March 13, 1956 J. LYNES 2,738,015

OIL WELL PACKER CONSTRUCTION

Filed July 23, 1954 3 Sheets-Sheet 1

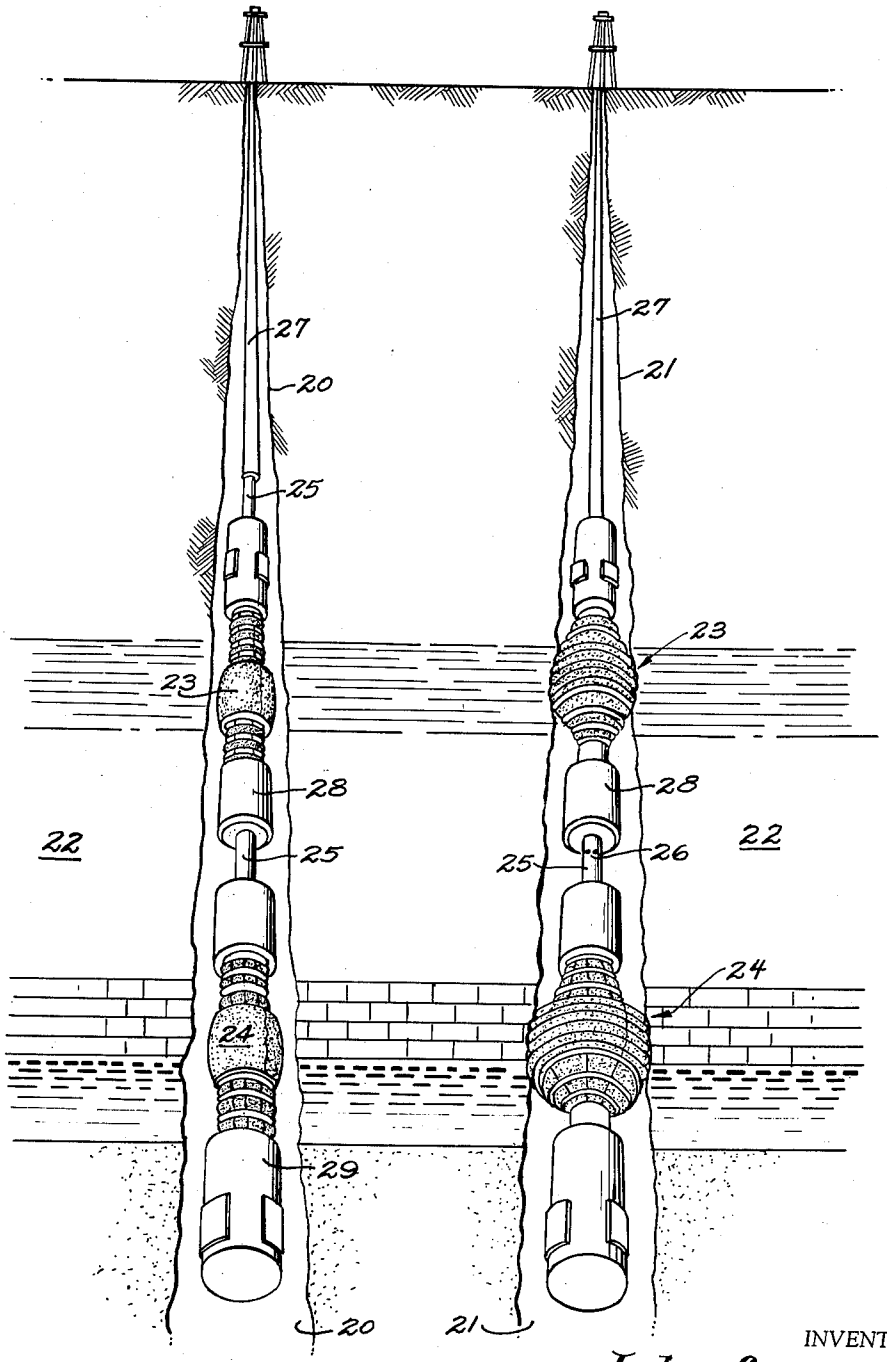


Fig. 1

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OIL WELL PACKER CONSTRUCTION

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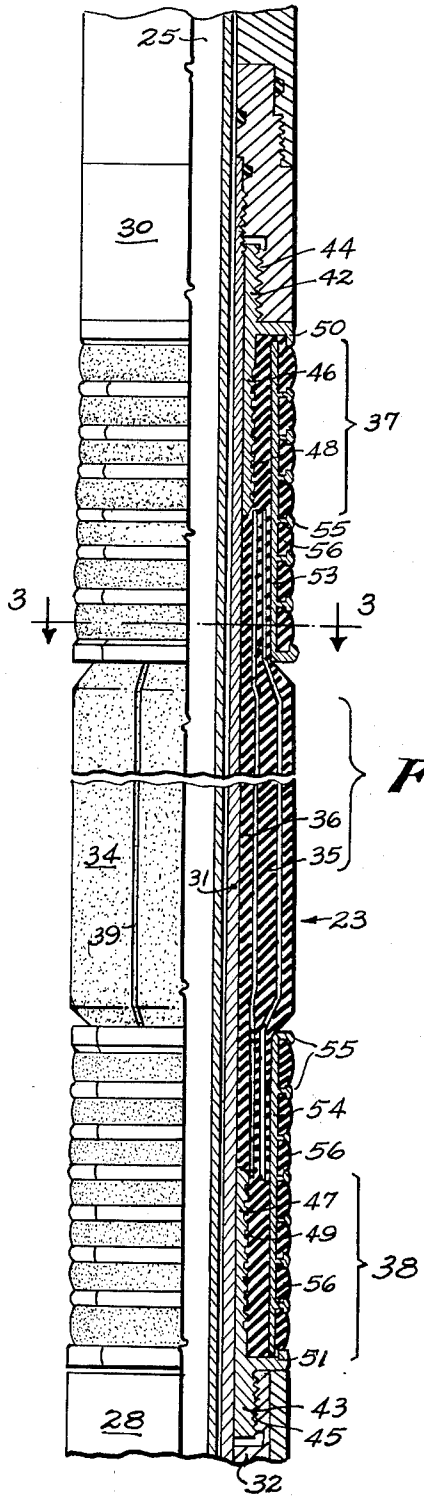


Fig. 2

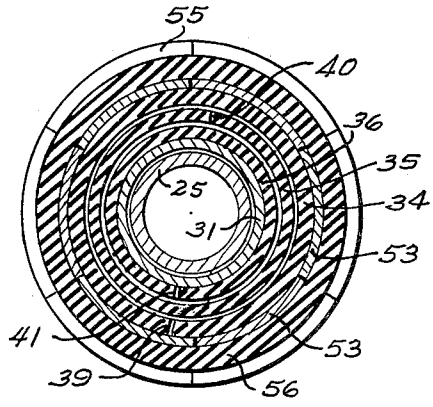


Fig. 3

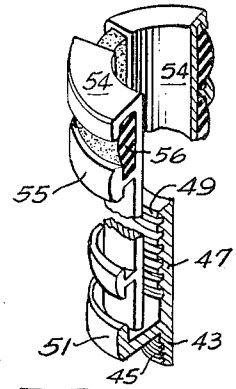


Fig. 6

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OIL WELL PACKER CONSTRUCTION

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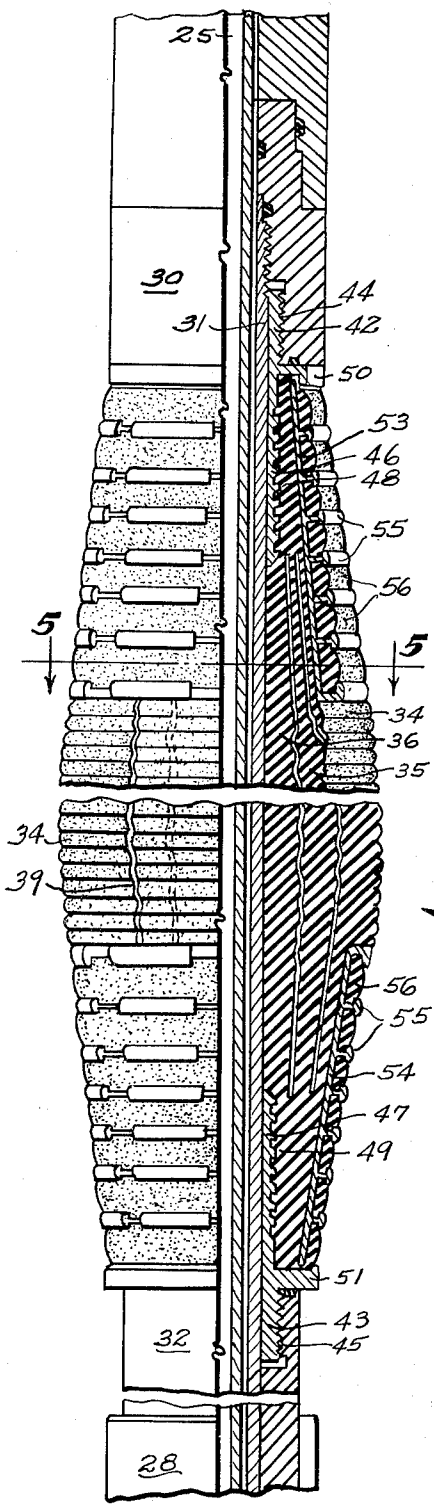


Fig. 4

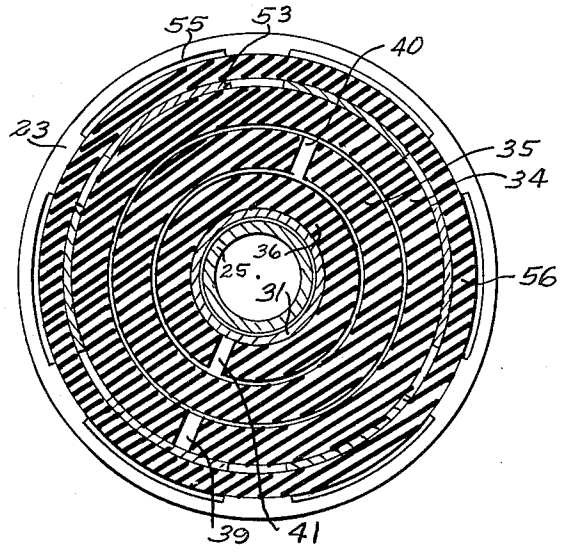


Fig. 5

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2,738,015

OIL WELL PACKER CONSTRUCTION

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Application July 23, 1954, Serial No. 445,412

6 Claims. (Cl. 166—185)

This invention relates to a new and improved packer construction for oil and gas well tools useful in the sealing off of oil bearing formations for the purposes of treating them in order to render them productive, and to recover the oil therefrom.

The present specification covers a tool which, generally speaking, has the same objects and advantages as those mentioned in my prior copending application Serial No. 307,958, filed September 5, 1952, entitled "Oil Well Tool," in my prior copending application Serial No. 341,896, filed March 12, 1953, entitled "Oil Well Treating and Production Tool," and in my prior copending application Serial No. 374,888, filed August 18, 1953, entitled "Packer Construction for Oil Well Tools," of which applications this application constitutes a continuation-in-part. The disclosures of said applications are hereby incorporated herein by this reference.

As previously explained, many valuable oil bearing formations are never successfully exploited after their discovery because of the great difficulty of gaining access to them. According to modern rotary drilling methods a column of drilling fluid or mud is present in the well which presents a formidable barrier to the driller in sealing off and gaining access to a productive formation which would produce if the proper conditions were present. Many packer tools have been devised to produce conditions favorable to recovery, but these have failed to keep pace with the progress made in drilling deep wells where pressures and temperatures deter the successful operation of such tools and make them short-lived.

Packer tools usually are designed to seal off a formation from the well liquids above and below it, by means of locating expansible members above and below the selected formation. When actuated, these members are intended to enlarge into contact with the bore hole to effect the seals. If this operation is successful, the formation may be relieved of the inhibiting pressures presented by fluid in the bore hole, and the oil induced to flow into ducts contained in the tool between the packers, then to the surface. Preliminarily, treating fluids, such as acids, may be injected into the selected formation to break it down.

Providing a tool which will operate accordingly has proved exceedingly difficult.

A particular object of the present invention relates to important improvements in the packer construction which renders such packers more rugged and capable of successful and sure operation.

As will be understood from my prior applications listed above, the packer component must comprise a resilient element of rubber or a rubber-substitute which must be enlarged with great force into contact with the bore hole walls in order to provide an effective seal. According to my prior inventions, I prefer to use a special type of packer element consisting of plural layers of resilient compressible material, each layer being bonded or vulcanized to its adjacent layers at the ends of the packer, each layer having an open seam longitudinally of its

body. These seams are located to avoid overlapping, and where necessary to insure this result, the seam may be omitted from the outer ply. The plies, if desired, may be formed of materials of differing elasticity in order to achieve the best results.

A packer element so constructed is capable of lateral enlargement when compressed longitudinally, which I accomplish by means of an hydraulically operated piston forcing the packer to bunch or wad together on its supporting means, the result being that its center portion enlarges laterally into firm contact with the well walls. In contrast to most packers which operate by hydraulic inflation the packer of my invention is not subject to as much internal stress and hence lasts longer.

Furthermore, the capability of my packer construction to enlarge from a small diameter to a relatively large one is highly satisfactory. The packer may be constructed to a small initial diameter which insures that it may be lowered into a well of any usual size without jamming. It may then be enlarged to an extent of which conventional packers are incapable. For example, a packer constructed according to my invention will enlarge from a diameter of 4 inches to 8½ inches upon the application of 2,000 lbs. pressure p. s. i.

A particular problem, to which this invention is related, has been to confine the packer ends so that longitudinal compression of the packer will not cause the material to escape from the compressive force exerted between the piston and the body member providing the support points for the packer ends. If the packer ends were not confined, this compressive force would be dissipated and the consequent wadding action of the packer body would be lost, and the packer would not achieve sufficient expansion in a lateral direction to engage the well walls. Further, rupture or tearing of the packer material would inevitably occur.

According to the invention, I provide collar means for confining the packer ends which include the following elements:

A ring of plates, in part bonded or vulcanized onto each packer end. Each ring substantially covers the packer end when the packer is actuated and opens out or separates in the manner of a fan into contact with the well walls when the packer material beneath enlarges.

External collar means comprising a plurality of sleeves or bands of elastic material, such as rubber or a rubber-substitute. These bands are positioned in recesses formed peripherally of the respective rings of plates. These bands are designed to expand in diameter along with the plates lying beneath but at all times confine the plates and the packer material beneath or between the plates. When the packer is to be collapsed these bands serve to compress the packer to its original diameter. A plurality of such bands is provided so that the breakage of one or more of them will not seriously affect the operation of the packer.

Couplings of a special design, housing each end of the packer and connecting the packer to the tool body and piston, respectively. These couplings provide surfaces to which the packer is vulcanized or bonded, and also means for securing the outer ends of the rings of plates.

More precise advantages of the invention will be explained hereinafter.

In the drawing:

Fig. 1 shows in perspective two views of a tool embodying the invention, as they would appear if located in bore holes of oil wells adjacent a formation selected for operations, the tool at the left being shown prior to actuation of the packers, the tool to the right being shown after the packers have made contact with the bore hole above and below a selected formation;

Fig. 2 is an elevation, with parts in section, of a packer

unit embodying the invention, the unit being in collapsed or inoperative condition;

Fig. 3 is a section on lines 3—3 of Fig. 2;

Fig. 4 is an elevation similar to Fig. 2, with parts in section, of the packer unit in enlarged or operative condition;

Fig. 5 is a section on lines 5—5 of Fig. 4; and

Fig. 6 is a fragmentary detail in perspective of the packer collar means and coupling of the invention.

The invention is illustrated in Fig. 1 as a tool suspended in bore holes **20** and **21** (the bore holes being shown in section), from a string of supporting pipe **27**. The tool as shown is composed of two packer units **23** and **24** located above and below a formation **22** selected for exploitation. The tool in bore hole **20** is shown as it would appear just subsequent to lowering in the well to the desired location, with packer units **23** and **24** in collapsed condition. The tool in bore hole **21** has been actuated so that packers **23** and **24** are providing effective seals in the well above and below formation **22**, whereupon formation **22** may be treated or produced through central ports **26**.

The control means whereby the packers are actuated and whereby ports **26** are operated do not form a direct part of the present invention, and may be those control means described in my Serial No. 307,958 or my Serial No. 341,896. Of these means it suffices to say that in the lowering position of the tool shown in bore hole **20**, fluid pressure may be delivered through pipes **27** and **25** through a port system to cylinders formed in body members **28** and **29** and containing the packer operating pistons to actuate the packers. With the packers actuated, as in bore hole **21**, the tool is locked in the bore hole, and pipe **25** may then be shifted relative to the tool to close off the packer cylinders with the pressure retained therein, and at the same time the central ports are opened to formation **22**. At this stage a fluid line connection exists between formation **22**, via ports **26**, and pipes **25** and **27** to the top of the well, whereupon treating or production operations may take place. A return shifting of pipe **25** relative to the tool will close ports **26** and open the port system to the packer cylinders, relieving the pressure and returning the packers **23** and **24** to a collapsed condition.

In Figs. 2–5, I show a packer unit **23** in enlarged scale, it being understood that the construction of packer unit **24** of Fig. 1 is substantially the same. The packer unit **23** is suspended from inner pipe **25** which in turn is coupled to supporting pipe **27**, shown in Fig. 1.

Each packer unit comprises an upper body member **30** and a lower body member **28** held in spaced relationship by a mandrel **31** externally of pipe **25**. The lower body member is formed with an internal recess which constitutes a ring-type cylinder containing ring-type piston **32**, to which fluid pressure may be delivered from inner pipe **25** by port means described above but not shown in these views.

The resilient compressible packer element of unit **23** is composed of a plurality of overlapping plies of material, three being illustrated at **34**, **35** and **36**. The ends of these plies are bonded together as by vulcanization, in the approximate zones indicated by brackets **37**, **38**. Preferably, between each bonded end each ply is provided with a longitudinal split seam, ply **34** having seam **39**, ply **35** having seam **40** and ply **36** having seam **41**. These seams are arranged on alternate sides per layer, or at least so arranged that the seams of adjacent plies will not register or overlap.

Packer **23** is mounted externally of mandrel **31** and pipe **25**, and is coupled to the lower internal end of body member **30** and to the internal upper end of piston **32** by means of couplings **42** and **43**, which make a threaded connection with these members at **44** and **45**. Couplings **42** and **43** are provided with extended flanges or sleeves **46**, **47** which extend inwardly along mandrel **31** beneath the packer ends. Sleeves **46**, **47** are provided with roughened or corrugated outer faces **48**, **49** for better adhesion to the inner walls of the packer ends to which they are vulcanized or bonded in the areas defined by brackets **37**, **38**. Couplings **42**, **43** are also provided with annular recessed flanges **50**, **51** for holding the ends of the rings of plates **53**, **54** described below. A perspective detail of coupling **43** is shown in Fig. 6.

With the construction so far described, it will be understood that when the piston is actuated, the packer **23** will be subjected to a powerful compressive force longitudinally of the tool so that it will wad together in the manner of an accordion and be forced against the bore hole walls. During this movement the packer unit would tend to splay out or tear loose from its fastenings so far described, without additional collar means to confine them.

The collar construction of the present invention includes a ring of bearing plates, there being one set of such plates disposed over each end portion of the packer, as shown at **53**, **54**. As best seen in Fig. 3, the ring of plates, of which six per ring are shown by way of example, substantially encircles the packer end when the latter is in collapsed condition, and tends to expand or fan out when the latter is actuated (Figs. 4 and 5).

Plates **53**, **54** are vulcanized or otherwise bonded to the packer ends to the extent shown by brackets **37**, **38**, and the ends of the plates are engaged in the recessed flanges **50**, **51** of couplings **42** and **43**.

Plates **53**, **54** are also provided with a series of annular flanges **55**, T-shaped in cross-section, to provide holding means for the external collar elements described below.

The external collar means of this invention consist of a plurality of elastic bands of rubber or rubber-substitute designated at **56** which are disposed peripherally of the packer ends and fit snugly in the spaces between flanges **55** of plates **53** and **54**. The collar bands are preferably made of a suitable compound of neoprene or hycar, or other elastic material which will not dissolve or lose its elasticity in wells where acids or sour crudes are present.

By way of example, a packer of this construction may preferably be designed to expand at a pressure of about 2,000 lbs. p. s. i., in which event if the plates forming the rings **53** and **54** are about 18 inches in length, external collar bands of ¾ inch thickness can resist expansion of the packer until about 1,700 lbs. p. s. i. is reached. The elastic bands can be made up and cured individually, but it is preferable to cure these bands after being placed over the bearing plates at the same time the packer ends are being vulcanized together and to the couplings and plates.

With this construction it will be appreciated that a packer having remarkable capabilities is provided. The drawings are not intended to be in scale and it may be cited by example that actual packers constructed according to this invention may be expanded laterally from about 4 inches diameter to about 15 inches, the latter diameter being in excess of that needed for actual operating conditions in standard size drill holes. These figures compare favorably with the expansion characteristics of conventional packers which usually do not expand more than 1 inch.

At the same time it will be appreciated that the novel collar means provide a secure bridge at each side of the packer units, the collars coming onto contact with the well walls when the packer is actuated as in bore hole **21** of Fig. 1 or in Fig. 4. The use of rubber or rubber-like bands for the external collar elements has unexpected advantages, since if these elements were metallic, a high-carbon steel would be required, which would be subject to corrosive action of the acids and other fluids present in a well. Breakage of such a band, if of steel, would also cause a more serious obstruction in the well compared to the case of breakage of a non-metallic collar band. Finally, the use of metallic springs to confine the bearing plates provides lesser potential expansion characteristics, since such springs take on a permanent set after a certain

amount of expansion, which is not true of the bands formed according to the invention. These latter may be expanded to a greater degree, and retain full resilience, which insures that the packer units will be collapsed to an inoperative position at once, when desired.

It will also be appreciated that the packer units of the invention are designed to be used singly or in pairs as illustrated herein, or three or more packers may be used in cases where well conditions indicate that a plurality of seals above or beneath a selected formation may be necessary.

What is claimed is:

1. In a well tool of the type described, a packer unit consisting of a pair of body members held in spaced relationship by a connecting member, said members being adapted for suspension in a well by a string of supporting pipe, one of said body members containing a cylinder and piston movable therein in the direction of said other body member, means for actuating said piston, a compressible resilient packer member connected between said piston and said other body member, and means for confining the end sections of said packer member when the piston is actuated, each means comprising an inner ring of plates disposed peripherally around each end portion substantially covering the area of said end portion when the packer is not actuated, said plates tending to separate from each other upon enlargement of the packer end portion beneath, and a collar formed of a plurality of bands of non-metallic elastic material substantially covering each ring of plates, confining each ring of plates and each end portion and having sufficient tension to collapse said rings of plates when said packer member is deactuated.

2. The tool according to claim 1, wherein each ring of plates is bonded to the end portion of the packer beneath, in the areas adjacent the extremities of said end portions.

3. The tool according to claim 1, wherein each packer end portion and ring of plates is connected to the piston and other body member by a coupling carried by said piston and body member, each coupling having a sleeve extending beneath the packer end portion and bonded thereto, each coupling also having an annular flange located adjacent the packer ends in which are contained the outer ends of the rings of plates, said plates being also bonded to said end portions in the areas adjacent the extremities of said end portions.

4. The tool according to claim 1, wherein the rings of bearing plates carry annular means for spacing and retaining the plural bands of elastic material forming the respective collars.

5. In a well tool of the type described, a packer unit consisting of a pair of body members held in spaced relationship by a connecting member, said members being adapted for suspension in a well by a string of supporting pipe, one of said body members containing a cylinder and piston movable therein in the direction of said other body member, means for actuating said piston, a compressible resilient packer member connected between said piston and said other body member, said packer member being composed of a plurality of overlapping plies of material having their ends bonded together, each ply having a longitudinal open seam therein located to avoid overlapping the seams of adjacent plies, and means for confining the end sections of said packer member when the piston is actuated, each means comprising an inner ring of plates disposed peripherally around each end portion substantially covering the area of said end portion when the packer is not actuated, said plates tending to separate upon enlargement of the packer end portion beneath, and a collar formed of a plurality of bands of non-metallic elastic material substantially covering each ring of plates, confining each ring of plates and each end portion and tensioned to resist the enlargement thereof.

6. In a well tool of the type described, a body adapted to be attached to the lower end of a string of pipe or the like in a well, an elongated compressible packer member carried by said body, actuating means also carried by said body operable against said compressible member to longitudinally compress and laterally expand said member, and means confining each end portion of said packer member, said means consisting of an inner ring of plates substantially covering the area of each end portion when the packer member is not actuated, the outer ends of each said ring of plates being secured against expansion by means carried by said body member, the inner ends of each ring of plates being free to separate upon enlargement of the packer end portion beneath, thereby constituting bridge means extending between the body and the well walls, each said ring of plates being substantially covered by a plurality of bands of non-metallic elastic material exerting sufficient tension to collapse said rings of plates when said packer member is deactuated.

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