Jan. 19, 1960 E. H. CLARK, JR 2,921,632

EXPANSIBLE AND RETRACTABLE PACKING STRUCTURE

Filed March 5, 1956

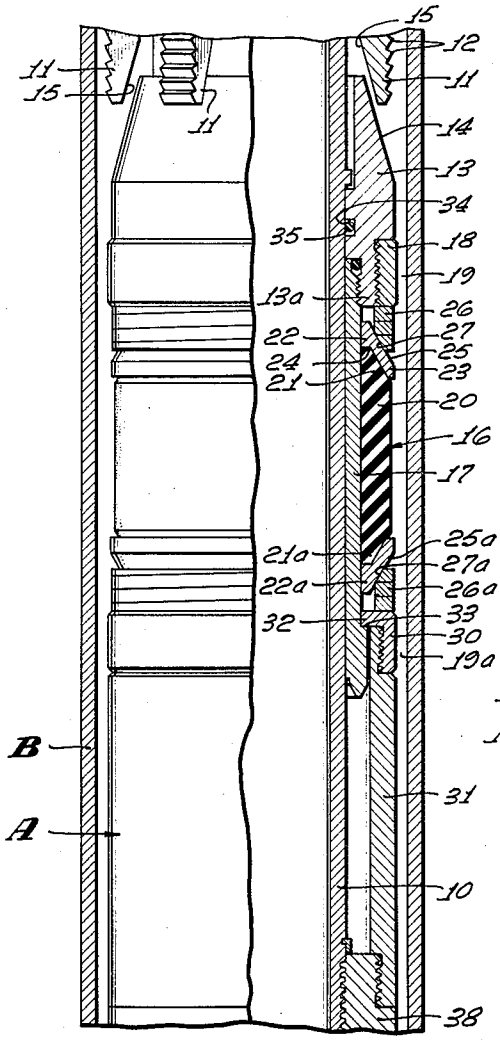


FIG. 1.

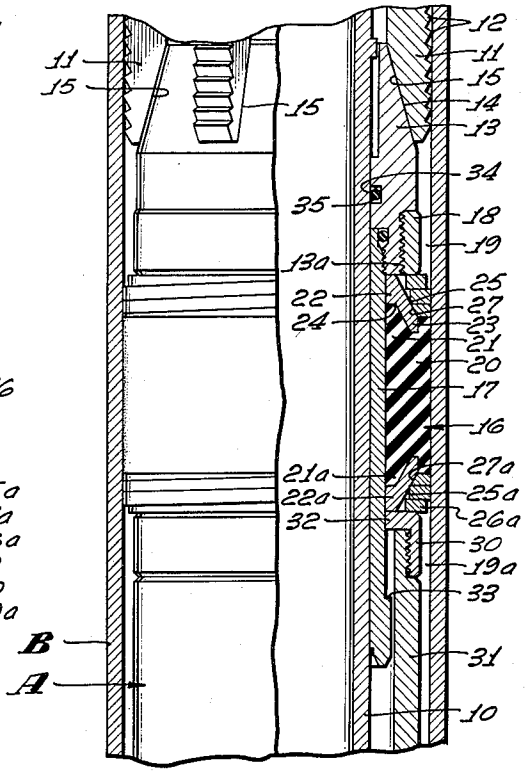


FIG. 2.

EARNEST H. CLARK, JR.
INVENTOR.

BY
Mellin and Hanscom
ATTORNEYS.

United States Patent Office 2,921,632
Patented Jan. 19, 1960

2,921,632

EXPANSIBLE AND RETRACTABLE PACKING STRUCTURE

Earnest H. Clark, Jr., Downey, Calif., assignor to Baker Oil Tools, Inc., Los Angeles, Calif., a corporation of California

Application March 5, 1956, Serial No. 569,617

9 Claims. (Cl. 166—204)

The present invention relates to packing structures, and more particularly to packing structures adapted to effect a seal against the wall of well casings, well liners, and other confining enclosures.

Well packers are run in a well bore to a desired location or locations at which the packer is to be sealed off against a well casing, or similar conduit, disposed in the well bore. The packer usually includes a non-metallic packing member which packs off against the well casing, the packing member being prevented from moving longitudinally by an abutment portion of the packer tool. This abutment portion has substantial clearance with the wall of the well casing, to enable the well packer to be moved longitudinally in the well casing free from interference by the abutment portion. In view of the substantial clearance required, a relatively wide annular space exists between the abutment portion and the casing into which the non-metallic packing member tends to flow or to be extruded when subjected to high pressures or high temperatures, or combinations of the two conditions. Under some situations a substantial portion of the packing material may be dissipated through the clearance space, causing failure of the packing member. If the non-metallic packing is of the expansible and retractable type, the forcing of substantial packing material into the aforenoted clearance space, when the packing member is in expanded condition, can result in subsequent inability to retract the packing member.

An object of the present invention is to provide an improved well packer, in which the non-metallic packing member is prevented from being forced into the annular clearance space around the adjacent abutment portion of the apparatus.

Another object of the invention is to provide a well packer embodying an expansible and retractable device for bridging the clearance space between the abutment portion and the casing wall when subjected to a substantial force, to prevent cold flow of the packing material, the bridging device being normally in retracted position and tending to return to such retracted position when the force urging the packing material toward the clearance space is relieved.

A further object of the invention is to provide a well packer of the type indicated, in which no gap through the expansible and retractable bridging device exists when the device is in expanded condition, thereby providing no space through which the packing material can be extruded.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a combined side elevational and longitudinal section through an embodiment of the invention, with the packing structure in retracted position;

Fig. 2 is a view similar to Fig. 1, with the packing structure in its expanded condition.

The apparatus is disclosed in the drawings as being applied to a well packer A of the retrievable type, which is adapted to be run in a well casing B, sealed off therewithin, and then released from the casing to be shifted to a different location therewithin, or to be withdrawn completely from the well casing. The invention will be described herein, by way of example only, in connection with the specific well packer of the kind disclosed in the application of Martin B. Conrad, Serial No. 536,415, filed September 26, 1955, for "Retrievable Double Holding Subsurface Well Tool," Patent No. 2,802,534. It is to be understood, however, that the invention is applicable to other specific types of well tools, and to packing structures generally.

As illustrated specifically in the above identified patent application, a tubular packer body **10** is provided, which is suitably connected to a tubular string (not shown), such as drill pipe or tubing, extending to the top of the well casing B in which the apparatus is movable longitudinally, and in which it is used. This body **10** is adapted to be releasably anchored to the well casing, as by providing a plurality of circumferentially spaced slips **11** around the body having wickers or teeth **12** engageable with the wall of the well casing. The slips are urged outwardly into engagement with the well casing by a tapered or frusto-conical expander **13** slidably mounted on the body of the tool, which has a tapered expander surface **14** adapted to coact with companion inner tapered surfaces **15** on the slips. Relative upward movement of the expander **13** within the slips **11** shifts the latter outwardly into anchoring engagement with the wall of the well casing B, after which a normally retracted packing structure **16** is expanded outwardly into sealing engagement with the wall of the wall casing.

The packing structure **16** includes a compression or booster sleeve **17** slidably mounted on the body of the tool, and threadedly secured to the lower portion of the expander **13**. This expander **13** actually forms an upper abutment for the packing structure in conjunction with a fixed gage ring **18** threaded on the exterior of the lower portion of the expander. The gage ring **18** has an external diameter substantially less than the internal diameter of the casing, there being a substantial annular clearance space **19** therebetween. Disposed around the compression sleeve **17** is an inherently contractible packing sleeve **20**, which may be made of rubber or rubber-like material. The upper end **21** of the packing sleeve is disposed within a generally cup-shaped expander member **22**, which is slidably mounted on the exterior of the compression sleeve, this expander member having a downwardly and outwardly tapering portion **23** providing a pocket **24** with the compression sleeve receiving the upper end **21** of the rubber or rubber-like packing sleeve.

The expander member **22** has a downwardly and outwardly tapering expander surface **25** engaging an inherently contractible, expandible gage ring or bridge member **26**, which is disclosed as being constituted by a helical spring member of several turns made of heavy wire of rectangular or square cross-sections. The upper end of the expanding gage ring engages the fixed gage ring **18** and lower abutment portion **13***a* of the expander, its lower portion being provided with an internally tapered surface **27** companion to the externally tapered surface **25** on the expander member.

The expansible and contractable gage ring **26** normally occupies a retracted position, in which its peripheral por-

tion extends outwardly no further than the periphery of the fixed gage ring **18**. However, the expansible gage ring can be shifted outwardly into contact with the wall of the well casing to bridge the annular clearance space **19** between the abutment portion **18**, that it continues to engage, and the wall of the well casing B.

The lower end **21***a* of the non-metallic rubber-like packing sleeve is disposed within a lower expander member **22***a*, which may be identical to the upper expander member **22**, although facing in an opposite direction. This lower expander member **22***a* has an expander surface **25***a* inclined in an upward and outward direction, engaging a companion internal expander surface **27***a* on an expansible flow preventing ring **26***a* which may be in the form of a helical spring like the other flow preventing member **26**, although facing in an opposite direction. The lower end of the helical spring or expansible gage ring **26***a* engages a fixed lower gage ring **30** threadedly secured onto the upper end of a thrust-tube or sleeve **31**, the lower end of which is threadedly attached to a guide member **38** secured to the body **10** of the tool. The lower expansible gage ring **26***a* normally occupies a retracted position with its periphery disposed no further outwardly than the periphery of the lower fixed gage ring **30**. The lower ring **26***a* is also adapted to be expanded outwardly into engagement with the well casing B, to bridge the annular clearance space **19***a* between the lower gage ring and the casing wall.

Downward movement of the sleeve **31** and the lower gage ring **30** with respect to the compression or booster sleeve **17** is limited by engagement of an inwardly directed flange **32** of the lower gage ring with an outwardly directed shoulder **33** provided on the lower portion of the compression sleeve **17**.

To prevent leakage of fluid through the working clearance spaces between the body **10**, on the one hand, and the compression sleeve **17** and expander **13**, on the other hand, the expander may be provided with an internal groove **34** receiving a non-metallic seal ring **35**, such as a rubber or rubber-like O-ring, which is in slidable sealing engagement with the periphery of the body.

As described in the above-identified patent application, the apparatus A disclosed is lowered in the well casing B to the location at which it is to be anchored in packed-off condition therewithin. When this position is reached, the slips **11** are prevented from moving upwardly by suitable means (not shown) which form no part of the present invention, but are specifically disclosed and described in the above-identified patent application, whereupon the body **10** is moved upwardly by the tubing string (not shown), the upward movement being transmitted through the guide member **38**, thrust-sleeve **31** and lower gage ring **30** to the lower expansible gage ring **26***a*, which tends to remain in its retracted position, since a substantial force is required before it can be expanded outwardly against the wall of the well casing. The lower expandible gage ring **26***a* transmits the longitudinal force of the body **10** to the lower expander member **22***a*, from where the force is transmitted through the packing sleeve **20**, which has a proper hardness, to the upper expander member **22**, from where it passes through the upper expandible gage ring **26** to the upper abutment structure and expander **18**, **13**, carrying the expander upwardly with respect to the slips **11**. The expander **13** is moved within the slips **11** to wedge the latter outwardly into firm anchoring engagement with the wall of the well casing B.

Following the anchoring of the slips against the well casing, the expander is prevented by the slips from moving upwardly to any further extent. Accordingly, a continuation of the upward movement and force of the body **10** of the tool will then shift the lower gage ring **30**, expansible gage ring **26***a*, and lower expander member **22***a*, which together may be considered as constituting a lower abutment structure, toward the upper abutment structure, consisting of the upper expander member **22**, upper expansible gage ring **26** and upper fixed abutment and gage structure **13***a*, **18**. The movement of the lower abutment device toward the upper abutment device foreshortens and compresses the packing sleeve **20** in a longitudinal direction, causing it to expand outwardly into sealing engagement with the wall of the well casing B.

The upper and lower expansible gage rings **26**, **26***a* have a very great resistance to outward expansion. As an example, a longitudinal force thereon of the order of about ten thousand to twenty five thousand pounds is required to expand them outwardly into engagement with the wall of the well casing. Accordingly, expansion of the packing sleeve **20** into full sealing engagement with the wall of the well casing occurs before there is any substantial expansion of the expandible gage rings **26**, **26***a* in an outward direction. However, the expansible gage rings will be expanded outwardly against the well casing before a sufficient pressure or force is applied upon the packing sleeve as to cause it to extrude to any substantial extent into the clearance space **19** or **19***a* between the expander member **13**, **18** or abutment **30** and the wall of the well casing.

As the upward expansible force on the body **10** increases, the expander members **22**, **22***a* begin expanding the expansible flow preventing rings **26**, **26***a* in an outward direction. An increase in the upward force will cause the expanded packing sleeve **20** to slide upwardly along the wall of the well casing B, moving the upper expander member **22** towards the upper abutment or expander **13**, **13***a*. When moving towards the latter, the expander member **22** will shift the upper expandible gage ring **26** outwardly toward the well casing. To place a definite limit on the extent of the expansion of the ring **26** against the wall of the well casing, the upper end of the upper expander member **22** will engage the upper abutment **13***a*, as shown in Fig. 2. At this time, several turns of the helical member **26** will be in engagement with the wall of the well casing B. The member **26** is also in contact with the expander surface **25** on the expander member **22**, the upper end of the expansible ring engaging the upper abutment **13***a* or its gage ring **18**. When this occurs, the annular space **19** between the upper expander member **13**, **18** and the wall of the well casing is completely bridged by the expandible member **26**, the rubber packing material being capable of flowing only partially around the upper expander member **22** until it contacts the expansible ring. The expansible ring **26** bridges this space, and also effectively bridges the annular space **19** around the fixed gage ring **18** and the wall of the well casing.

The lower expansible member **26***a* functions in a similar manner. As the upward force imposed thereon by the body **10** increases sufficiently, the lower gage ring **30** moves toward the lower expander member **22***a*, shifting the expansible ring **26***a* along the tapered surface **25***a* of the latter and radially outward toward engagement with the wall of the well casing B, to bridge the annular clearance space between the lower expander member **22***a* and the casing wall. Although the force required to fully expand the lower expandible member **26***a* outwardly is rather high, yet such force is lower than the force imposed on the packing sleeve **20** which will cause it to tend to extrude through the clearance space between the lower expander member **22***a* and the casing wall. When such extruding forces are reached, as a result of further compression forces being exerted on the packing structure, the expandible gage rings are both engaged firmly with the wall of the well casing B, to prevent the rubber packing material from flowing therebeyond.

In the event that very high pressures or very high temperature conditions are present in the well casing below the well packer A, or in the event that combinations of high pressures and high temperatures exist in the well casing below the well packer, forces will be exerted on the packing structure **16** in an upward direction, the forces being resisted by the wedging action of the ex-

pander 13 within slips 11, to hold the latter anchored against the well casing. The upwardly directed forces imposed on the packing structure cannot extrude the packing sleeve 20 through any clearance spaces, in view of the bridging action of the upper expanding gage ring 26. The bridge formed is circumferentially continuous, there being no gaps at any point around its circumference through which the packing material can be forced.

Similarly, in the event that a very high pressure differential exists in the annulus above the packing structure 16 between the body 10 of the tool and the well casing B, such downwardly directed force will merely slide the packing structure 16 downwardly, while it remains in a packed-off condition, as described in the above-identified patent application and in United States Patent 2,675,876. If the pressure differential in the annulus above the packing structure 16 is not too high, then the expandible gage rings 26, 26*a* may actually retract, at least to some extent, which will facilitate the sliding action of the packing structure 16 along the wall of the well casing when moving in a downward direction. However, in the event that the pressure becomes very high, then such great downwardly directed forces will expand the lower gage ring 26*a* into full contact with the wall of the well casing, preventing the pressure from extruding the packing material through the lower clearance spaces around the lower expander member 22*a* and around the fixed lower gage ring 30.

Regardless of the direction in which the pressure is acting upon the packing structure 16, when it is desired to release the tool and move it longitudinally within the well casing, it is only necessary to relieve the pressure differential on the packing structure and lower the body 10. Such lowering action will move the lower fixed gage ring 30 away from the upper fixed gage structure 18, 13, permitting the expansible gage rings 26, 26*a* and the packing sleeve 20 to retract to their normal positions, such as disclosed in Fig. 1, wherein substantial clearance exists around the entire packing structure 16. The well tool A may be now moved longitudinally in the well casing to a new setting location, or withdrawn entirely from the well bore.

It is, accordingly, apparent that a packing structure has been provided which embodies expansible elements for insuring against the cold flowing of the packing material through any clearance spaces existing between parts of the apparatus and the wall of the surrounding enclosure, such as the wall of the well casing. The devices for preventing cold flowing of the packing material are retractible, so that the release of the expansible force on the non-metallic, elastic packing member causes such devices 26, 26*a* to retract, which permits the apparatus to be moved, with facility, longitudinally in the well casing. Not only are the cold flow preventing devices expansible and retractable, but when expanded outwardly against the wall of the confining enclosure, to bridge the annular clearing spaces, no gaps remain longitudinally therethrough, into and through which the packing material can be forced. Because of the fact that the bridge members or gauge rings 26, 26*a* are flexible, they will conform to different internal diameters of casings against which they engage, assuring that no gap remains through which the packing material will extrude.

The inventor claims:

1. In a packing assembly: a pliant packing engageable with a companion member; abutment means adjacent said packing and providing a clearance space with the companion member; an expander member engaging said packing and having a tapered surface; and a helical spring wound about an axis substantially coaxial of the packing; said spring engaging said abutment means and said tapered surface and shiftable by said tapered surface of said expander member laterally into engagement with the companion member to bridge said clearance space upon relative longitudinal movement between said expander member and abutment means while maintaining said spring in engagement with said expander member and abutment means.

2. In a packing assembly: a pliant packing engageable with a surrounding companion member; abutment means adjacent said packing and providing a clearance space with the companion member; an expander member engaging said packing and initially spaced from said abutment means, said expander member having a tapered external surface converging in a direction toward said abutment means; and an inherently contractible helical spring wound about an axis substantially coaxial of said packing and engaging said abutment means and said expander member and expandible by said tapered surface of said expander member laterally outward into engagement with the companion member to bridge said clearance space upon movement of said expander member toward said abutment means while maintaining said spring in engagement with said expander member and abutment means.

3. In a packing assembly: a pliant packing engageable with a companion member; abutment means adjacent said packing and providing a clearance space with the companion member; a rigid metallic expander member engaging said packing and disposed between an end of said packing and said abutment means; and a shiftable expansible and contractible metallic one-piece flexible bridge member between and engaging said abutment means and said expander member and shiftable by said expander member laterally into engagement with the companion member to bridge said clearance space upon relative longitudinal movement between said expander member and abutment means while maintaining said bridge member in engagement with said expander member and abutment means; said bridge member having an arcuate extent of more than 360 degrees and having portions in overlapping contact when engaging the companion member, whereby there is an absence of any space extending longitudinally through said bridge member through which said packing can be forced.

4. In a packing assembly: a pliant packing engageable with a companion member; abutment means adjacent said packing and providing a clearance space with the companion member; a rigid metallic expander member engaging said packing and disposed between an end of said packing and said abutment means, said expander member having a tapered surface; a shiftable expansible and contractible metallic one-piece flexible bridge member between and engaging said abutment means and said tapered surface and shiftable by said tapered surface of said expander member laterally into engagement with the companion member to bridge said clearance space upon relative longitudinal movement between said expander member and abutment means while maintaining said bridge member in engagement with said expander member and abutment means, said expander member being engageable with said abutment means to limit the extent of lateral movement of said bridge member.

5. In a packing assembly: a pliant packing engageable with a surrounding companion member; abutment means adjacent said packing and providing a clearance space with the companion member; a rigid metallic expander member engaging said packing and initially spaced from said abutment means, said expander member being disposed between an end of said packing and said abutment means; an inherently contractible metallic one-piece flexible bridge member between and engaging said abutment means and said expander member and expandible by said expander member laterally outward into engagement with the companion member upon movement of said expander member toward said abutment means to bridge said clearance space while maintaining said bridge member in engagement with said expander member and abutment

means; said bridge member having an arcuate extent of more than 360 degrees and having portions in overlapping contact when engaging the companion member, whereby there is an absence of any space extending longitudinally through said bridge member through which said packing can be forced.

6. In a packing assembly: a pliant packing engageable with a surrounding companion member; abutment means adjacent said packing and providing a clearance space with the companion member; a rigid metallic expander member engaging said packing and initially spaced from said abutment means and disposed between an end of said packing and said abutment means, said expander member having an external tapered surface; an inherently contractible metallic one-piece flexible bridge member between and engaging said abutment means and said tapered surface and expandible by said tapered surface of said expander member laterally outward into engagement with the companion member upon movement of said expander member toward said abutment means to bridge said clearance space while maintaining said bridge member in engagement with said expander member and abutment means, said expander member being engageable with said abutment means to limit expansion of said bridge member.

7. In a packing assembly: a pliant packing engageable with a surrounding companion member; abutment means adjacent said packing and providing a clearance space with the companion member; a rigid metallic expander member engaging said packing and initially spaced from said abutment means and disposed between an end of said packing and said abutment means, said expander member having an external tapered surface converging in a direction toward said abutment means; an inherently contractible metallic one-piece flexible bridge member between and engaging said abutment means and said tapered surface and expandible by said tapered surface of said expander member laterally outward into engagement with the companion member upon movement of said expander member toward said abutment means to bridge said clearance space while maintaining said bridge member in engagement with said expander member and abutment means, said expander member being engageable with said abutment means to limit expansion of said bridge member.

8. In a packing assembly: a pliant packing engageable with a companion member; abutment means adjacent said packing and providing a clearance space with the companion member; an expander member engaging said packing and disposed between an end of said packing and said abutment means; and a helical spring wound about an axis generally coaxial of said packing member and disposed between and engaging said abutment means and said expander member; said expander member engaging a side portion of said spring and being movable relatively toward said abutment means and along said spring to shift said spring laterally into engagement with the companion member to bridge said clearance space while maintaining said spring in engagement with said expander member and abutment means.

9. In a packing assembly: a pliant packing engageable with a surrounding companion member; abutment means adjacent said packing and providing a clearance space with the companion member; an expander member engaging said packing and initially spaced from said abutment means and disposed between an end of said packing and said abutment means; a helical spring wound about an axis substantially coaxial of said packing and engaging and being disposed between said abutment means and said expander member; said expander member engaging an inner side portion of said spring and being movable relatively toward said abutment means and along said spring to shift said spring laterally outward into engagement with the companion member to bridge said clearance space while maintaining said spring in engagement with said expander member and abutment means.

References Cited in the file of this patent

UNITED STATES PATENTS

785,907	McBride	Mar. 28, 1905
1,357,958	Crowell	Nov. 9, 1920
2,171,049	Simmons	Aug. 29, 1939
2,217,038	Alley	Oct. 8, 1940
2,603,294	Barnes	July 15, 1952
2,695,069	Baker et al.	Nov. 23, 1954
2,734,582	Bagnell	Feb. 14, 1956
2,767,795	Bush	Oct. 23, 1956