

March 12, 1963

J. R. BAKER ETAL

3,080,924

ANCHORS FOR TUBULAR STRINGS

Filed March 18, 1960

2 Sheets-Sheet 1

FIG. 1.

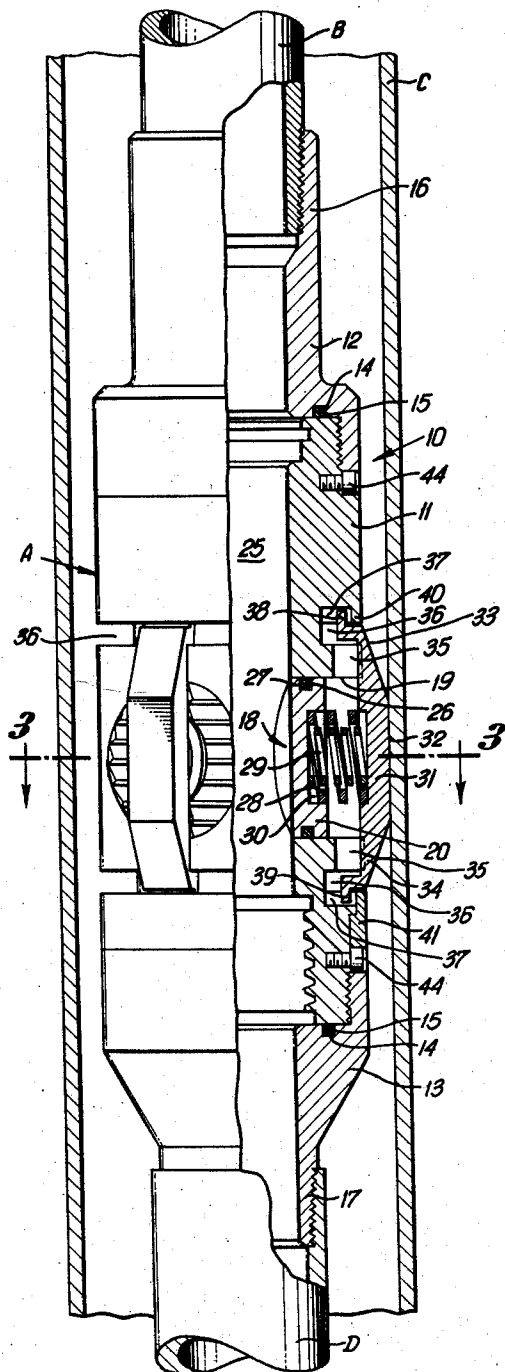


FIG. 2.

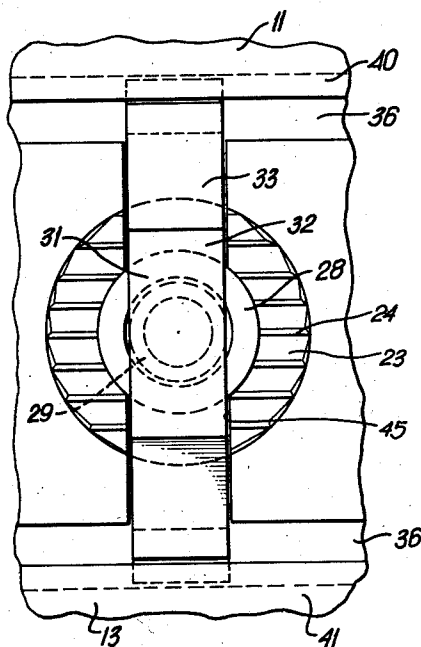
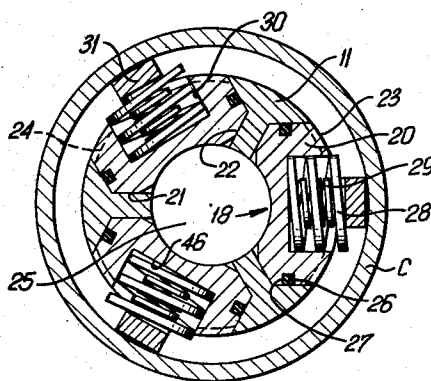


FIG. 3.



JOHN R. BAKER
JULIAN D. KEITHAHN
INVENTORS.

BY

Mellin and Hanson
ATTORNEYS.

March 12, 1963

J. R. BAKER ETAL

3,080,924

ANCHORS FOR TUBULAR STRINGS

Filed March 18, 1960

2 Sheets-Sheet 2

FIG. 4.

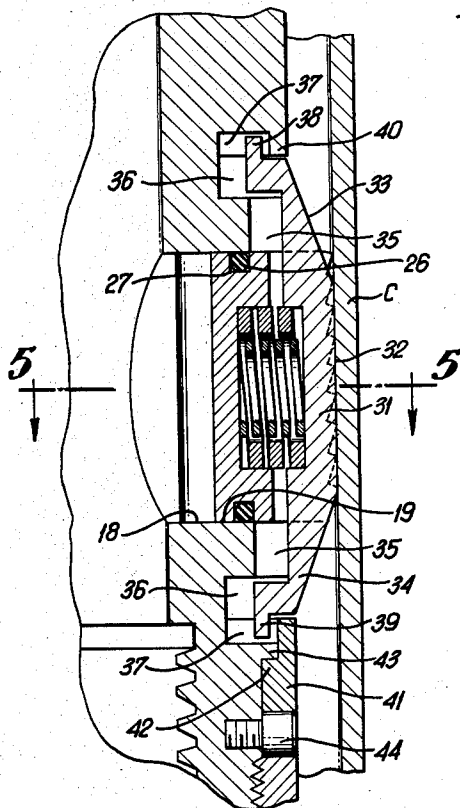


FIG. 5.

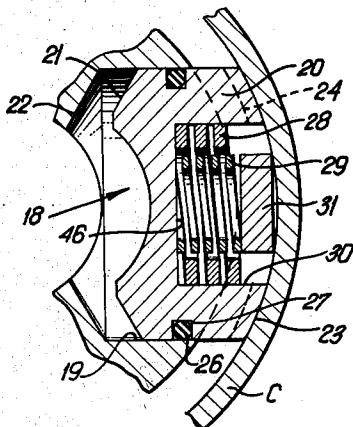
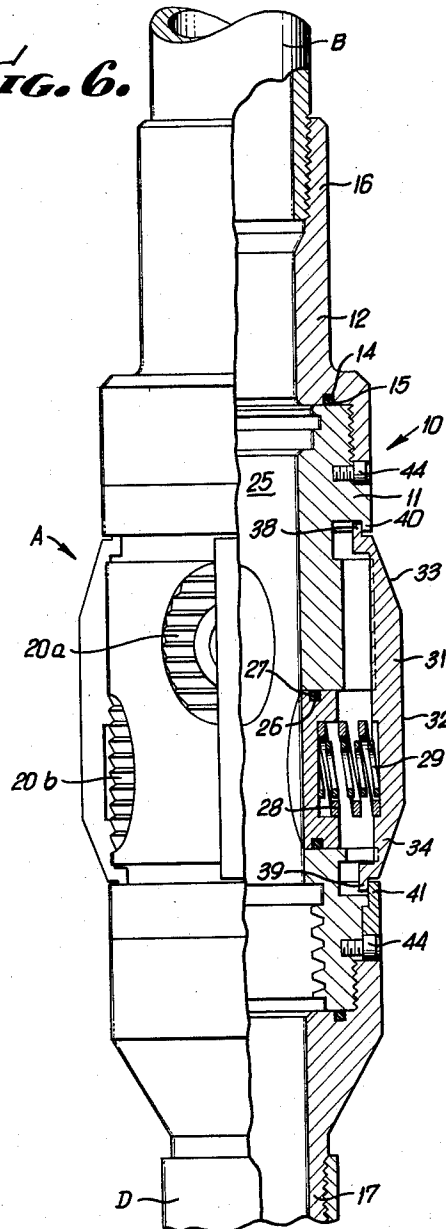


FIG. 6.



JOHN R. BAKER
JULIAN D. KEITHAHN
INVENTORS.

BY

Mellen and Hanson
ATTORNEYS.

1

3,080,924

ANCHORS FOR TUBULAR STRINGS

John R. Baker, Pasadena, and Julian D. Keithahn, Anaheim, Calif., assignors to Baker Oil Tools, Inc., Los Angeles, Calif., a corporation of California

Filed Mar. 18, 1960, Ser. No. 15,884

10 Claims. (Cl. 166—212)

The present invention relates to anchors for tubular strings, and more particularly to hydraulically actuated anchors having gripping members adapted to be expanded outwardly into anchoring engagement with a surrounding well casing, or similar conduit string.

Some types of tubing anchors include gripping members or slips which are expanded into anchoring engagement with the walls of well casings by the pressure of hydraulic fluid passing through the anchors themselves. During running of an anchor of the above type in a well casing, or its removal therefrom, the gripping members or slips should be in a retracted position, or prevented from contacting the wall of the well casing, to avoid interference with movement of the anchor through the casing and to prevent the casing gripping portion of the gripping members from becoming dull as a result of sliding along the casing. Springs have heretofore been employed to retain the gripping members in retracted position. However, the size springs that could be incorporated in the anchor was limited, the springs being incapable of holding the gripping members in retracted position, or from engaging the wall of the well casing, against the hydraulic pressures often developed in the anchor solely as a result of lowering or elevating the anchor through the fluid in the well casing.

An object of the invention is to provide a tubing anchor of the type indicated embodying springs that can exert greater retracting force on the gripping members, thereby requiring greater hydraulic pressures to expand the gripping members against the well casing.

Another object of the invention is to provide a tubing anchor of the type indicated embodying springs capable of exerting greater retracting force on the gripping member, allowing the gripping member to be made of a larger size and yet be held in a non-casing gripping position despite the presence of a larger area on each gripping member subject to hydraulic pressure within the anchor. The making of the gripping members of a larger size requires fewer of them, as well as fewer other parts, with consequent savings in manufacturing cost.

A further object of the invention is to provide a tubing anchor embodying springs tending to retract hydraulically actuated gripping members from the surrounding casing wall, in which the retracting force exerted by a spring on a gripping member when the latter is anchored to the casing is the same, regardless of the inside diameter of the casing engaged by the gripping member.

An additional object of the invention is to provide a tubing anchor having hydraulically actuated gripping members in which the extent to which the anchor can deviate from a position coaxial of the surrounding casing is reduced considerably.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

2

Referring to the drawings:

FIGURE 1 is a combined side elevational and longitudinal sectional view through a hydraulic tubing anchor embodying the invention, with the gripping members in retracted position;

FIG. 2 is a side elevational view, on an enlarged scale, of a portion of the anchor disclosed in FIG. 1;

FIG. 3 is a cross-section taken along the line 3—3 on FIG. 1;

FIG. 4 is an enlarged longitudinal section through a portion of the apparatus shown in FIG. 1, with the gripping member expanded against the well casing;

FIG. 5 is a cross-section taken along the line 5—5 on FIG. 4;

FIG. 6 is a combined side elevational and longitudinal sectional view through a modified form of tubing anchor.

As illustrated in the drawings, the tubing anchor A includes a tubular body 10 consisting of a main or intermediate body portion 11, an upper section 12 threadedly attached to the upper end of the main body portion, and a lower body section 13 threadedly secured to the lower end of the main body portion. Leakage of fluid through the threaded connections is prevented by suitable gasket type of O ring seals 14 mounted in grooves 15 in the upper and lower sections 12, 13 and sealingly engaging the upper and lower ends of the main body 11. The upper section 12 has a threaded box 16 for threaded attachment to an adjacent upper tubular section B forming part of the tubular string extending to the top of the well bore or well casing C in which the anchor is to be used; whereas, the lower body section 13 has a threaded pin 17 for threaded attachment to a lower section D of the tubing string. In lieu of such lower section D, the threaded connection may be to the lower body portion of a well packer D, or the like, preferably one that is adapted to anchor the tubing string in packed-off condition against downward movement in the well casing C.

The tubular body 11 has one or a plurality of lateral or radial bores 18 extending through its wall. The outer portion 19 of each bore is actually a cylinder in which is located a piston-like gripping member or slip 20 adapted to slide laterally or radially in the cylindrical bore 19 between a fully retracted position, in which the inner portion 21 of the piston engages tapered ends 22 in the inner part of the bore 18, and an outer position in which the outer gripping portion 23 engages the wall of the well casing. The outer gripping portion is curved to conform generally to the periphery of the cylindrical body 10 of the anchor when in the retracted position, and preferably does not extend beyond the outer surface of the body when in a fully retracted position. The outer gripping portion 23 may have a plurality of wickers or teeth 24 thereon adapted to firmly grip the wall of the well casing when expanded outward thereagainst. The teeth may face in an upward direction to anchor the apparatus A against upward movement in the well casing, or the teeth may be otherwise formed to prevent downward movement of the anchor in the well casing or to prevent both upward and downward movement therein.

The gripping members 20 are preferably circumferentially spaced around the body 10 of the tool, each one being disposed in its confining bore 18. They are urged outwardly by hydraulic pressure in the central passage 25 through the body, the pressure acting on the inner sides of the pistons 20 to urge them outwardly against the well casing C. Leakage of fluid around the exterior of each piston is prevented by a suitable seal ring 26, such as a rubber or rubber-like O ring, disposed within an external groove 27 in the periphery of the piston and slidably and sealingly engaging the wall of the cylinder

3

19 of the cylindrical bore. Outward movement of each gripping member or slip 20 is resisted by one or a plurality of springs 28, 29, which are preferably arranged radially, the inner ends of the springs being received within an inner socket 30 in the inner portion of the gripping member 20, the outer ends of the springs bearing against a retaining member or block 31, of elongate form, which includes a central portion 32 whose outer surface is parallel to the axis of the body 10, and which bears against the inner wall of the well casing C. From the intermediate portion 32 each block or member has an upper tapered guide portion 33 and also a lower tapered guide portion 34 slidable in upper and lower longitudinal body grooves 35 opening into the cylindrical bore 19, the grooves 35 running into upper and lower circumferential body grooves 36, which, in turn, merge into upper and lower circumferential recesses 37 in the body portion 11. Each block has upper and lower stop terminals 38, 39 extending within the upper and lower recesses 37. Outward movement of each retaining block is limited by engagement of the upper terminal 38 with an upper stop flange or ring 40 forming part of the main body 11, and also by engagement of the lower terminal 39 with a retaining ring 41 surrounding the lower portion of the body section 11 and having an inwardly directed flange 42 disposed under an outer flange 43 of the body. The lower retaining ring 41 is held in place by the lower body section 13, which is prevented from being inadvertently unthreaded from the main body 11 by a cap screw 44. A similar cap screw 44 may also be used to prevent inadvertent unthreading of the upper section 12 of the body from the main body section 11.

Each gripping member or slip 20 has a longitudinally extending groove 45, which is illustrated as being formed centrally thereof, opening to the exterior of the gripping member, this groove being of a width conforming to the width of the retaining block 31, thereby providing spaced gripping portions 23 that straddle the retaining block, the retaining block 31, in effect, forming a guide in conjunction with the cylindrical bore 19 for each gripping member during its outward and inward movement in the cylindrical bore. The retaining block 31 also serves to prevent turning of each gripping member 20 in its bore 18, so that the outer wickers or teeth 24 remain oriented in the proper direction, preferably lying in planes normal to the axis of the apparatus A.

One or a plurality of retracting springs 28, 29 may be used. As illustrated, an outer main spring 28 is disposed in the socket 30 of each gripping member with its outer portion adapted to bear against the central part 32 of the retaining member 31. An inner auxiliary spring 29 is also disposed within the main spring 28, its inner end bearing against the base 46 of the gripping member socket 30, and its outer end bearing against the retaining member or block 31. The retaining member or block functions as a spring seat for the outer ends of the springs, which spring seat is movable radially of the main body 10 of the apparatus, depending upon the inside diameter of the casing C, in which the apparatus is to be used. When the apparatus is out of the well casing C, the springs 28, 29 will move the retaining block 31 outwardly to the extent limited by engagement of its terminals 38, 39 with the upper and lower retaining rings 40, 41. However, upon inserting the apparatus in the well casing, the blocks 31 are shifted inwardly of the body 10 to some extent, possibly compressing the springs to a slight extent, the inner ends of the springs forcing each piston 20 inwardly to its fullest extent.

Following lowering of the apparatus A on the tubular string in the well casing to the desired setting point, pressure is imposed on the fluid in the tubular string and in the central passage 25 of the body, which might result from performing a pressuring operation in the well bore below the point at which the anchor is set. As an ex-

4

ample, if the lower portion of the anchor is attached to a set down type of hook wall packer D, then the setting of the packer against the well casing C will result in a closing of the annulus between the packer body and the wall of the well casing. Accordingly, fluid under pressure can be pumped down through the apparatus, and such fluid under pressure will act on the inner ends of the pistons 20 to urge them outwardly against the force of the springs 28, 29. When the fluid pressure becomes sufficiently great, the gripping members 20 are shifted outwardly until their wickers or teeth 24 are embedded in the wall of the well casing, thereby anchoring the body to the wall of the well casing. The greater the pressure, the greater will be the force holding the gripping members 20 anchored against the casing, thereby precluding longitudinal movement of the anchor A in the well casing C. When the pressure is relieved, the springs 28, 29 will shift the pistons 20 inwardly from engagement with the well casing, and to their fully retracted position.

By virtue of use of the laterally or radially movable retaining blocks 31 the slide along the wall of the well casing C, larger size springs 28, 29 can be mounted in the apparatus between each retaining block and the inner portion of each gripping member 20. The springs 28, 29 can be of a greater length and may be made of metal having greater cross-sections than was heretofore possible. The main spring 28 for each gripping member 20 is preferably so designed that it may actually exert very little, if any, spring force when the gripping member is in its fully retracted position, and it will exert a maximum force when the gripping member has moved outwardly into gripping engagement with the wall of the well casing C, just before the spring 28 would be compressed to its solid height. Thus, the main spring 28 exerts a maximum force tending to prevent the wickers or teeth 24 of the gripping member from engaging the wall of the well casing, and thereby requiring a greater pressure for the same cross-sectional area of gripping member 20 to shift the gripping member outwardly into firm anchoring engagement with the wall of the well casing.

The aforementioned powerful main springs 28, requiring greater fluid pressures before each gripping member is shifted into anchoring engagement with the well casing, insures that each gripping member will not be shifted outwardly sufficiently to bring its wickers 24 into contact with the wall of the well casing during raising or lowering of the apparatus through the fluid in the well casing, which actually develops pressure within the body passage. As an example, if the springs 28, 29 exert sufficient force as to require at least 200 p.s.i. pressure differential to be built up in the body passage 25 before the wickers 24 are engaged with the wall of the well casing, such pressures are not reached as a result of merely running the apparatus in the well casing or removing it therefrom. Accordingly, the wickers do not become dull as a result of sliding along the wall of the well casing C during the lowering or elevating of the apparatus A therewithin.

The springs 28, 29 exert the same resisting force to outward expansion of each gripping member 20 for different inside diameters of the casing C in which the tubing anchor A can be used. With smaller inside diameters of well casing, the retaining blocks 31 are shifted inwardly of the body 10 to a greater extent; whereas, in large inside diameters of well casing, the retaining blocks 31 move outwardly to a greater extent, such inward or outward position relative to the body being permitted by the compression or elongation of the springs 28, 29, and particularly by the auxiliary springs 29, which normally exert a much lesser force than the outer, much heavier main springs 28. Regardless of the inside diameter of the well casing C in which the apparatus is used, the springs 28, 29 are compressed to the same extent when its associated gripping member or slip 20 is shifted into anchoring en-

5

gagement with the well casing C. This is due to the fact that each retaining block 31 engages the well casing at all times, regardless of its inside diameter (within the range of use of a particular anchor), and the gripping member must, therefore, be expanded outwardly to the same position along the block to bring its wickers into anchoring engagement with the wall of the well casing. In other words, the gripping member 20 occupies a final position relative to the retaining block 31 which is the same, regardless of the inside diameter of the well casing C. When the wickers 24 firmly grip the well casing, the main springs 28 are preferably compressed almost to solid height. Thus, with lesser inside diameters of casing, each retainer block 31 will be disposed inwardly of the body 10 to a greater extent than with greater inside diameters of casing, so that each spring 28 may be initially compressed to some extent before pressure is applied to the gripping member, urging it outwardly. However, the same final pressure is required to bring the gripping member 20 into anchoring engagement with the well casing, regardless of its inside diameter, since the gripping member occupies the same final position with respect to the retaining block 31.

In addition to functioning as movable spring seats, and spring seats that extend a greater distance from the axis of the body of the apparatus so that longer and heavier springs 28, 29 can be incorporated in the apparatus A, the retaining blocks 31 also serve as centering devices or centering vanes tending to prevent the main body 10 of the apparatus from leaning against one side of the casing C. Accordingly, greater assurance is had that the main body 10 will be disposed in a position coaxial of the well casing, insuring better gripping engagement of the slips 20 with the wall of the well casing, with greater ability to resist relatively large forces tending to shift the anchor A longitudinally in the well casing C.

After the anchor A has served its purpose, the fluid pressure therewithin may be relieved, the springs 28, 29 shifting the gripping members 20 inwardly away from the well casing, which enables the anchor to be moved in the well casing to a different setting point or, if desired, to be removed entirely from the well casing.

In the form of invention illustrated in FIGS. 1 to 5, inclusive, a single set of circumferentially spaced gripping members 20 is disclosed. In the form of invention illustrated in FIG. 6, the anchor is substantially the same as in the form heretofore described, except for the fact that sets of longitudinally spaced gripping members 20a, 20b are illustrated. The upper set 20a is in staggered relation to the lower set 20b, actually being displaced 90 degrees from the lower set. With this arrangement, each gripping member can have a rather large diameter, which reduces the number of gripping members necessary for anchoring the apparatus against the wall casing to withstand great longitudinally directed hydraulic or other forces, since the hydraulic pressure in the apparatus is acting on each gripping member of much greater area. Each gripping member 20 in the other form of the invention (FIGS. 1 to 5) can also be made of a much greater cross-sectional area because of the ability to use heavier springs 28, 29, which will also reduce the number that are required. The reduction of the number of gripping members reduces the cost of the apparatus considerably since fewer parts and machining operations are required to produce the complete anchor A.

The inventors claim:

1. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; a retaining member movable laterally on said body and engageable with the well conduit; and spring means engaging said retaining member and gripping member to urge said gripping member laterally

6

inwardly toward the axis of said body and said retaining member outwardly against the well conduit.

2. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening in leakproof relation to the wall of said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; a retaining member carried by said body and movable laterally thereof to and from the axis of said body; and compression spring means engaging said retaining member and gripping member to urge said gripping member laterally inwardly toward the axis of said body and said retaining member outwardly against the well conduit.

3. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening in leakproof relation to the wall of said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; a retaining member carried by said body and movable laterally thereof to and from the axis of said body; said gripping member being slidable along said retaining member in moving to and from gripping engagement with the well conduit; and a spring between and engaging said retaining member and gripping member and adapted to be compressed between said gripping member and retaining member as said gripping member moves laterally in said opening toward the conduit string.

4. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; a retaining member movable laterally on said body and engageable with the well conduit; spring means engaging said retaining member and gripping member to urge said gripping member laterally inwardly toward the axis of said body; and means on said body engageable with said retaining member to limit its lateral outward movement on said body.

5. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; said body having guide means; a retaining member slidable laterally in said guide means and engageable with the well conduit; and spring means engaging said retaining member and gripping member to urge said gripping member laterally inwardly toward the axis of said body and said retaining member outwardly against the well conduit.

6. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; said body having guide means; a retaining member slidable laterally in said guide means and engageable with the well conduit; said gripping member being slidable along said retaining member in moving to and from gripping engagement with the well conduit; and spring means engaging said retaining member and gripping member to urge said gripping member laterally inwardly toward the axis of said body and said retaining member outwardly against the well conduit.

7. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; said body and gripping member having aligned guide portions; a retaining member in said

7

guide portions and engageable with the well conduit; said retaining member being slidable laterally along said body guide portion and said guide portion of said gripping member being slidable laterally along said retaining member; and spring means engaging said retaining member and gripping member to urge said gripping member laterally inwardly toward the axis of said body and said retaining member outwardly against the well conduit.

8. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; said body and gripping member having aligned grooves generally parallel to the axis of the body; a retaining member in said aligned grooves and movable laterally in said grooves relative to said body and gripping member, said retaining member being engageable with the well conduit; and spring means engaging said retaining member and gripping member to urge said gripping member laterally inwardly toward the axis of said body and said retaining member outwardly against the well conduit.

9. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; said body and gripping member having aligned grooves generally parallel to the axis of

8

the body; a retaining member in said aligned grooves and movable laterally in said grooves relative to said body and gripping member, said retaining member being engageable with the well conduit; and a spring between and engaging said retaining member and gripping member and adapted to be compressed between said gripping member and retaining member as said gripping member moves laterally in said opening toward the conduit string.

10. In apparatus to be lowered in a well conduit: a body having a fluid passage and a lateral opening in the body communicating with said passage; a gripping member movable laterally in said opening and movable by the pressure of fluid in said passage into gripping engagement with the well conduit; said body and gripping member having aligned grooves generally parallel to the axis of the body; a retaining member in said aligned grooves and movable laterally in said grooves relative to said body and gripping member, said retaining member being engageable with the well conduit; a spring between and engaging said retaining member and gripping member and adapted to be compressed between said gripping member and retaining member as said gripping member moves laterally in said opening toward the conduit string; and means on said body engageable with said retaining member to limit its lateral outward movement in said body groove.

References Cited in the file of this patent

UNITED STATES PATENTS

2,603,163	Nixon	July 15, 1952
2,792,063	Jones	May 14, 1957