Oct. 10, 1933. F. M. KILMER, JR 1,930,361

CONTRACTIBLE AND EXPANSIBLE WELL PACKER

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Fig. 1.

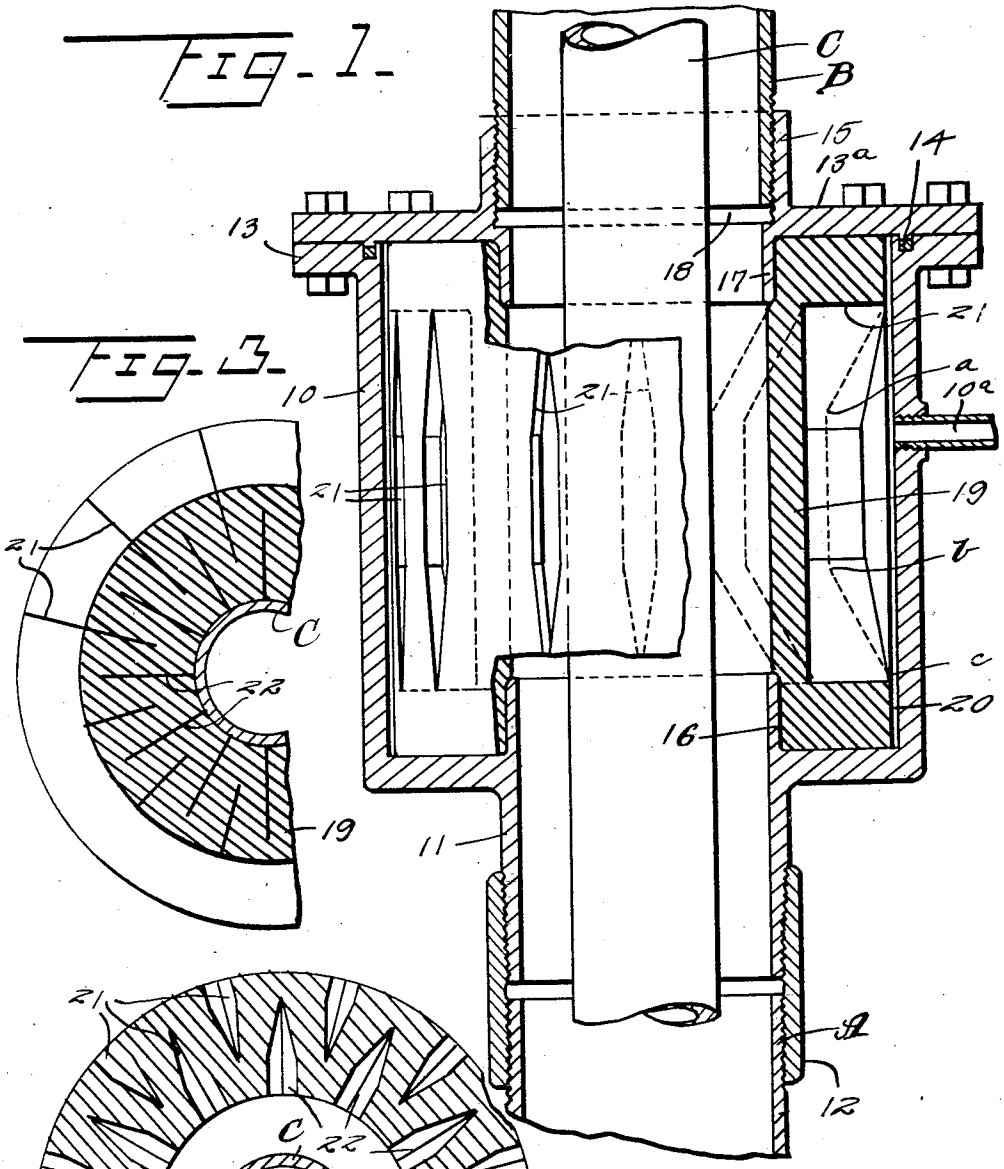


Fig. 3.

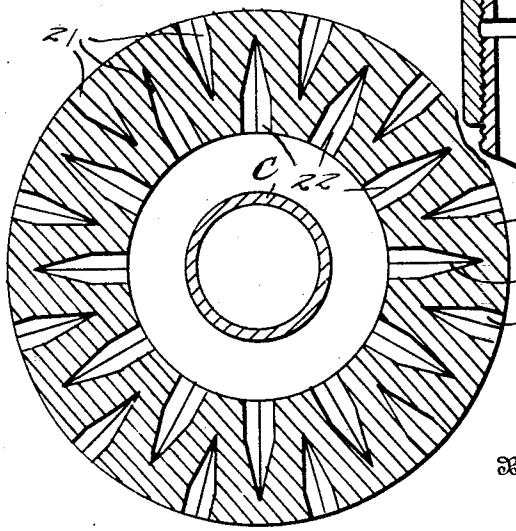


Fig. 2.

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Fig. 4.

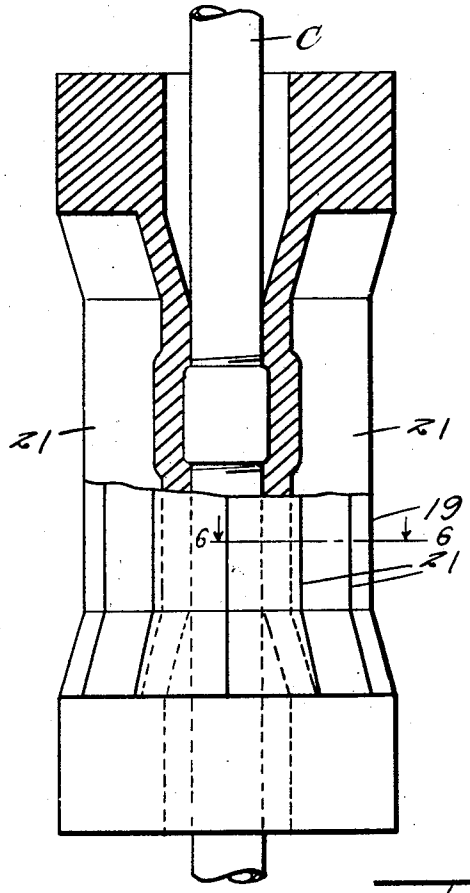


Fig. 7.

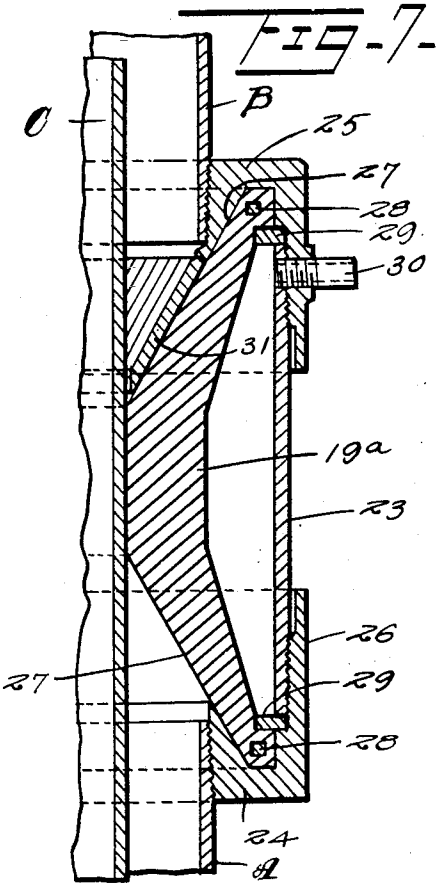


Fig. 5.

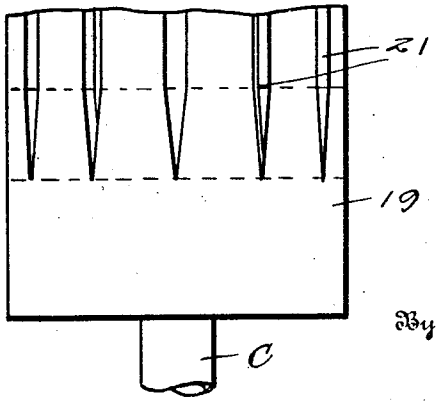
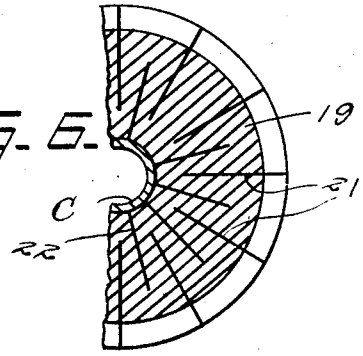


Fig. 6.



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UNITED STATES PATENT OFFICE

1,930,361

CONTRACTIBLE AND EXPANSIBLE WELL PACKER

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Application March 20, 1930. Serial No. 437,414

20 Claims. (Cl. 286—26)

This invention relates to improvements in well packers and particularly to flexible bushings or packers disposed around the casing of a well which has been drilled or is being drilled.

The general object of the present invention is to provide a packer of this character which may be quickly and certainly operated, which is extremely simple, and which, under the control of the operator, is capable of permitting any object of a diameter less than that of the inside end of the casing to pass in or out of the well or at the will of the operator can be caused to close about such object while in the well and extending through the packing device.

A further object is to provide a packing device of this character in which the closure between the casing and the object, such for instance as tubing or pipe or a tool string, shall be fluid-tight against any internal pressure in the casing from below, and a further object is to provide a packing of this character which shall be ready at an instant notice to effect this closure without the need of the operator approaching the casing head to make any manual adjustment.

A further object is to provide a construction of this character which may be made in two general types, in one of which the bushing is normally the same interior diameter as the interior diameter of the well casing or a diameter slightly larger than that of the well casing so that the opening therethrough will be unrestricted and another type in which the bushing has a restricted central passage, normally closed by the constriction of the bushing itself but through which an object a size larger than the internal diameter of said passage may be passed, the passage of said object distending the passage through the bushing and the bushing closing around said object immediately after its passage.

Other objects will appear in the course of the following description.

My invention is illustrated in the accompanying drawings, wherein:—

Figure 1 is a vertical longitudinal section of a well packing mechanism constructed in accordance with my invention;

Figure 2 is a transverse section of the packing bushing in its normal condition;

Figure 3 is a like section to Figure 2 but showing the bushing constricted or contracted around the central pipe;

Figure 4 is a vertical sectional view of a modified form of bushing, the bushing being normally constricted;

Figure 5 is a fragmentary elevation of the bushing shown in Figure 4 when fully expanded;

Figure 6 is a fragmentary section on the line 6—6 of Figure 4;

Figure 7 is a fragmentary longitudinal section of a modified form of packing and bushing.

Referring to these drawings, it will be seen that my packer includes in its construction a housing designated generally 10, which is made of suitable metal or alloys, this housing being formed to provide an enlarged extension of the usual well casing A. The lower end of this housing is formed with the nipple 11 screw-threaded for engagement by the casing sleeve or coupling member 12. The housing 10 is cylindrical in form and at its upper end is provided with a flange 13. The head 13^a of the housing is bolted to the flange 12 and preferably this head is formed with a rib 14 engaging in a circumferential recess formed in the flange 13 and provided with packing. The central portion of the head 13^a is formed with the upwardly extending nipple 15 interiorly screw-threaded for engagement with an upper section of well casing designated B. The lower end of the housing 10 immediately above the end of the wall 11 is formed with an upwardly extending annular flange or nipple 16 whose upper end is rounded upwardly and centrally. The head 13^a immediately beneath the nipple 15 but slightly inward of this flange or nipple 16 is formed with a depending annular flange 17.

Between the flange or nipple 17 and the screw-threads of the nipple 15 there is formed an annular recess 18. Entering the cylinder 10 is a fluid pressure supply pipe 10^a connected to any source of fluid pressure and under any suitable control. It will be understood, of course, that the internal diameter of the interiorly screw-threaded nipple 15 and of the interior diameter of the nipple 11 is substantially the same as that of the well casing and greater than that of the pipe C illustrated as extending through the casing.

Disposed within the cylindrical housing 10 and approximately filling the space between the head 13 and the bottom of the housing is a bushing or packing member designated generally 19. This bushing is made of rubber or other flexible material, the bushing being approximately cylindrical in cross section. The upper and lower ends of the bushing are solid so as to nearly fill the space between the flange or nipple 17 and the outer wall of the housing and between the flange or nipple 16 and the outer wall of the housing. A space 20, however, is left between the outer

face of the bushing and the outer wall of the housing as is clear from Figure 1. The middle portion of the bushing between the ends thereof is formed upon its outer surface with a plurality of slits 21 extending longitudinally of the bushing but terminating short of the ends thereof. Like radial slits designated 22 are formed upon the interior face of the bushing and extend radially outward from said interior face while the slits 21 extend radially inward. These slits 21 and 22 are of such form that under normal circumstances with no fluid pressure bearing against the exterior face of the packing and forcing it inward to the position shown in Figure 3, these slits will be opened on their outer and inner ends respectively.

In other words, each of these slits at its outer end is relatively wide and decreases inward toward its inner end, that is, it has inwardly converging walls so that in effect, segments have been cut at regular intervals from the material of the outer portion of the packing and like segments have been cut from the inner portion of the packing, these slits or cut out segments being disposed in staggered relation to each other. Each of these grooves or slits 20 and 21 commences adjacent each end of the bushing in mere slits or lines radially disposed and widened more or less uniformly in their extension toward the middle of the bushing or as they extend toward the middle gradually widening to the point *a*. Each slit from the point *a* has a uniform width to the point *b* and then grows gradually narrower and narrower to the point *c*, the slit or groove at opposite ends being in the form of a mere line as before remarked.

Normally and under ordinary circumstances, the bushing has the cross section shown in Figure 2 wherein the inner diameter of the bushing is approximately equal to the interior diameter of the well casing A and B but when fluid pressure is exerted through the pipe 10^a upon the bushing, this fluid pressure will cause the middle portion of the bushing between the upper and lower ends thereof and between the extremities of the flanges or nipples 16 and 17 to be forced inward and thereby contracted in internal diameter, this being permitted by the "gores", grooves or slits 21 and 22 which are formed in the rubber of the bushing or packing. Thus under sufficient fluid pressure, the bushing may be forced tightly against the well tubing C or any other element which may be passed through the housing 10 and into the well casing.

When the packing or bushing is so compressed, all the grooves will be closed evenly and the bushing will have a tubular but grooveless form in the center section with an internal passage having the same diameter as that of the pipe C passing therethrough or other cylindrical object. Inasmuch as the bushing, by reason of its being of rubber, is more or less flexible, the cross section of the bushing may be varied to bring the closure about other cross sections of objects extending through the center of the housing 10 other than true circles such as objects square in section or having the sectional form of regular polygons.

The total length of the bushing is preferably somewhat greater than the inside height of the housing 10 so that in placing the head 13 in place upon the housing, some compression of the material of the bushing will be effected, thus insuring contact between the ends of the bushing and the flanges or nipples 16 and 17. By this construction of bushing and housing the space 20 heretofore referred to becomes fluid-tight to internal pressure supply through the pipe 10^a from an outside source, and under the action of a suitable control valve and upon applying suitable pressure of fluid through the pipe 10^a, the bushing may be readily made to assume the form shown by the dotted lines in Figure 1 and will close the annular passage normally surrounding the object C extended through the packer and will prevent the passage of any fluid upward through said passage where the pressure on said fluid is substantially less than the pressure applied through the pipe 10^a.

While I have heretofore referred to the bushing as being entirely made of rubber, it is readily possible, as is obvious from Fig. 2, to provide a wear resisting facing for the inner faces defined by the grooves 22, which wear resisting facing will permit the object C to be moved up and down at will without injury to the packer or bushing. By using hard steel or alloy in the flanges or nipples 16 and 17, and in the head flange 13, and incorporating wear resisting faces in the body of the bushing which is in contact with said nipples and flanges, the bushing may rotate with the object C without undue deterioration or wear. In Figure 4 I show a second type of bushing which I will call the closed type. This bushing initially has the same form as is taken by the open type of bushing disclosed in Figure 2 when this open type of bushing is closed. In other words, the bushing has a contracted or constricted middle portion which is, however, longitudinally slitted both outward from the inner face and inward from the outer face. Such a bushing will bear yieldingly against an object such as the pipe C but it may be readily opened by an object of a size larger than its internal passage and if such an object has an enlargement in its cross section, such, for instance, as pipe couplings or tool joints, the bushing will be distended as this enlargement passes through the bushing and when the bushing is so distended, the slits or grooves will be caused to open and the bushing will have the form and cross section shown in Figure 2.

It will be seen that I have provided what I term an "accordion" bushing, that is, a bushing which by reason of being longitudinally cut out upon its inside and outside faces is capable of being constricted or expanded either by pressure bearing against the outside of the bushing or by pressure (such as the passage of a tool joint or coupling as before stated) against the inner face of the bushing.

While I have illustrated the head 13 as being formed with the nipple 15, it will be obvious that this nipple 15 may be in the form of an outwardly and upwardly extending flange or bell mouth whereby to guide tubes down into the well or to provide a bowl into which slips may be inserted in a manner well known in the art.

In Figure 7, I show a modification of my construction wherein the bushing or packer 19^a is constructed in general accordance with what I have heretofore described. In this case, however, the housing 10 is formed by a tube 23, the heads 24 and 25 being flanged as at 26 for screw-threaded engagement with the tube 23. Each of said heads is formed with a recess 27, for the reception of the upper and lower ends of the packer 19*a*. Steel rings 28 are disposed within the ends of the rubber packing 19^a. The steel rings 29 bear against the ends of the packing 19^a and are disposed against shoulders formed in the heads and against the extremities of the pipe section 23.

An opening 30 is provided for the inlet of fluid under pressure. The heads 24 and 25 are interiorly screw-threaded for engagement with the well casing sections A and B and the steel strips or "petals" 31 are disposed against the inner face of the packing member 19ª above the middle thereof. In this construction, the packing member is non-rotatable, but the tool string or tubing C is intended to be rotatable within the packing section. It will be understood that this packing section is likewise in accordion formation, that is, is formed with the interior longitudinally extending slits and the exterior longitudinally extending slits.

However, the normal position of the packing is in contact with the object C. When a tool joint or like element engages the strips 31, it will force them inward, forcing inward on the packing as before described to permit the passage of the tool joint or enlargement of a tool string.

The metallic strips 31 are not necessary in the smaller sizes of my device, but will help prevent extrusion of the bushing in its upper tapered portion into the annular space between the part C and the nipple 17. These separate strips are preferably in the form of truncated polyhedral hollow prisms, replacing a coating of rubber composition in the cases where used and act to resist compression from inside of the housing 10 or housing 23, it being understood that these strips might be used in connection with Figure 1 as well as with the construction shown in Figure 7. The packer shown in Figure 1 in actual use and when closed with 15 lbs. per sq. in. of water pressure in the pipe 10 and with 2200 lbs. per square in. in space 20 held two thousand pounds in the well casing without a drop or leak or any show of fault. Not only so, but the packer closed perfectly about irregular objects, such for instance, as Kelly bars and bore the same test of pressure. When closed, packer took the form shown in section in Figure 3.

Attention is particularly called to one feature of construction, the advantages of which are not altogether obvious. It will be noted that in Figure 1 and in Figure 7, the outer casing formed by the part 10 and by the upper and lower ends of this outer casing are provided with the inwardly extending annular flanges 16 and 17 and that in the construction shown in Figure 7, the end members 24 and 25 are provided with flanges which extend toward each other. In both instances, therefore, the ends of the packer 19 or 19*a* are held rigidly against inward movement and only the middle portion of the packer is capable of being distended. Furthermore, as shown in Figure 1, the ends of the packer are relatively thick in cross section and unslitted so that these ends are solid and strong and in Figure 7 these ends are reinforced by the reinforcing rods 28. These flanges which overlap the inner faces of the ends of the packer act to absolutely prevent the packer from becoming deformed and rolled, upward or downward under the pressure of fluid below the packer, or upon an upward movement of the pipe, or upon a downward movement of the central pipe C. These flanges prevent any pulling out of the packer into the space between the casing A and the pipe C. It has been proposed to provide a packer of this character wherein the packer is hollow and a nipple projects out through the packer through an aperture in the outer casing whereby air may be forced into the hollow interior of the packer and the packer expanded. Such a construction is open to the disadvantage heretofore pointed out and in addition to this, any upward or downward movement of the packer not only tends to pull the packer out of its casing, but also tends to pull the nipple out through the aperture in the casing or break the nipple off and furthermore in a construction of this character, if the central drill pipe is rotating and the packer rotates with the drill pipe, here again the nipple which is attached to the packer and extends out through said aperture is likely to be broken off.

In my construction, the flanges 16 and 17 in Figure 1, for instance, absolutely prevent the packer as a whole from being pulled out of the casing in which it is disposed and forced either upward or downward into the space between the pipe C and the casing A and furthermore inasmuch as the air pipe 10*a* is not connected to the packer, but simply enters the outer casing and discharges into the space between the outer casing and the packer, the packer can rotate with the pipe without in any way affecting the nipple 10*a* or the nipple 30 shown in Figure 7. In my construction the ends of the packer are relatively strong and solid. It is the middle portion of the packer, however, which is weakened by the longitudinal slots so that it yields inwardly toward the drill pipe. I have provided by my construction a bushing or packer which cannot extrude beyond the upper or lower limits of the packer under any working condition of pressure which modern casings will stand. Furthermore the nipples 16 and 17 hold the packer centrally and force the drill pipe to center with them. When the packer in my construction is closed, that is, forced inward around the pipe C, the rubber is in compression and not under tension. Furthermore the introduction of air behind the packer tends to force the ends of the packer against the ends of the nipples 16 and 17 and force the ends of the packer upward against the walls of the casing in which the packer is disposed, and thus leakage around the ends of the packer is avoided. In my construction, the packer may rotate and to be practically useful, a packer of this character must permit movement of the drill pipe to prevent any freezing or sticking and this is secured in my construction. There is no necessity in my construction of a fluid-tight engagement of the packer with the supply pipe or nipple 10*a* and a packer requiring such fluid-tight engagement would fail under field conditions. The solid end portions of my packer in combination with the nipples 16 and 17 or their equivalent as shown in Figure 7 acts to resist any pressure or force tending to extrude the packer into the annular space between the drill pipe and the casing. To recapitulate, the nipples 16 and 17 or their equivalent are necessary to keep the bushings from distorting at their ends and to keep fluid from leaking from the space 20 and furthermore necessary in order to keep the bushing or packing centered at all times. With by construction, there is no chance of failure due to disconnection of the supply pipe 10*a*, the packer has freedom to rotate and furthermore the packer is very cheaply made inasmuch as there is no interior chamber to be formed, thus permitting the packer to be molded under high pressure. The longitudinally extending slots 21 and 22 permit ready closure of a massive packer or bushing without distortion and through a wide range between open and closed sizes while at the same time securing strength to resist all sorts of working conditions when in practical use.

The omission of such longitudinal slots would

result in a weak bushing which would be unable to withstand the field pressures commonly occurring or a bushing sure to distort it into an elliptical form if walls are strong enough to stand working conditions.

It will be understood that the pressure in space 20 is greater than that on inside of the bushing, that is, the internal passage for the pipe C. Accordingly while pressure is registered against the sides of the grooves or slits 21, this is a balanced effect and the peripheral compressive pressure on the ribs is not balanced. Therefore, the bushing contracts and in so doing, closes the grooves, if correctly formed.

I do not wish to be limited, therefore, to the exact form of the casing enclosing the bushing, nor do I wish to be limited to the exact form of the bushing itself, as obviously these parts might be modified in many ways without departing from the spirit of the invention as defined in the appended claims.

I claim:—

1. A packing device for wells including a hollow body having nipples at its upper and lower ends, screw-threaded for engagement with well casing sections and having inwardly extending vertical annular flanges at its upper and lower ends and disposed approximately in line with the inner faces of the nipples, and an annular packer of yielding material disposed between the upper and lower ends of the body and at its upper and lower ends being disposed between said flanges and the circumferential wall of the body, the intermediate portion of the packer being formed so that the packer may be inwardly distended, and means for causing the discharge of fluid under pressure between the packer and the body to cause the packer to be forced inward against an object passing through the well casing and body.

2. A packing device for wells including a hollow, annular body adapted to be disposed in the length of a well casing, and a packer of yielding material disposed within said body, the packer being annular and formed with longitudinally extending grooves upon its outer and inner faces, the grooves on the inner face being staggered with relation to the grooves on the outer face, means at the upper and lower ends of the body engaging the inner face of the packer at its ends and preventing inward movement of the upper and lower ends of the packer and means for discharging fluid under pressure into the space between the wall of the body and the outer face of said packer to cause the middle portion of the packer to be forced inward against an object passing through the well casing and body.

3. As an article of manufacture, a packer for wells, the packer being formed of yieldable material, the packer being annular and having slits upon its inner and outer faces said slits extending parallel to the longitudinal axis of the packer terminating short of the upper and lower ends of the packer.

4. As an article of manufacture, a packer for wells, the packer being formed of yieldable material, the packer being annular and having longitudinally extending slits upon its inner and outer faces, the slits extending nearly the length of the packer but terminating short of the ends thereof, said slits growing wider as they near the middle of the length of the packer.

5. A packing device for wells including a hollow body annular in cross section and having removable heads at one end, the heads in the opposite ends of the body being formed with nipples screw-threaded for engagement with the screw-threads of the well pipe sections, the interior of the body being provided at its opposite ends with flanges extending inward parallel to the outer wall of the body, said flanges being disposed in approximate alinement with the nipples and a packer of yieldable material annular in cross section and having solid annular portions at its upper and lower ends disposed between said flanges and the outer wall of the body, the outer surface of the packer, between said solid annular end portions, being spaced from the outer wall of the body and the packer filling the space between the lower end of the body and the upper end thereof.

6. A packing device for wells including a hollow body adapted to be disposed in the length of a well casing and engaged at its upper and lower ends therewith, the body being annular and having an interior diameter approximately that of the well casing, and a packer of yielding material disposed within said body and extending from the upper end of the body to the lower end thereof, the body at its upper and lower ends having inwardly extending flanges overlapping the upper and lower ends of the packer, the packer being formed with a plurality of radial grooves upon its inner face and upon its outer face, the grooves upon the inner face being staggered with relation to and overlapping the grooves upon the outer face, each of said grooves being wider toward the middle of the packer than at its ends, and means for introducing fluid under pressure into the interior of said body exteriorly of the packer.

7. As an article of manufacture, a packer for wells, the packer being formed of yieldable material and being annular in cross section and having longitudinally extending slits upon its inner and outer faces, the slits extending nearly the length of the packer, but terminating short of the ends thereof, the slits growing wider as they near the middle of the length of the packer, the middle portions of the slits being of uniform width.

8. A packing device for wells including a hollow body, annular in cross section and having means whereby it may be engaged with alined well pipe sections, a cylindrical packer of yieldable elastic material, annular in cross section disposed within said hollow body and extending from one end to the other of the same, means on the body for holding both ends of the packer from inward and longitudinal movement, and means for introducing fluid under pressure into the interior of the body behind the packer to force the middle of said packer inward.

9. A packing device for wells including a hollow annular body adapted to be disposed in the length of a well casing, and a packer of yieldable material disposed within said body, the packer being annular and formed with recesses upon its outer and inner faces extending in a general direction longitudinally of the packer, the recesses on the inner face being staggered with relation to the recesses on the outer face, means at the upper and lower ends of the body engaging the inner face of the packer at its ends and preventing inward movement of the upper and lower ends of the packer, and means for discharging fluid under pressure into the space between the walls of the body and the outer face of the packer to thereby cause the middle portion of the

packer to be forced inward against an object passing through the well casing as a body.

10. A packing device for wells including a hollow annular body adapted for alined engagement with a well casing, and a packer of yielding material disposed within said body, the packer, being annular and formed with recesses extending in a general longitudinal direction, the recesses on the inner face being staggered with relation to the recesses in the outer face, means at the upper and lower ends of the body preventing inward movement of the upper and lower ends of the packer, and means for discharging fluid under pressure into the space between the wall of the body and the outer face of said packer to thereby cause the middle portion of the packer to be forced inward against an object passing through the well casing and body.

11. As an article of manufacture, a packer for wells, the packer being cylindrical in form and annular in cross section and formed of yieldable material and having one face thereof concentric to the longitudinal axis of the cylinder weakened on lines extending in the direction of the length of the packer.

12. As an article of manufacture, a packer for wells, the packer being annular in cross section and formed of yieldable material and having its inner and its outer faces weakened on generally longitudinal lines.

13. As an article of manufacture, a packer for wells including a cylindrical wall formed of yieldable material annular in cross section adapted to surround an object extending longitudinally through the center of the packer, one face of the wall concentric to the longitudinal axis of the cylinder having a series of recesses arranged in general longitudinal lines relative to said longitudinal axis whereby the packer may be contracted around the object when the packer is under pressure.

14. As an article of manufacture, a packer for wells including an annular wall formed of yieldable material adapted to surround an object extending longitudinally through the packer, the inner and outer faces of the wall having a series of recesses arranged in general longitudinal lines, the recesses of the outer face being staggered with relation to the recesses of the inner face, said recesses permitting the packer to be contracted around the object when the packer is under exterior pressure and to expand to permit the passage of said object.

15. A packer of the character described, including an annular wall of yieldable material, the outer and inner faces of the wall having a series of recesses extending generally in a longitudinal direction, the recesses in the inner face being disposed between the recesses in the outer face, the recesses in one face having a depth equal to the depth of the recesses in the other face.

16. A packer of the character described having an annular wall of yieldable material, the outer and inner faces of the wall having a series of recesses weakening the wall in longitudinal lines whereby the wall may be expanded outward or compressed inward.

17. As an article of manufacture, a packer for wells, the packer being of yieldable material and approximately annular in cross section, the cross sections of its end portions being solidly annular, the middle portion of the packer between the end portions being annular but having notches extending inwardly in a general radial direction from the inner and outer faces of the packer.

18. As an article of manufacture, a packer for wells, annular in cross section, the opposite end portions of the packer being solid, the middle portion of the packer on any cross section being annular but varied from the solid annular cross sections of the end portions by notches extending radially from the outer and inner faces of the packer.

19. As an article of manufacture, a packer, annular in form having recesses in the middle portion of the packer between its ends, the recesses being approximately radial and generally longitudinal with relation to the axis of the packer whereby the middle portion is able to contract to a predetermined size upon the application of fluid pressure therethrough to the exterior of the packer by flexure of the material without simultaneous compression of the whole packer.

20. A packing device for wells including a hollow body annular in cross section and having means whereby it may be engaged with alined pipe sections, a packer of yieldable elastic material generally annular in cross section disposed within said hollow body and extending from one end to the other of the same, means on the body for holding both ends of the packer from inward movement, the middle portion of the packer being formed with a plurality of more or less radially and longitudinally extending recesses so that this middle portion may be forced inward by pressure to a predetermined form by flexure of the material without simultaneous compression of the mass of material forming the contracting portion, and means for introducing fluid under pressure into the interior of the body behind the packer or allowing said fluid to escape to flex said packer inward or permit the outward flexure of the packer.

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