

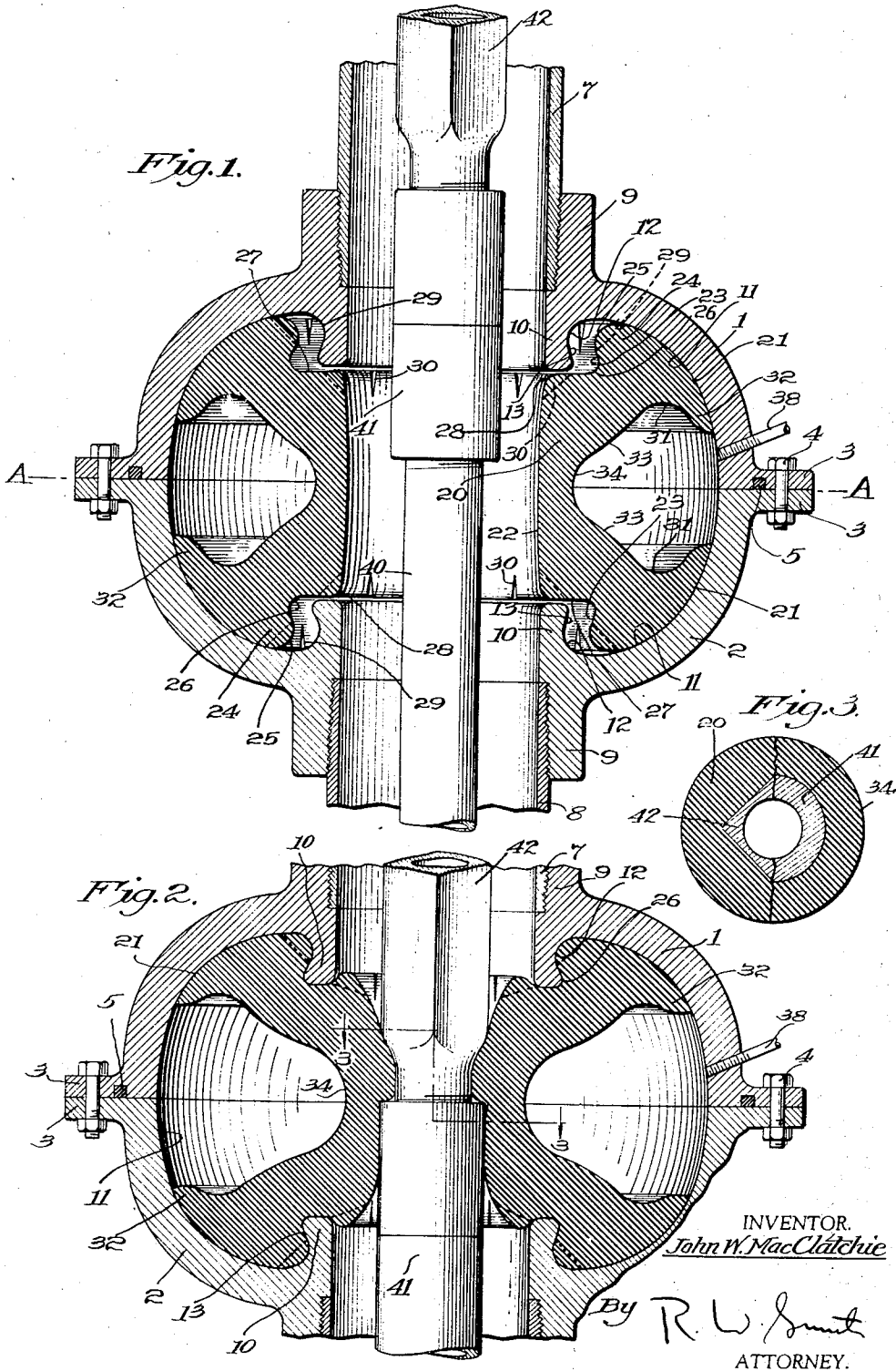
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PACKER

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This invention is a packer for sealing off between a well string and a surrounding casing, and it is the object of the invention to provide a packer of improved construction adapted to maintain a seal while inserting or withdrawing the well string and irrespective of the cross-sectional contour of the string.

The packer is an annular packer received in the bore of the casing, with the well string extending through the bore of the packer; and it is a further object of the invention to provide a packer of improved construction adapted for ready contraction of its bore for sealing around the well string or as ready expansion of its bore for clearing the bore of the casing.

Further objects of the invention will be readily understood from the following description of the accompanying drawing, in which:

Fig. 1 is a vertical section through the packer, showing its bore expanded to clear the bore of the casing in which the packer is mounted.

Fig. 2 is a similar view showing the bore of the packer contracted around a well string.

Fig. 3 is a transverse section on the line 3—3 of Fig. 2.

The packer is an annular packer received in the bore of well casing, with the bore of the annular packer adapted to have a well string projected therethrough. The packer is preferably mounted in a housing which is incorporated in the well casing at the top of the well, and which forms an annular chamber of greater diameter than the bore of the well casing, for reception of the annular packer so that the bore of the packer may be contracted to engage the well string or may be expanded to clear the bore of the well casing.

As an instance of this arrangement the housing is shown as a two-part housing 1—2, preferably having its parts detachably connected at a medial transverse plane A—A, as for example by flanging the housing parts as shown as 3 and connecting the flanges by bolts 4, with packing 5 preferably provided at the abutting surfaces of the flanges. The ends of the assembled housing are connected to upper and lower sections 7—8 of a well casing, preferably by threaded nipples 9 which are shown as integral with the housing.

The assembled housing forms an annular chamber or enlargement of appreciably greater diameter than the bore of the casing sections 7—8, and annular flanges 10 project longitudinally of the housing and toward one another from the respective ends of this annular en-

largement, with the bores of the flanges preferably substantially in prolongation of the bore of the casing sections 7—8 and with the flanges preferably fixed with relation to the housing, as for example by forming the flanges integral with the housing.

The assembled housing has an inner surface defining its annular enlargement, preferably curving inwardly toward the respective ends of the housing from its medial transverse plane A—A as shown as 11, so as to define both the peripheral and end walls of the annular enlargement. The portions of this curved inner surface which define the end walls of the annular enlargement terminate at the bases of the annular longitudinally projecting flanges 10 and preferably merge into the radial outer surfaces of the flanges at curved surfaces 12, and the radial outer surfaces 13 of these annular flanges preferably flare radially outwardly toward the ends of the flanges which project longitudinally toward one another, whereby the ends of the annular enlargement which is formed by the assembled housing form undercut annular pockets 14 in back of the flanges 10.

The packer 20 which is mounted in the annular enlargement of the housing is an annulus of resilient packing material such as rubber or the like. This annulus has an outer periphery longitudinally curved in accordance with the curved surface 11, as shown at 21, and has a bore 22 which is counter-bored at its ends so that when the resilient packing annulus is mounted in the housing and is in its normal position as shown at Fig. 1, its bore 22 is substantially in prolongation of the bores of the annular flanges 10, with these annular flanges extending into the counterbores at the ends of the packing annulus, and with the walls 23 of the counterbores preferably appreciably radially spaced from the radial outer surfaces of the annular flanges.

The ends of the packing annulus thus define annular lips 24, which are received in the ends of the annular enlargement of the housing and which when the packer is shifted from its inoperative to its operative position, are adapted for appreciable radial inward movement in the annular undercut pockets at the ends of the annular enlargement of the housing before these lips abut the annular flanges 10. The annular lips 24 are preferably curved at their outer ends as shown at 25 so as to merge into the peripheral curved surface 21 of the packing annulus. These curved surfaces 25 are preferably curved similarly to the curve of the surfaces 12 which de-

fine the bases of the flanges 10, and merge into those annular surfaces of the packing annulus which define the walls 23 of its counterbores. The surfaces 23 preferably flare toward the bases of the counterbores, substantially parallel to the flaring surfaces 13 of the flanges 10, and preferably curve at the bases of the counterbores as shown at 26 so as to merge into the lateral surfaces 27 which define the bases of the counterbores. These lateral surfaces 27 at the respective ends of the packer are preferably longitudinally spaced from one another such distance that when the packer is in normal position prior to its distortion, they just clear the proximate ends of the longitudinally projecting flanges 10, and the packer is preferably rounded off as shown at 28 where the surface of the bore 22 meets the lateral surfaces 27. The annular lips 24 are preferably notched in circumferentially spaced relation as shown at 29, and the rounded off corners 28 are preferably similarly notched as shown at 30.

The outer periphery of the packer is annularly recessed medially of the length of the packer. This recess is preferably symmetrically undercut at its upper and lower sides as shown at 31, so that the packing annulus forms lips 32 at the upper and lower sides of the annular mouth of the recess, and from its undercut portions 31 the recess preferably symmetrically tapers toward its base as shown at 33, with the base of the recess preferably curved as shown at 34 and symmetrical at opposite sides of the plane A-A which is medial of the length of the packer. The lips 32 are preferably of less thickness than that of the packer between its bore 22 and the base 34 of its annular recess, and this thickness of the packer at its bore is in turn preferably less than the thickness of the packer between its respective ends and the proximate surfaces 31-33 of its annular recess.

Pressure fluid is conducted to the annular recess of the packer for contracting the bore 22 from its normal inoperative position as shown at Fig. 1, to its operative sealing position as shown at Fig. 2. The pressure fluid may be admitted to the annular recess via a pipe 38 which opens through the wall of the housing 1-2 into said recess, the pressure fluid being preferably that of a liquid such as water, supplied from any suitable source (not shown), with the supply pipe 38 provided with a suitable valvular control (not shown) whereby pressure fluid may be conducted to the annular recess of the packer for operatively contracting its bore 22, or may be exhausted from the annular recess to permit the resiliency of the packer to return it to its normal inoperative position.

In operation, with pressure fluid exhausted via the pipe 38, the packer assumes its normal position as shown at Fig. 1, with the lips 24 radially spaced from the flanges 10 and with the bore 22 substantially in prolongation of the bore of said flanges. The bore of the well casing is thus unobstructed so that a well string, such as drill pipe 40 connected by a coupling 41 to a usual square kelly 42, may be freely run into or out of the well casing.

When pressure fluid is exerted in the annular recess of the packer, the pressure fluid directed against the surfaces 31-33 tends to swing the end portions of the packer so that they move along the curved surface 11 until the lips 24 are hooked over the flaring surfaces 13 of the flanges 10 as shown at Fig. 2, with the lips 32, which are

comparatively thin and thus readily flexed, maintained by the pressure in sealing contact with the curved surface 11. The resilient material of the packer is such that it is readily compressible to allow annular compression of the lips 24 responsive to said movement of the ends of the packer and whereby the counterbores at its ends are radially contracted, with the normally open slots 29 providing space for reception of a portion of the compressed material so that the desired contraction may be obtained without excessive compressive stress. This compression of the material which constitutes the ends of the packer also tends to shift the mass of said material so as to somewhat increase the mass of material at the end portions of the bore 22 of the packer.

The pressure fluid exerted against the base 34 of the annular recess of the packer radially inwardly projects that portion of the packer which defines its bore 22, with the compressibility of the packing material and its limited thickness along said bore permitting annular compression of said portion of the packer whereby its bore 22, for some appreciable length medially thereof, is readily radially contracted for sealing around the drill string 40-42 as shown at Fig. 2.

As a result of sealing contraction of the bore 22 medially of its length, those portions of the packer which define the ends of the bore 22 are subjected to radial tensile stress and to annular compressive stresses. The tensile stress results from the stretch of the packing material at the ends of the bore 22 which allows the packing material at the medial portion of said bore to project inwardly for sealing engagement with the drill string, and the compressive stress results from the radial contraction of the packing material where its sealing portion, medially of the length of the bore 22, merges into its portions which define the ends of said bore. The spaces defined by the normally open slots 29 provide for reception of a portion of the compressed packing material at the ends of the bore 22 for partially relieving the annular compressive stress, and the radial shifting of the lips 24 into engagement with the flanges 10, with the resulting shifting to some degree of the mass of material from the ends of the packer toward the end portions of its bore 22 as previously explained, allows the necessary stretch at the end portions of the bore 22 without excessive tensile stress of the material. The annular compressive stress and the radial tensile stress at the end portions of the bore 22 thus tend to counteract one another, whereby distortion of the packer for sealing the medial portion of its bore 22 around the drill string, may be obtained by pressure fluid in the annular recess of the packer without excessive stress or distortion of the packing material.

The bore of the packer may thus be contracted for sealing around a drill string, with the lips 32 maintaining the seal between the packer and the housing 1-2, without stretching the packing material to its elastic limit and without unduly compressing any part of the packing material. A tight seal may thus be maintained between a drill string and a surrounding well casing, without danger of tearing the packer or so distorting the same that the resiliency thereof might be incapable of returning the packing to its inoperative position, clear of the bore of the well casing, as soon as the pressure in the annular recess of the packer is relieved.

The portion of the packer medially of the length of its bore 22 is thus capable of such annular com-

pression for contraction around a drill string as to maintain a fluid tight seal around the drill string. As shown at Fig. 3 this portion of the packer is also capable of such different distortion at different circumferential portions of its annulus as to adapt itself to the contour of and seal around any part of the drill string, e. g. the round drill pipe 40 or the square kelly 42, and the sealing portion of the packer, which is of some appreciable length, is also capable of such different distortion at different portions of its length as to adapt itself to the different contours of and seal around the drill string where said different contours merge into one another, e. g. where the coupling 41 connects the drill pipe 40 to the kelly 42. Furthermore the stress of the packing material where the bore 22 is contracted for sealing engagement with the drill string, is such as to maintain a fluid tight seal, but with friction at the sealing surface so limited as to permit the drill string being drawn through the packer while still maintaining the seal.

The invention thus provides for maintaining a seal between any part of a well string and a surrounding casing, irrespective of the cross-sectional contour of that portion of the well string which is being sealed off, and provides for maintaining the seal as the well string is run into or out of the well and while portions of the string where its cross-sectional contour changes, e. g. where the couplings 41 connect adjacent portions of the string, are being drawn through the packer. Furthermore the invention provides for readily contracting the bore of the packer to provide the seal or for expanding the bore of the packer so as to clear the bore of the well casing, with the packer so proportioned and with its mass so shifted responsive to the stresses exerted, that tensile and compressive stresses tend to offset one another during contraction of the bore of the packer, and with the packing material readily distorting responsive to said stresses so that pressure fluid will readily operatively position the packer, and relief of said pressure fluid will allow the packer to readily return to its inoperative position responsive to the inherent resiliency of the packing material.

I claim:

1. In combination, a housing having a bore and an annular enlargement therein curved inwardly toward the respective ends of said enlargement from the medial transverse plane of the housing, annular flanges in the bore of the housing at the ends of its annular enlargement and projecting longitudinally toward one another, the outer surfaces of the annular flanges flaring radially outwardly as they extend toward the projecting ends of the flanges, an annular resilient material packer having an outer surface curved toward its respective ends in accordance with the curve of the annular enlargement and having a bore which is counterbored at its ends, the counterbores defining annular lips at the ends of the packer with the walls of the counterbores flaring radially outwardly as they extend toward the bases of said counterbore, the annular lips being radially slotted at circumferentially spaced points at the outer ends of the counterbores, the bases of the counterbores being radially slotted at circumferentially spaced points at their junction with the bore of the packer, the packer being adapted for mounting in the annular enlargement with its lips surrounding and normally spaced radially outwardly from the annular flanges and with its bore normally clear of the bore of the housing,

the packer having an annular recess in its outer periphery medially of its length and forming flexible lips at the respective sides of the mouth of the recess, the annular recess tapering toward its base, the portion of the packer which defines its bore being of less radial thickness than the longitudinal thickness of the end portions of the packer, and means for conducting pressure fluid to the annular recess in the packer.

2. In combination, a housing having a bore, and an annular enlargement in said bore, an annular flange projecting longitudinally into the bore of the housing from an end of the annular enlargement, the outer surface of the annular flange flaring radially outwardly as it extends toward the projecting end of the flange, an annular packer having a bore which is counterbored at an end of the packer, the counterbore defining a radially displaceable annular lip at said end of the packer with the wall of the counterbore flaring radially outwardly as it extends toward the base of said counterbore, the packer being adapted for mounting in the annular enlargement with its lip surrounding and normally spaced radially outwardly from the annular flange and with its bore normally clear of the housing, the packer having an annular recess in its outer periphery, and means for conducting pressure fluid to the annular recess to cause radial inward displacement of the annular lip to position engaged over and around said annular flange and the bore of the packer to contract to position in sealing engagement with and around a well string extending therethrough.

3. An annular packer having an outer surface curved inwardly toward its respective ends from the medial transverse plane of the packer and having a bore which is counterbored at its ends, the counterbores defining annular lips at the ends of the packer with the walls of the counterbores flaring radially outwardly as they extend toward the bases of said counterbores, the annular lips being radially slotted at circumferentially spaced points at the outer ends of the counterbores, the bases of the counterbores being radially slotted at circumferentially spaced points at their junction with the bore of the packer, the packer having an annular recess in its outer periphery medially of its length and forming flexible lips at the respective sides of the mouth of the recess, the annular recess tapering toward its base, and the portion of the packer which defines its bore being of less radial thickness than the longitudinal thickness of the end portions of the packer, the annular recess being adapted to receive pressure fluid for contracting the counterbores of the packer and radially outwardly distorting its flexible lips and for contracting the medial portion of the length of its bore.

4. In combination, a housing having a bore and an annular enlargement in said bore, an annular flange projecting longitudinally into the bore of the housing from an end of the annular enlargement, an annular yielding material packer floatingly mounted in said enlargement and having a bore which is counterbored at an end of the packer, the counterbore defining an annular radially displaceable lip at said end of the packer, the packer being adapted for mounting in the annular enlargement with its lip surrounding but normally spaced radially outwardly from the annular flange and with its bore normally clear of the bore of the housing, the packer having an annular recess in its outer periphery, and means for conducting pressure fluid to said annular

recess to distort the end of the packer radially inwardly to cause radial inward displacement of said lip and to force said lip under pressure into engagement with and around said annular flange, 5 and also to cause distortion of the body of the packer to contract the packer bore into position engaged and sealing around a well string extending therethrough.

5. In combination, a housing having a bore and 10 an annular enlargement in said bore having its inner surface curved inwardly toward an end of said enlargement, an annular flange projecting longitudinally into the bore of the housing from said end of the annular enlargement, the outer 15 surface of the annular flange flaring radially outwardly as it extends toward the projecting end of the flange, an annular packer having an outer surface curved toward an end thereof and having a bore which is counterbored at such end of 20 the packer, the outer surface of the packer being curved in accordance with the curve of the inner surface of the enlargement and being in sliding engagement with said enlargement inner surface

for radial movement of the packer thereover, the said counterbore defining a radially displaceable annular lip at said end of the packer with the wall of the counterbore flaring radially outwardly 5 as it extends toward the base of said counterbore, the packer being adapted for mounting in the annular enlargement with said annular lip surrounding and normally spaced radially outwardly from the annular flange and with its bore normally clear of the bore of the housing, the 10 packer having an annular recess in its outer periphery forming a flexible lip, and means for conducting pressure fluid to the annular recess to radially displace the end of the packer to cause radial displacement of the annular lip to force 15 the same into position engaged over and around said annular flange and the flexible lip to seal against the housing, and also to cause the bore of the packer to contract into sealing engagement with and around a well string extending through 20 said bore.

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