May 22, 1956 B. S. MINOR 2,746,709

BLOWOUT PREVENTER AND PACKER AND HOLE CLOSER THEREFOR

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Fig. 1.

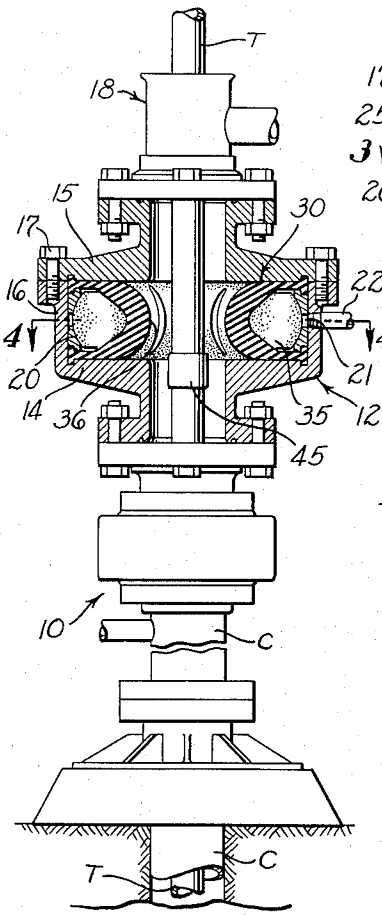

Fig. 2.

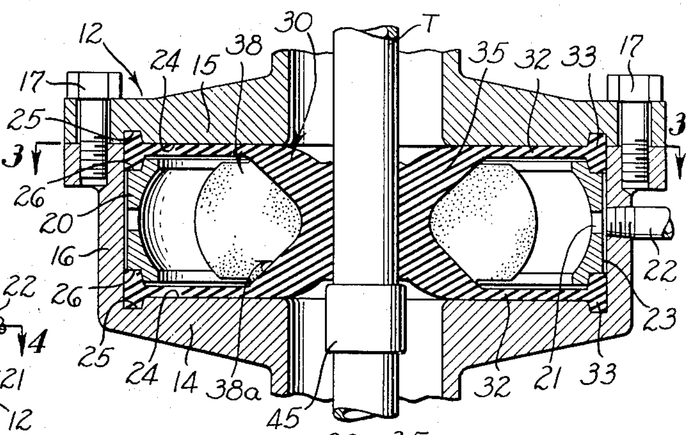

Fig. 3.

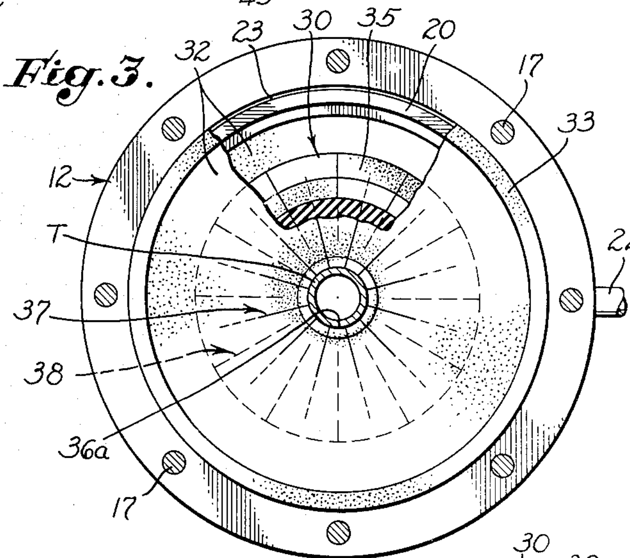

Fig. 4.

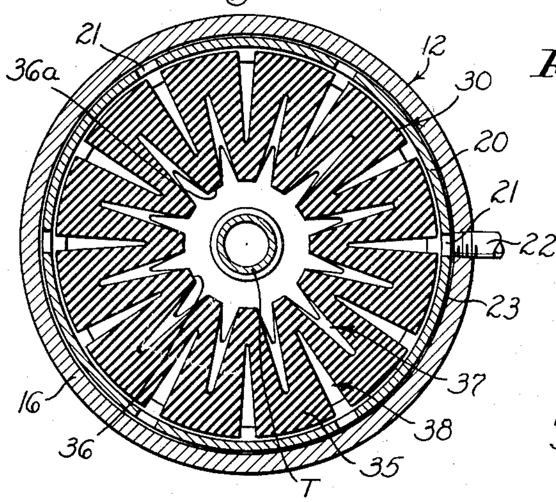

Fig. 5.

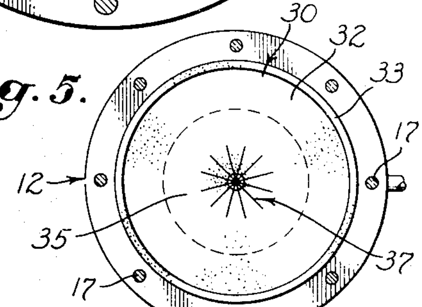

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Fig. 6.

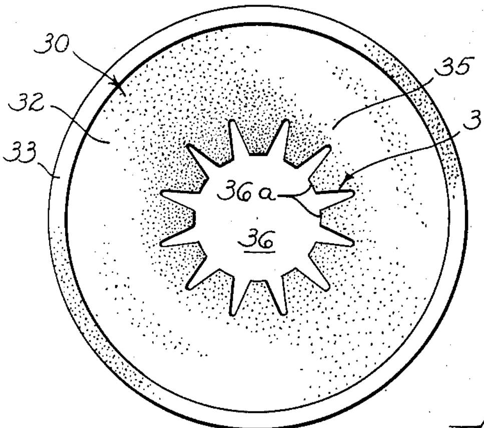

Fig. 8.

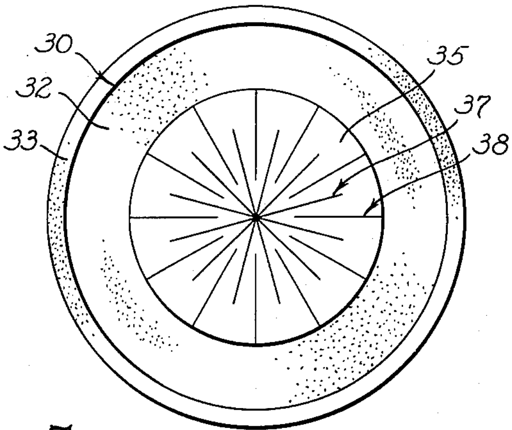

Fig. 7.

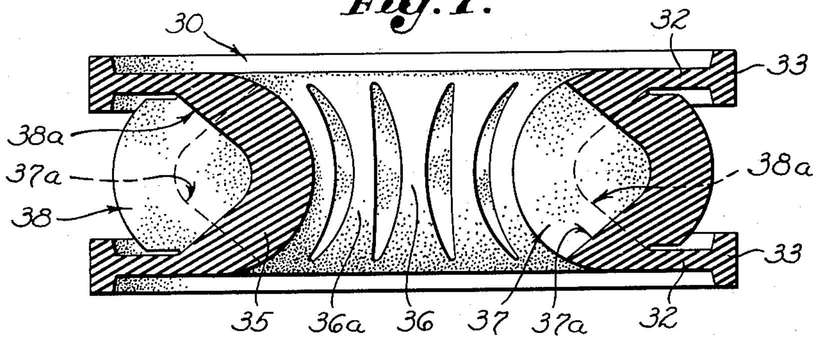

Fig. 9.

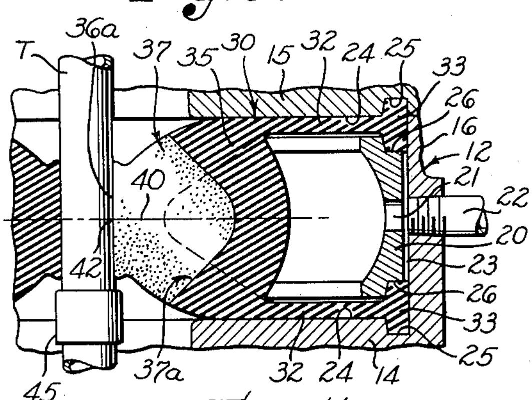

Fig. 10.

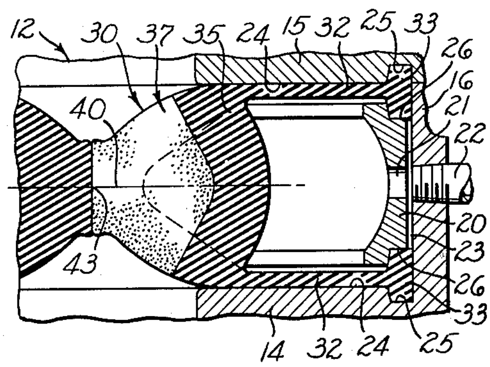

Fig. 11.

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BLOWOUT PREVENTER AND PACKER AND HOLE CLOSER THEREFOR

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Application January 23, 1951, Serial No. 207,291

2 Claims. (Cl. 251—1)

This invention relates to packers and blowout preventers for deep wells, and more particularly to yieldable packers adapted to be actuated by fluid under pressure.

It is a particular object of this invention to provide an annular resilient rubber packer for a blowout preventer, the packer having means to be gripped by the housing of the preventer to insure centering the packer in the blowout preventer housing when the packer is compressed by fluid pressure against tubing extending through the opening of the packer, such packer being capable of being forced inward by such fluid pressure toward its center for sealing engagement with the tubing or for completely closing the central opening of the packer in the absence of tubing, such packer being formed to permit such sealing against the tubing or to insure such complete closing of its central opening.

A further object of the invention is to provide an annular resilient rubber packer, the body of which is circular in cross section to provide a structure which may be considered as doughnut shaped, the innermost circular wall and preferably also the outermost or peripheral circular wall of the annular packer being provided with V-shaped or tapered slits or kerfs, the outer slits or kerfs alternating with the inner slits or kerfs, so that fluid pressure applied against the peripheral wall and in its slits or kerfs will force the body of the packer inward toward its center to effect the required closing or sealing function.

A further object is to provide the upper and lower walls of a doughnut-like rubber packer with means both to center the packer and any tubing which may be positioned therein when fluid pressure is applied, and also to retract the doughnut body of the packer uniformly upon release of pressure. This object may be attained by integral flanges extending radially outward and having retaining means which may be positively gripped in a blowout preventer housing and held during application of the aforementioned fluid pressure, whereby said flanges are stretched and placed under extreme tension as the body portion of the doughnut ring is forced inward toward the center thereof. Such stretching and tension are uniform, by reason of the retention of the peripheral portions of such flanges by the housing, and act to center and return the body uniformly.

An additional object is to provide for optimum engaging and sealing contact and to provide for presentation of optimum mass against the contacted tubing surface, and a complementary object, both of which result from the approximately circular, normal cross section of the doughnut body, is to provide for optimum lateral extrusion of the rubber packer body inward toward its center, when placed under fluid pressure, while at the same time avoiding substantial axial extrusion or bulging which often occurs with other types of packers and is objectionable because it makes difficult the passage of tubing collars and commonly results in serious damages to the axially extruded portions of the packer. For optimum results, the diameter of the central opening of the doughnut-shaped body is approximately the diameter of any cross section, that is a section on a plane in which the axis of the packer lies. Such a construction insures not only optimum extrusion and contact with tubing extending through the central opening of the packer but also provides for optimum closing of the opening when no tubing is present. In addition, it provides for appreciable variation in diameters of tubing which may be accommodated. Since such a circular construction provides an optimum rubber mass in an effectively solid conformation bearing against the engaged tubing surface, a greater pressure within a well may be retained than with any other known type of yieldable packer.

Heretofore, packers of this general character, if they have had means to retain them positively in the blowout preventer housing, have been capable of construction for a given size of tubing only; they have not been usable for substantial variation in tubing sizes; and it has been impossible to use them both for engaging tubing and for completely sealing their central openings. Where slitted types of packers have been employed, they have been elongated, have been useful only for given pipe sizes, have tended to deform and bulge axially under substantial inward distortion, and under such substantial inward distortion have pulled out from their seats in their blowout preventer housings.

All objectionable factors of the prior packers of the nature just indicated are overcome by the present construction.

The present construction comprises primarily, as above indicated, an annular packer of doughnut-ring type having flanges extending radially outward from the uppermost and lowermost walls of the annulus, the peripheries of such flanges being adapted to be positively engaged in retention grooves or the like in blowout preventer housings. Staggered, tapered slits or kerfs extending inward into the annular body of the doughnut packer from its inner circular wall, and inward from its outermost circular or peripheral wall (without intersecting the uppermost and lowermost wall faces) provide for proper inward distortion to compress and seal such tapered kerfs or slits, when fluid pressure is supplied to the peripheral wall of the packer between its outwardly extending flanges, whereby to close especially the slits extending from the inner circular wall and whereby to effect the required sealing against tubing in the central opening of the packer or to close the central opening of the packer. In a more preferred form the diameter of the central opening of the packer approximates the cross-sectional diameter of the body as taken in the direction of the axis of the packer.

Other objects and the various features of construction of the blowout preventer and packer of this improvement will become apparent to those skilled in the art by reference to the following specification and the accompanying drawings wherein certain embodiments are illustrated.

In the drawings:

Fig. 1 is in part a side elevation and in part a vertical section of a deep well casing and casing head equipped with the blowout preventer and packer of my invention with the packer in normal, noncompressed position;

Fig. 2 is a vertical cross section on an enlarged scale showing the blowout preventer and packer of Fig. 1, the packer, however, being compressed against a length of tubing suspended therethrough;

Fig. 3 is principally a top plan view taken from the line 3—3 of Fig. 2, a portion being broken away to illustrate the relationship of the packer to the housing of the blowout preventer;

Fig. 4 is a horizontal cross section taken on the line 4—4 of Fig. 1;

Fig. 5 is a plan view similar to that of Fig. 3 illustrating the packer compressed to its inwardmost limits to close the central passage through a blowout preventer in which no tubing is disposed;

Fig. 6 is a plan view of the packer per se in normal position, the housing of Figs. 1 to 5 being omitted;

Fig. 7 is a vertical cross section on an enlarged scale of the packer per se in normal condition showing in detail the relationship of the inner and outer series of slits or kerfs;

Fig. 8 is a diagrammatic representation of a horizontal median section of the packer per se showing it compressed in the hole-closing position illustrated in Fig. 5;

Fig. 9 is a fragmentary, vertical, sectional view on an enlarged scale indicating the general nature of the change in the packer body configuration when the body is compressed against a length of tubing extending through the central opening thereof;

Fig. 10 is a view similar to that of Fig. 9 illustrating the nature of the distortion when the packer body is compressed to close the central opening when no tubing is present; and

Fig. 11 is a fragmentary median section illustrating a possible form of a packer in which only an inner annular series of kerfs or slits is employed.

Fig. 1 of the drawing illustrates a common well casing C in which depends flow tubing T, drill pipe or the like, a casing C carrying a common casing head assembly **10**, or equivalent. The casing head assembly **10** carries above it a blowout preventer in the form of a housing **12** comprising a lower wall member **14**, an upper wall member **15** and an annular side wall member **16** through the medium of which the lower and upper wall members **14** and **15** are properly spaced. These wall members are connected in any desired manner such as illustrated in Figs. 1 and 2 showing the annular wall member **16** and the bottom wall member **14** as integrally formed, the upper wall member **15** being secured to the annular wall member **16** by screws **17** and appropriate bosses, which form of connection might also be used to mount the annular wall member **16** on the bottom wall member **14**, if desired. Above the blowout preventer housing there is disposed any appropriate superstructure required, such as a slip seat **18**, fluid take-off, or the like. Within the annular wall **16** there is positioned an annular metal seating ring **20** provided with one or more pressure-supplying ports **21** (Fig. 2) adapted to be supplied with pressure fluid from a feed line **22**. Desirably the seating ring **20** is slightly spaced from the inner wall **16** as indicated at **23** in Fig. 2, whereby readily to supply each of the ports **21**. Each of the opposing inner faces **24** of the wall members **14** and **15** of the housing **12** is provided with an annular groove **25**, and each of the outer annular corners of the seating ring **20** is similarly supplied with a peripheral annular groove **26**.

Within the cavity provided by the members of the housing **12** there is mounted an annular yielding rubber packer **30** of the present invention. This packer is provided with upper and lower radially extending flanges **32**, and the peripheries of the flanges **32** are provided with upwardly and downwardly directed annular beads **33** which are received in the mentioned annular grooves **25** and **26** and are gripped and held therein through the medium of the seating ring **20**, as best seen in Fig. 2. The packer **30**, in addition to the described flanges **32** has a ring-like or torus-shaped body **35** of doughnut or annulus configuration as perhaps best indicated in Fig. 7. Any cross section of the annulus or body **35** taken in the direction of the axis of the ring is substantially circular, and in a preferred form this cross-sectional dimension is substantially equal to the diameter of the central opening **36** of the ring (Fig. 7) and in a preferred combination of parts, such diameter approximates the internal diameter of the conventional central openings provided in the circular lower and upper wall members **14** and **15** of the blowout preventer housing **12**. When positioned in the housing **12**, the upper flange **32** bears against the adjacent inner face **24** of the upper wall member **15**. Similarly the lower face of the lower annular flange **32** bears against the upwardly directed wall face **24** of the lower wall member **14**, and the ring-like body **35** spans the space between the wall faces **24** of the members **14** and **15** as indicated in Figs. 1 and 2. The relationship of the parts of the packer **30** in a normal condition is seen also in Fig. 7.

It is intended that the body **35** of the packer **30** be forced inward toward the center of the opening **36** or toward the tubing T of Figs. 1 and 2 by the application of pressure to its outer peripheral wall by way of the pressure supply line **22** and the ports **21** in the seating ring **20**. To provide for adequate compression of the rubber mass as it is moved inward toward the center of the packer, the body **35** is provided with an inner series of kerfs or slits **37** which extend in the direction of the axis of the central opening **36** and of the ring-like body **35**, and are directed radially into the body **35** and at right angles to the core of the body **35**. The side walls of these slits **37** converge so that the slits taper as they extend inward. In addition, the slits **37** have their upper and lower edges **37*a*** arranged in tapering relationship to form an apex which lies preferably beyond the core of the body. In the preferred form, the body **35** is provided also with an outer series of kerfs or slits **38** which are disposed in the direction of the axis of the central opening **36** and extend inward preferably beyond the core of the body. The upper and lower edges **38*a*** of these slits taper toward the core like the formation of the slits **37**, and their vertical sides converge as they extend inward as illustrated in Fig. 4. Preferably the slits **37** extend into the body **35** a greater distance than do the slits **38**, thereby compensating for wear on the inner circular wall around the central opening **36**. As shown especially in Figs. 2 and 7, the upper and lower ends of the slits **38** terminate within the confines of the flange **32**, and the upper and lower ends of the slits **37** terminate short of the top and bottom centers of the uppermost and lowermost wall portions of the ring-like body **35**.

It will be apparent that, as pressure is applied to the outer periphery of the body **35** between the flanges **32**, the flanges **32** will stretch from the condition of Figs. 1 and 7 to assume a relation approximately as indicated in Figs. 2 and 9. Also, the inner slits **37** will be compressed to close them and seal the corresponding passages, as seen in Figs. 3 and 8. Under such circumstances the inner arcuate wall portions **36*a*** (Figs. 4, 6, and 9) of the central opening **36** are compressed against the wall of the tubing T, thus sealing against fluid passage outside of the tubing T. Similarly, where no tubing is present, the central opening **36** is completely closed, as indicated in Figs. 5 and 10, by a similar action. The converging side walls of the slots **37** and **38** make for uniformity of action.

In addition to the stretching of the flanges **32** and the sealing operation effected by inward compression of the body **35**, such body **35** is to a considerable extent deformed as indicated in Figs. 9 and 10 so that the slits **37** tend to elongate appreciably as best indicated at **37*a*** (Fig. 7). This elongation and corresponding distortion are somewhat more exaggerated when entirely closing the opening as indicated in Fig. 10 than when sealing against the tubing T as indicated in Fig. 9. In either case, however, the slits **37** are completely closed, and the slits **38** are nearly or entirely closed depending upon the amount of movement of the body **35** inward toward its center.

It will be appreciated that, in operating the packer of this invention by the application of fluid pressure through the ports **21**, the annular beads **33** of the flanges **32** are permanently gripped in the annular grooves **25** and **26** of the wall members **14** and **15** and the seating ring **20**. As a consequence, the flanges **32** are uniformly stretched and tensioned, and as a further consequence the inner movement of the ring-like body **35** will act to center the tubing T if it should otherwise tend to hang in eccentric position. Similarly, when pressure is released against the outer peripheral wall of the body **35**, such body **35** will be uniformly and concentrically drawn back into its initial position to lie concentric with the axis of the apparatus.

With the structure here described, tubings T of somewhat differing diameters will be accommodated, and also the central opening may be completely closed if the tubing is removed, as indicated in Fig. 5.

For some purposes, and with tubing of appropriate diameter, the outer series of kerfs or slits **38** may be omitted, and only the inner series of tapered slits or kerfs **37** employed, as illustrated in Fig. 11.

When operating with the packer of this invention, whose body **35** is circular in cross section as described, that is, of doughnut-like configuration, it has been possible to hold pressures of as much as 6,000 pounds per square inch, even with no pipe present, whereas with previous devices of somewhat similar nature, the maximum pressures held have been only about 3,000 pounds per square inch using rubber of the same tensile strength. This is largely attributable to the fact that the employment of the doughnut-like body **35** of circular cross section applies the greatest possible mass of rubber against the surface acted upon (wall of the tubing T) for any given axial dimension of packer. The action of the body **35** during closure is a progressive closing of the slits or the kerfs by what is commonly called flexure of the rubber, such action taking place up to the point of normal closure where the body contacts the tubing T, at which point the body assumes a substantially solid doughnut-like shape. Further closure movement of the body **35** beyond this point causes rapid radial extrusion of the mass, quickly closing the opening in the absence of the tubing (see Fig. 10), especially since the flanges **32** tend to restrain the inward movement of the upper and lower portions of the body, thereby permitting the most central portions to advance at a considerably greater rate. Otherwise expressed, the more the rubber mass can be concentrated in a body of approximately circular cross section, the more extrusion of rubber toward the center will occur along the median plane of the body with minimum axial extrusion. Thus, with the present packer construction, by concentrating the rubber mass of the body **35** in a doughnut-like shape having a cross section approximately circular, the rubber extrusion toward the center occurs principally along a median plane indicated at **40** in Figs. 9 and 10, thereby first contacting the tubing **T** on a central circular line as indicated at **42** in Fig. 9, or first closing the central opening at the point **43** of Fig. 10 when no tubing is present. This approximately circular cross sectional construction also places a large rubber mass at the periphery of the body **35** and between the flanges **32**. Such circular mass arrangement and the resultant action very greatly reduce the tendency toward appreciable extrusion longitudinally of the axis of the rubber body, which extrusion under pressure occurs excessively with axially elongated bodies and with hollow bodies. Such axial or longitudinal extrusion is objectionable because it reduces the body thickness and thereby unduly weakens the body walls. Further, such excessive axial extrusion renders it difficult to pull the tubing **T** and its usual connecting collars **45** through a packer having portions so materially extruded under pressure, and also causes damage to the packer. Such difficulties are avoided with the present construction.

Fluid under pressure to be applied to the packer body **35** by way of the supply line **22** desirably will be in the form of water, but carbon dioxide gas, drilling mud or other fluid may be employed as conditions dictate.

It is intended to cover all such variations of construction as fall within the scope of the invention.

I claim as my invention:

1. A blowout preventer comprising a casing consisting of an upper wall member, a lower wall member, such upper and lower wall members having aligned openings therethrough for the passage of a well tube, and an annular side wall member spacing said upper and lower wall members, an annular packing member of yieldable material disposed between said upper and lower wall members, and consisting of a torus portion and integral flanges extending outwardly from the upper and lower faces of the torus portion and terminally connected to said upper and lower wall members, the central opening of the torus portion, the aligned openings in said wall members and the axial cross-section of the torus portion being of approximately the same size, said torus portion being provided with radially extending vertical slits on the outer side thereof located between said flanges, and also with radially extending vertical slits on the inner side thereof facing its central opening, the slits on the outer side of the torus portion being in staggered relation to the slits on the inner side thereof, said slits extending less than a semi-circle whereby they do not intersect said flanges or the upper or lower surfaces of the torus portion, and means for introducing pressure into the space between said flanges to force the torus portion inwardly to close its central opening or to close around a pipe occupying said opening.

2. An annular packing member for insertion horizontally between vertically spaced facing members of a blowout preventer for wells, said packing member consisting of a central portion of toroidal form and integral flat flanges extending outwardly from the upper and lower surfaces of the central toroidal portion, said flanges having means whereby they may be retained peripherally on said spaced facing members, respectively, the central opening of said toroidal portion being of a size not substantially greater than an axial cross-section of the toroidal portion, the inner side of the toroidal portion and the outer side thereof between said flanges having axial slits less than 180° in axial extent whereby they do not intersect either said flanges or the top or bottom surfaces of said toroidal portion, the slits on said inner side being in staggered relation to the slits on said outer side.

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