantially no distortion at temperatures up to 410° F. and even higher. The copolymers are also very strong. The 41.7% triallyl cyanurate copolymer is the best from the standpoint of resistance to heat distortion but it is also much more brittle than the copolymers with lesser amounts of this component.

In general, the metal, metal alloy, or synthetic resin should be one capable of withstanding pressures up to 15,000 p. s. i. and preferably capable of withstanding pressures up to 20,000 p. s. i.

Referring specifically to Figures 5 through 7 inclusive, segments **24**, which form packing **18**, are so arranged as to provide a fluid-tight surface to surface seal when expanded into engagement with the wall of casing **12**. By having segments **24** in an overlapping relationship with each other, a fluid-tight seal will be provided when packing **18** is expanded into engagement with the wall of casing **12**. To provide a fluid-tight seal, the segments must overlap each other in both a radial and a longitudinal direction. In other words, there must be longitudinally overlapping surfaces of adjacent segments **24** as well as radially overlapping surfaces. Each segment **24** is provided with a circumferentially extending projecting portion **30** which is of less radial thickness than the segment and also of less longitudinal length than the longitudinal length of the segment. Each segment **24** is also provided on its outer periphery **32** with a recess **34** of a size complementary to the size of circumferentially extending projecting portion **30**. The recess portion **34** is adapted to receive the projection or overlapping portion **30** of an adjacent segment **24** and adapted to form a fluid-tight seal between its radially extending surface **36** and the radially extending surface **36'** of the overlapping portion **30**. Also a fluid-tight sealing surface will be provided between the longitudinally extending surface **38** of recess **34** and the longitudinally extending surface **38'** of the overlapping portion **30** of an adjacent segment.

The normal process of manufacture, such as machining or molding of the segments, makes their sealing surfaces true enough for an adequate seal. However, to further insure a fluid-tight seal, the surfaces of each of the segments **24** of packing **18** may be polished, lapped or smoothed. By polishing the surfaces of segments **24**, the surface to surface seal between adjacent segments is insured as well as the surface to surface seals between the packing **18** and the packer head **16** and the casing **12**.

In order that packing **18** may be expanded into engagement and sealing position with the walls of casing **12**, each segment is provided on its inner periphery with a tapered slightly concave surface **40**. When packing **18** is in the retracted position, the tapered concave surface **40** on each of the segments **24** will form a tapered bore **42** therethrough. As previously explained, to expand packing **18**, tapered mandrel **20** having a taper complementary to the taper of surface **40** and a bore **41** therethrough, is lowered with the flow tubing **14** and into contact with the tapered bore **42** after the packer assembly **10** has been temporarily anchored to the well casing. The wedging

action of mandrel **20** against the tapered bore **42** will evenly expand the segments **24** into engagement with the walls of the casing **12**.

As shown in Figure 2, the packer **18** has been expanded into sealing engagement with the walls of casing **12**. It will be noted that the segments **24** of packing **18** overlap both radially as indicated at **36''** and longitudinally, as shown in Figure 4, at **38''**.

Although the invention has been disclosed as forming a seal between the casing **12** of an oil well and a packer head **16**, it is well within the scope of the invention that the packing structure may also be used to form a fluid-tight seal in any portion of a string of pipe of an oil well or in any confined enclosure such as a conduit or the like.

The operation of the device may be briefly summarized as follows:

If the packer assembly is to be utilized to form a seal between oil well flow tubing and a previous run casing, the packer head **16** is slidably supported on the section of well tubing **12** by means such as the tubing anchor shown in the aforementioned Barnes patent. Packing **18** is supported in abutting relationship on the packer head **16** and the mandrel **20** which is attached or affixed to flow tubing **14** in any suitable manner is supported adjacent the packing **18** but not in expanding contact with the packing **18**. The flow tubing **14** is lowered with the packer assembly **10** into the well casing and when the packer assembly has reached a desired position in the well casing, the packer head **16** is restrained from further downward movement in the casing **10** by any suitable means such as the tubing anchor of the aforementioned Barnes patent. The flow tubing **14** which has the mandrel **20** fixed thereto is then lowered a short distance with respect to the packer head **16** and it engages the tapered bore **42** of packing **18** expanding the same outwardly into sealing engagement with the wall of casing **12**. In other words, the relative movement toward each other of the packer head **16** and the mandrel **20** wedges the segments **24** of packing **18** outwardly into sealing engagement with the wall of casing **12**. Since the end surfaces **44**, as well as the peripheral and overlapping surfaces of each of the segments **24** can form surface to surface seals, packing **18** will form a fluid-tight seal when the packer is expanded into engagement with well casing **12** or the like. The overlapping portions of segments **24** will insure that the packing **18** provides a seal not only radially but also longitudinally.

The advantages of having a packer assembly which is made of metal, metal alloys, or synthetic resins are obvious in present-day drilling of deep wells. High temperatures and high pressures are encountered or developed and the packer assembly of the present invention can be used with the high temperatures and pressures and yet will not deteriorate from such conditions. Further, the materials mentioned herein will not deteriorate under the use of high caustic muds or oil base or asphalt emulsion drilling fluids. By having the packing comprised of a plurality of radially movable, substantially rigid segments normally urged into abutting relationship with each other, the packing may be lowered into the well in its retracted position and then positively expanded into sealing engagement with the casing. Since the device is not affected by temperature, heat, or the chemicals in the drilling, the packer assembly may be retracted and removed from the well when the necessity arises and, thus, may be used repeatedly.

The terminology used in this specification is for the purpose of description and not for limitation, as the scope of the invention is defined in the claims.

I claim:

1. In a packer assembly for use in a well casing or the like: said packer assembly including a cylindrically-shaped segmental expansible packing member, a packer head positioned at one end of said packing member and a tapered mandrel positioned at the other end of said packing member for expanding said packing member; said packing member having a retracted diameter substantially less than the diameter of the casing and comprising a plurality of outwardly movable arcuate segments having inner surfaces defining a tapered bore, outer sealing surfaces having a radius of curvature when said packing member is expanded substantially equal to the radius of curvature of the inside surface of the casing and endwise sealing surfaces; each of said arcuate segments of said packing member being provided with a circumferentially extending portion of less thickness than the segment and of less longitudinal length than the longitudinal length of the segment, each of said arcuate segments also having a recess oppositely disposed from and of a size complementary to the size of said circumferentially extending portion, said recess in each of said segments receiving said circumferentially extending portion of an adjacent segment so that the segments overlap each other forming longitudinal and radial sealing surfaces; resilient means circumscribing said arcuate segments for retaining them in position as a unit and normally urging them into a retracted abutting relationship with each other; said packer head having a circular cross-section with a maximum diameter substantially smaller than the diameter of the well casing, said packer head also having an end sealing surface, said end sealing surface of said packer head abutting said endwise sealing surfaces of the segments of said packing member; and said tapered mandrel and said packer head being movable relative to each other to cause said mandrel to engage the tapered bore of said packing member and expand the segments of said packing member outwardly into engagement with the inner surface of the well casing to form a fluid seal between the packer head and the inner surface of the well casing.

2. A packer assembly of the character described in claim 1 including well flow tubing, and wherein said packer head is provided with a longitudinal bore and is positioned on said flow tubing, said packing member also being positioned on said flow tubing and said mandrel being attached to said flow tubing for movement into the tapered bore of said packing member.

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