

Aug. 22, 1944.

J. J. FITZPATRICK

2,356,232

PACKING DEVICE

Filed March 13, 1943

2 Sheets-Sheet 1

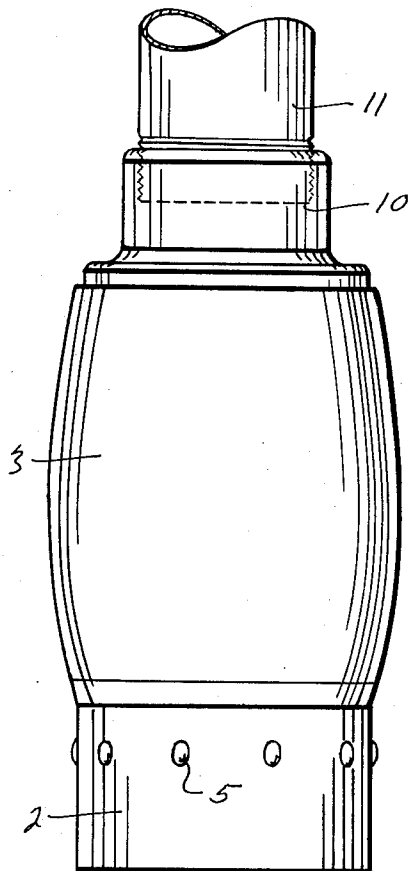


Fig. 1

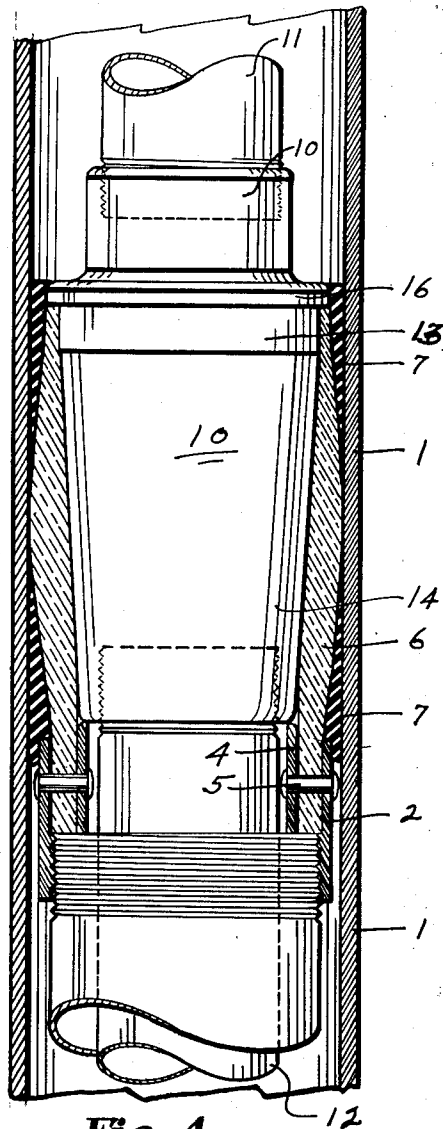


Fig. 4

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2 Sheets-Sheet 2

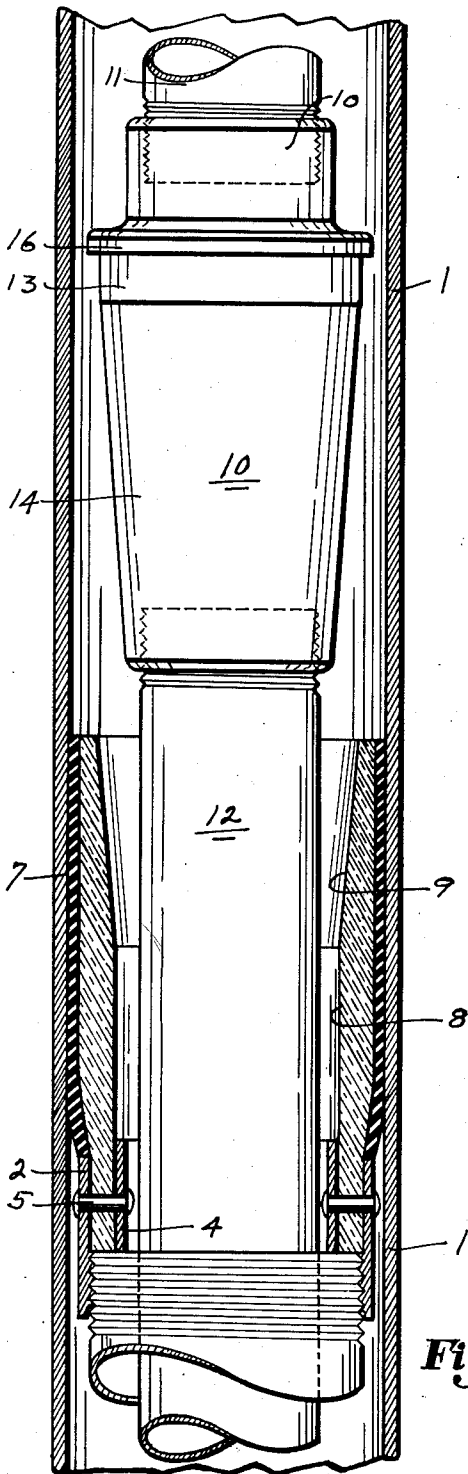


Fig. 2

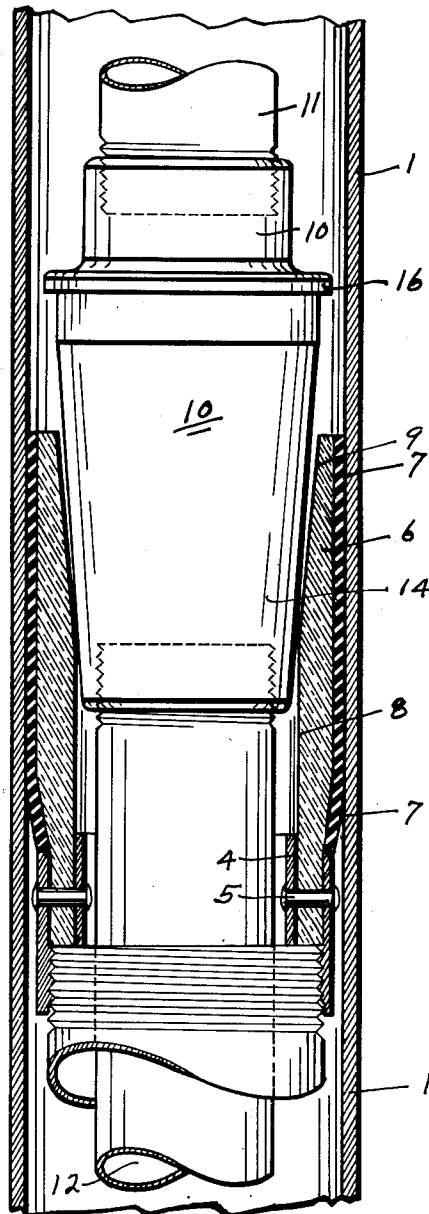


Fig. 3

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2,356,232

PACKING DEVICE

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8 Claims. (Cl. 166-10)

My invention relates generally to apparatus for hermetically packing between two concentrically disposed tubular elements, and more particularly to apparatus for packing between a well casing and a string of production tubing therein.

This invention is the outcome of experiments which were begun prior to the filing of my application for patent on improvement in well packer filed in the United States Patent Office on February 17, 1940, under Serial No. 319,494, wherein is disclosed a packer sleeve and packer expander having some of the features used in the present invention.

One object of the invention is to provide an improved packing device for use with usual setting slips or other gripping means of a well packer, or similar device.

A particular object is to provide a packing device which may be repeatedly re-set without material injury to the sealing element, and which when once set will hold enormous fluid pressures.

A further object is to provide a device of this class which seals through the application of a laterally exerted expanding pressure in contradistinction from those well or tubing packers which are expanded laterally through the exertion of a vertical compressive force.

In the majority of well packers of present use, a resilient or elastic tubular sleeve is utilized to seal the annular space around a production tubing section, or a continuation thereof within the well casing, and the sleeve is expanded laterally by vertical compression. That type of packer sleeve scrapes the packer sleeve longitudinally downward along the rough inside surface of the casing during the expanding operation, and consequently becomes quickly worn exteriorly when re-set frequently.

A further important object of the present invention is to provide a well packer structure which will positively release from its sealing position without injury, and which may be pulled without the creation of a swabbing effect.

After much experimentation, carried on in many wells of the various oil fields of the United States, with packers of practically every type which has been offered for sale during the last twenty-five or thirty years, I have discovered that in order to accomplish the desired results, the elastic packer sleeve must be expanded laterally from within, in contradistinction to lateral expansion through longitudinal compression of the sleeve. Also, that the inner tubular element, against the exterior surface of which the packer sleeve seals, must be capable of complete and

unimpeded removal from the packer sleeve in order to prevent the usual swabbing effect.

It has further been discovered that the expansion of the elastic sleeve from within must, in order to be entirely practicable, be accomplished with little or no longitudinal compression of the sleeve.

Further objects of the present invention therefore are to provide a packer structure wherein the inner tubular element, against which the elastic packer sleeve seals, is completely removable from the packer sleeve before the sleeve is pulled upwardly in the well casing; and wherein the relationship of the packer sleeve and the sleeve expander are such that the sleeve is expanded into sealing position without any material longitudinal compression.

Other objects of the invention will be apparent from the following description when taken in connection with the accompanying two-sheet drawings, wherein:

Figure 1 is an elevational view of the packer as it appears when expanded, but not confined within a well casing;

Figure 2 is an elevational view, partially in section, showing the relationship of the packer sleeve and the packer sleeve expander before the expander has entered the sleeve;

Figure 3 is a similar view showing the expander within the sleeve, but before it has been downwardly moved sufficiently to cause any expansion of the sleeve; and,

Figure 4 is a similar view showing the expander fully within the packer sleeve, and showing the sleeve fully expanded.

Like characters of reference designate like parts in all of the figures.

In the drawings:

The reference numeral 1 indicates a usual well casing within which the device is adapted to operate. The packer structure includes a supporting ring 2 interiorly threaded at its lower end to receive the upper end of any conventional setting apparatus whereby the ring 2 may be anchored against downward movement within the casing. Setting apparatus such as is disclosed in U. S. Pat. No. 1,699,050 issued January 15, 1929, to Erd V. Crowell would function suitably with the present packer structure, and is "conventional" as referred to hereinabove.

An elastic packer sleeve 3 has its lower end rigidly supported by the upper portion of the supporting ring 2, and is anchored thereto through the office of an inner ring 4 and rivets 5. The packer sleeve 3 is preferably made of a

laminated canvas portion 6 and an outer layer 7 of rubber or similar product. The sleeve 3 has a longitudinal through bore which consists of a lower portion 8 having a uniform diameter, and an upper portion 9 which is conically tapered downwardly and inwardly at a small degree of pitch.

A hollow exteriorly tapered sleeve expander 10 is provided above the sleeve 3 and is connected to the lower end of a section 11 of a production tubing string. A section 12 of tubing is threadedly attached to the expander 10 and extends downwardly through the sleeve 3. It is pointed out that the outside diameter of the tubing section 12 is such that the section 12 does not contact the bore 8 of the sleeve 3 at any time, and consequently the sleeve 3 cannot be expanded sufficiently to seal between the section 12 and the casing 1.

Exteriorly, the expander 10 has an upper cylindrical portion 13 and therebelow a downwardly and inwardly tapered conical portion 14. The outside diameter and the degree of taper of the conical portion 14 of the expander 10 is such in relation to the taper and diameter of the tapered bore 9 of the sleeve 3, that when the expander is moved downwardly into the sleeve 3, the lower end of the expander passes well into the portion 8 of the bore of the sleeve before the expander contacts the sleeve. This relationship is shown in Fig. 3. The result is that when the expander is further moved downwardly, from the position shown in Fig. 3, the sleeve is expanded laterally with little or no downward compression, and there is therefore no downward scraping of the sleeve 3 along the well casing 1.

In Fig. 4 the packer sleeve 3 and expander 10 are shown in the relative positions they assume when the expander has reached the lower end of its travel, and the sleeve 3 is in its fully expanded or sealing position. In this view the lower end of the expander has been stopped by contact with the upper end of the ring 4.

It is pointed out that the portions 8 and 9 of the bore of the sleeve 3 have conformed to the taper of the expander 10. Also, that the outer layer 7 of rubber no longer lies parallel or contiguous with the canvas portion 6 of the sleeve 3. Instead, the rubber 7 has flowed upwardly and downwardly from the vertical center line 15 of the sleeve. At the upper end, the rubber has flowed beyond the upper end of the canvas portion 6 and has partially enveloped an annular flange 16 made integral with the portion 13 of the expander. This flange 16 is provided for limiting longitudinal expansion of the canvas portion 6 of the sleeve. At the same time, the rubber 7 at the lower end of the sleeve has flowed downwardly to partially envelope the upper end of the supporting ring 2.

It is a scientifically established fact that when subjected to sufficient pressure, rubber becomes substantially a liquid and will flow through a very minute aperture, but when backed up by a solid surface, rubber acts as a solid body and will hold unlimited pressures.

In the present device, the sleeve 3 is expanded laterally to the extent that along the vertical center portion of the sleeve there is no appreciable amount of rubber lying between the canvas layer 6 and the well casing 1. The result is that the rubber 7 lying above the vertical center line of the sleeve is backed up therebelow against downward pressure from above as efficiently as if the juncture of the layer 6 and the inner surface of

the well casing 1 were a solid element. Consequently no amount of fluid pressure from above will cause the rubber at the upper end of the sleeve to flow downwardly between the layer 6 and the casing 1. By the same token, no amount of well pressure below the packer can force the rubber at the lower end of the sleeve upwardly between the layer 6 and the casing.

The condition of the packer layers 6 and 7 as shown in Fig. 4 are not problematical, but have been definitely established through experimentation.

When it is desired to pull the present packer, the tubing string 11 is lifted. This raises the expander 10 out of the packer sleeve 3. Since the expander is comparatively long and only slightly tapered, there is little frictional resistance to its removal from the sleeve. As soon as the expander is moved out of the sleeve, the sleeve is free to return to its original configuration as shown in Fig. 2, and since there is then no inner pipe member against which the packer can seal, the weight of the fluid column above the packer can have no tendency to prevent the sleeve from returning to its original configuration. There is therefore no chance of a swabbing action when the sleeve is finally raised in the casing. The well fluid thereabove can freely pass downwardly both inside and outside of the sleeve 3 during upward movement of the sleeve in the casing.

I claim:

1. In a well packer: a tubular packer expander mounted in a production tubing string to form a continuation thereof, a downwardly and inwardly tapered exterior surface carried by the expander; a tubular elastic packer sleeve surrounding the tubing below the expander and adapted to be anchored against downward movement in a well casing; and a downwardly and inwardly tapered bore in the sleeve; the diameter of the lower end of the tapered surface of the expander being considerably less than the diameter of the lower end of the bore of said sleeve, said expander adapted to be lowered into the bore of the sleeve for intimate contact therewith to expand the same laterally.

2. Organization as described in claim 1, in which the interior portion of the sleeve is constructed of fabric, and the outer portion consists of a layer of rubber sufficient in thickness to flow slightly longitudinally when the sleeve is expanded against a well wall.

3. Organization as described in claim 1, and means for limiting longitudinal expansion of the sleeve.

4. A well packer including: a tubular elastic sleeve surrounding a section of tubing and adapted to be anchored within a well casing against downward movement; an upwardly and outwardly flared bore in the upper portion of said sleeve; a uniformly cylindrical bore in said sleeve below and in communication with the flared bore; a tubular expander connected to the tubing above the sleeve and adapted to be moved downwardly into the sleeve for intimate contact therewith; a downwardly and inwardly tapered exterior surface carried by the expander, the diameter and degree of taper of said surface being such that a portion thereof passes below the junction of said bores before any expansion of the sleeve is accomplished.

5. Organization as described in claim 4, in which the interior portion of the sleeve is constructed of fabric, and the outer portion consists

of a layer of rubber sufficient in thickness to flow slightly longitudinally when the sleeve is expanded against a well wall.

6. Organization as described in claim 4, and means for limiting longitudinal expansion of the sleeve.

7. A well packer including: a substantially tubular elastic sleeve; a downwardly and inwardly tapered bore in the sleeve and extending downwardly therein for substantially one-half of the length of said sleeve; a cylindrical bore joining

the lower end of the tapered bore and extending throughout the remaining portion of the sleeve; and tapered means for laterally expanding the sleeve, the initial expansion of said sleeve being accomplished at the junction point of said bores.

8. A well packer including: a substantially tubular elastic sleeve; a downwardly and inwardly tapered bore in said sleeve; and tapered means for laterally expanding the sleeve initially at only the lower end of the bore.

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