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Jan. 23, 1967, abandoned.
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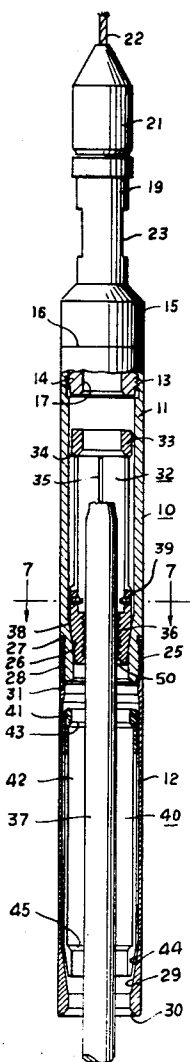
[54] **BROKEN SUCKER ROD RETRIEVERS**
1 Claim, 14 Drawing Figs.

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 294/86.22, 294/86.31, 294/86.32
 [51] Int. Cl. E21b 31/02,
 E21c 19/00
 [50] Field of Search 294/86.1,
 86.22, 86.26, 86.30, 86.31, 86.32, 86.33

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ABSTRACT: A broken sucker rod retriever having a one-piece tubular gripping member of heat-treated and stress-relieved spring steel freely reciprocable between upper and lower shoulders in a housing and being split longitudinally below its upper end to provide semirigid fingers of limited flexibility. Gripping means at the lower interiors of the fingers coact to form an internal annulus of less transverse dimension than the diameter of the rod to be retrieved so as to necessitate forcing thereof over said rod, and the lower end portions of said fingers preferably being deformed inwardly so as to permanently abut one another when relaxed whereby the annulus is of noncircular contour. The limited flexibility of the fingers is sufficient only to permit spreading thereof upon engagement of the gripping member with the rod and the upper shoulder of the housing. The biting engagement of the gripping means with a retrieved rod is so positive that the gripping member can be dislodged from the rod substantially only by mechanically spreading the fingers, radial pusher means being screw-threaded in said fingers adjacent said gripping means for engagement upon inward movement with said rod to force said fingers outwardly and disengage said gripping means. Optionally, the retriever may include a secondary gripping member underlying and somewhat similar to the first gripping member but of greater flexibility and larger diameter for engagement with an enlargement of the rod.



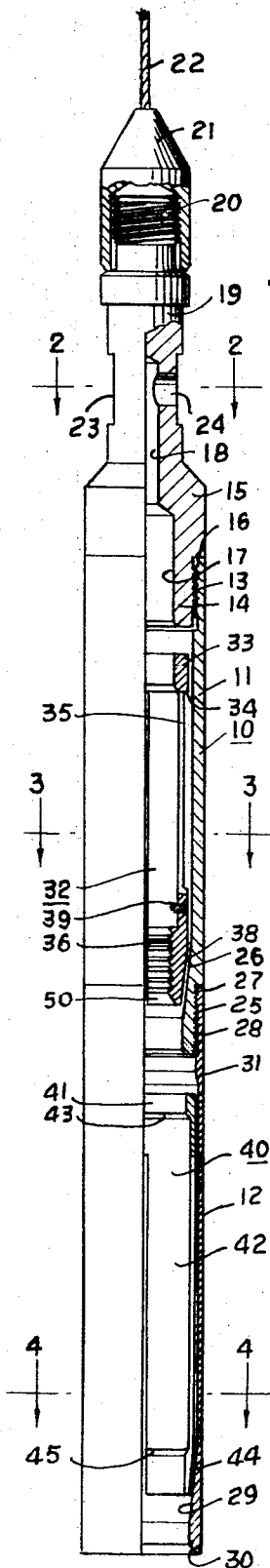


Fig. 1

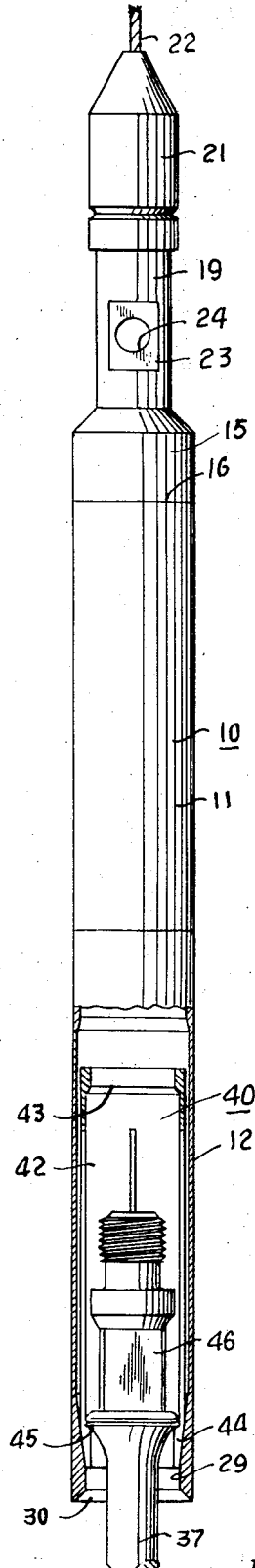


Fig. 5

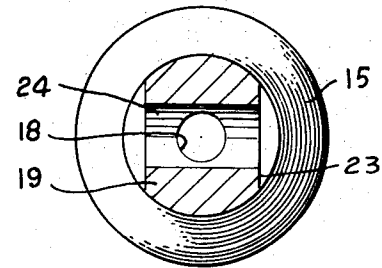


Fig. 2

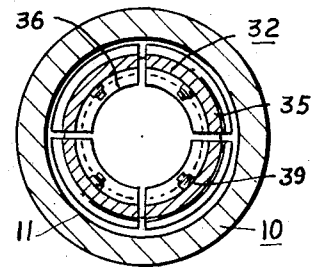


Fig. 3

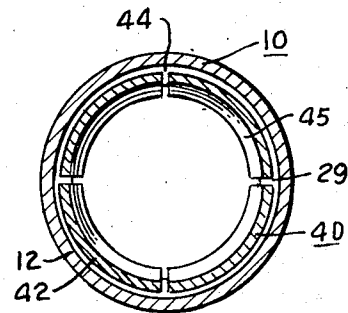


Fig. 4

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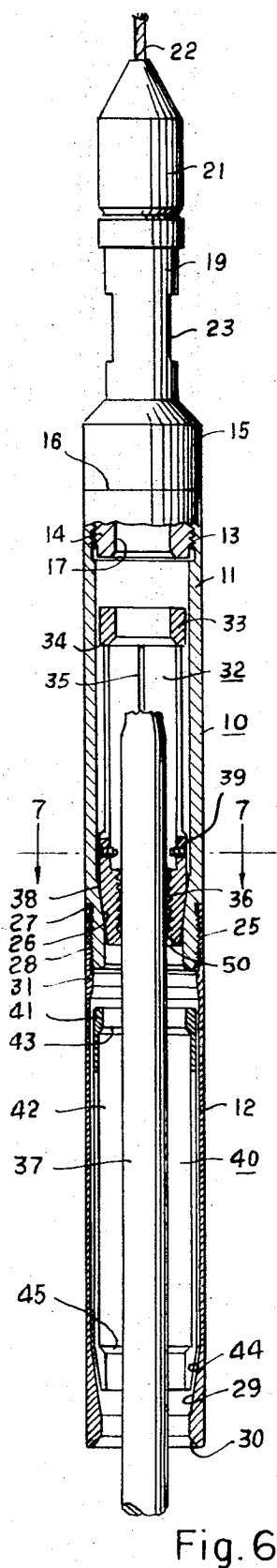


Fig. 6

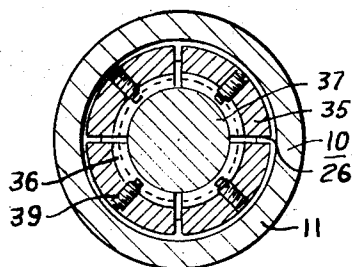


Fig. 7

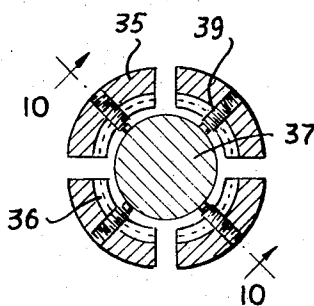


Fig. 9

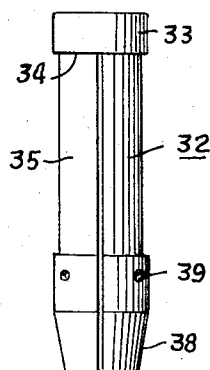


Fig. 8

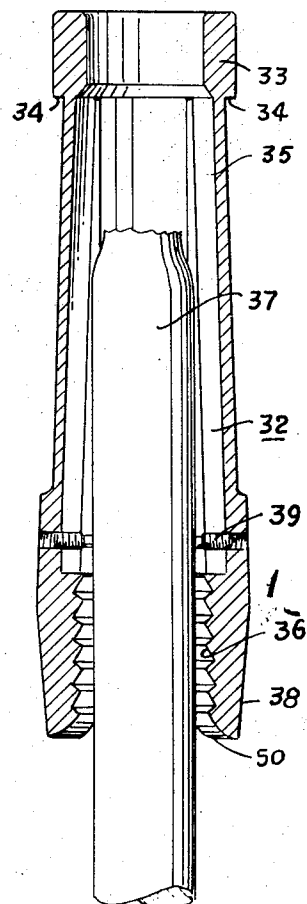


Fig. 10

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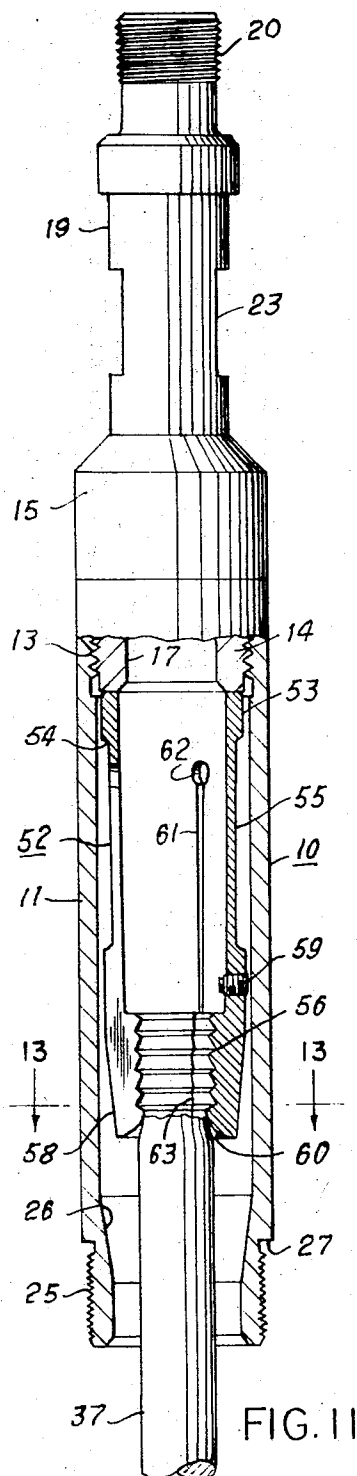


FIG. 11

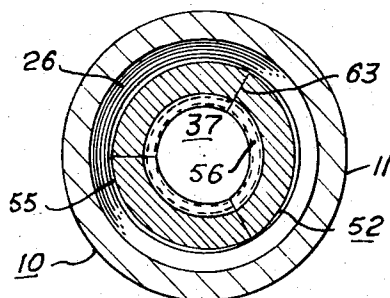


FIG. 13

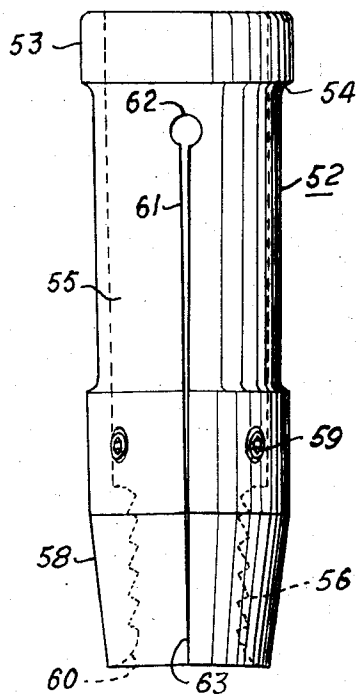


FIG. 14

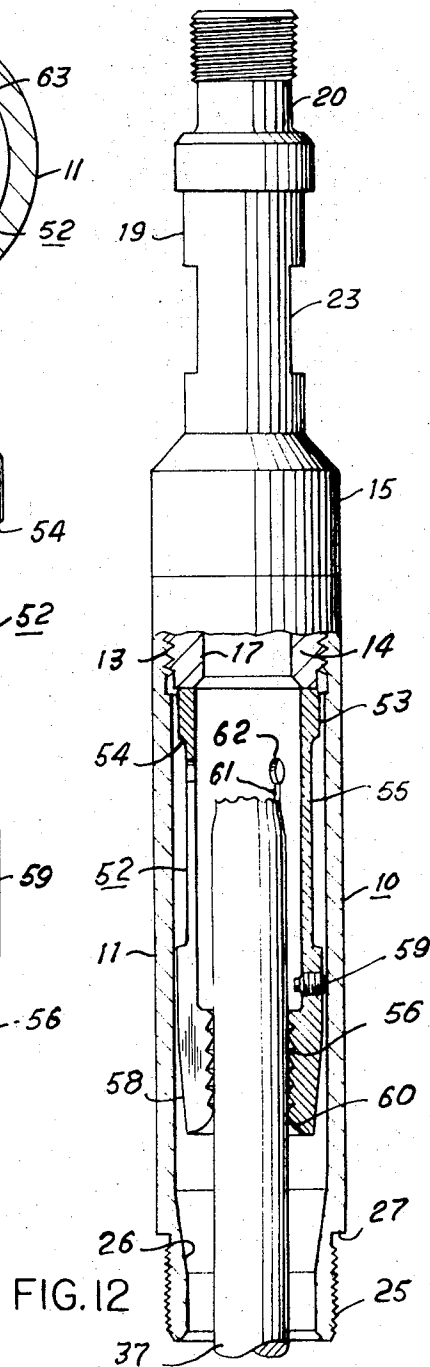


FIG. 12

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BROKEN SUCKER ROD RETRIEVERS

This application is a continuation-in-part application of my copending application Ser. No. 610,919, filed Jan. 23, 1967, now abandoned.

BACKGROUND OF THE INVENTION

In the pumping of wells, particularly oil wells, elongate strings of sucker rods are reciprocated by mechanisms at the ground surface and extend several thousand feet into well bores for operating pumps below the liquid level. These sucker rod strings are made up of a large number of individual sucker rod lengths which may be 30 or 40 feet in length and which are coupled together through screw-threaded boxes or joints. Often, through overloading, metal fatigue, or for other reasons, the sucker rods break or part, or even the screw-threaded joints between the individual rods become unscrewed accidentally. As used herein, "broken" covers the breakage of sucker rods within the lengths of the rods themselves or in the couplings or box connections which join adjacent sucker rods as well as the accidental or inadvertent unscrewing of one of such joints. The portion of the sucker rods above the break or point of disconnection can be readily withdrawn to the surface, but gripping means is required to engage and retrieve the lower portion of the sucker rod string which remains in the well.

SUMMARY OF THE INVENTION

This invention relates to a novel broken sucker rod retriever having an elongate tubular housing adapted to be lowered into a well bore over a broken sucker rod and a one-piece tubular gripping member of heat-treated and stress-relieved spring steel freely reciprocable between upper and lower internal shoulders in the housing whereby the shoulders limit the movement of the gripping member relative to said housing. A plurality, three or four, semirigid fingers of limited flexibility are provided by longitudinally slotting or splitting the gripping member below its upper end, gripping elements or teeth being formed on the lower interior surfaces of said fingers and coacting with one another to provide an internal noncircular or out of round annulus having a transverse dimension or diameter less than the smallest diameter of the rod to be retrieved whereby it is necessary to force the gripping member over said rod. The fingers are of minimum quantity so as to be of maximum strength without sacrificing the necessary resiliency essential to limited flexing thereof. Preferably, the lower end portions of the fingers are deformed inwardly so as to permanently abut one another when said fingers are relaxed or unflexed for exerting maximum inward force when engaged around the rod of proper diameter.

Due to the lesser diameter provided by the coaction of the gripping elements when the fingers are relaxed and the semirigidity of said fingers, the flexibility thereof is limited and sufficient only to permit spreading of said fingers upon engagement of the lower ends thereof with the rod and the abutment of the upper portion of the gripping member with the upper shoulder of the housing whereby said gripping elements may ride over said rod into positive biting engagement therewith. In fact, the biting engagement of the gripping elements with a retrieved rod is so positive that the gripping member can be dislodged from the rod substantially only by mechanically spreading the fingers, such as by radial pusher elements screw-threaded in said fingers adjacent said gripping elements for engagement upon inward movement with said rod to force said fingers outwardly and disengage said gripping elements.

Either or both the external lower portions of the fingers and the lower shoulder of the housing may be downwardly convergent to prevent accidental spreading of said fingers and disengagement of the gripping elements from the rod in the event of breakage of one of said fingers. If desired, the retriever may include a third shoulder in the housing below its lower shoulder and a secondary somewhat similar gripping member freely reciprocable in said housing lower portion between the

third and lower shoulders for connection with a coupling or other enlargement of a rod.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal view, partly in elevation and partly in section, showing one embodiment of broken sucker rod retriever constructed in accordance with the invention and in the position in which it would be lowered into a well bore;

FIGS. 2, 3, and 4 are enlarged, horizontal, cross-sectional views taken upon the respective lines 2-2, 3-3 and 4-4 of FIG. 1;

FIG. 5 is a longitudinal view, taken at a right angle to FIG. 1 and partly in elevation and partly in section, showing the secondary or lower gripping member in supporting engagement with the coupling or connection box of a sucker rod;

FIG. 6 is a longitudinal view, partly in elevation and partly in section, showing the primary or upper gripping member in supporting engagement with a broken sucker rod and engaged with the bowl or lower shoulder of the primary or upper housing section;

FIG. 7 is an enlarged, horizontal, cross-sectional view taken on the line 7-7 of FIG. 6;

FIG. 8 is a side elevational view of the primary gripping member with its fingers in partially expanded or outwardly flexed position relative to the now-known preferred embodiment of the invention;

FIG. 9 is an enlarged, horizontal, cross-sectional view illustrating the mechanical spreading of the fingers and disengagement of the gripping elements of the upper gripping member from the sucker rod by pusher elements screw-threaded in said fingers;

FIG. 10 is a longitudinal, sectional view taken on the line 10-10 of FIG. 9;

FIG. 11 is an enlarged, longitudinal, sectional view, partly in elevation, of the preferred embodiment of the invention, wherein the secondary or lower gripping member and its housing are omitted and the fingers of the primary upper gripping member are decreased from four to three, showing the resting of the relaxed or unflexed fingers of said primary member upon the broken sucker rod prior to gripping engagement of said primary member with said rod, and the abutment of the lower end portions of the gripping elements;

FIG. 12 is a view, similar to FIG. 11, illustrating the positive biting engagement of the gripping elements of the fingers of the primary gripping member with the rod upon final downward movement of the retriever and prior to the engagement of said fingers with the bowl or lower shoulder of the housing for said member upon upward movement of said retriever;

FIG. 13 is a horizontal, cross-sectional view, taken on the line 13-13 of FIG. 11, showing that the internal annulus formed by the gripping elements of the primary gripping member is of less transverse dimension than the diameter of the rod, shown in broken lines, and that said annulus is noncircular; and

FIG. 14 is a side elevational view of the primary gripping member with its fingers in relaxed or unflexed position and the lower end portion of the gripping elements in abutment.

DESCRIPTION OF ONE OF THE PREFERRED EMBODIMENTS

In the drawings, the numeral 10 designates an elongate tubular housing of a broken sucker rod retriever which may include upper and lower or primary and secondary cylindrical sections 11 and 12. The upper end of the upper housing section 11 is internally screw-threaded at 13 for receiving the depending, thick-walled, screw-threaded pin 14 of a ported cap member 15 which is externally shouldered at 16 at the upper end of the pin so as to abut the upper end of said upper hous-

ing section. Due to the thick wall of the pin 14, a downwardly facing shoulder is formed by the lower end of said pin. A coaxial bore 17 extends through the pin and communicates with a reduced, coaxial bore 18 extending upwardly into a conventional fishing neck 19 which has a reduced screw-threaded pin 20 at its upper end. The pin 20 may engage within a conventional rope socket member 21 to which a flexible cable or wire line 22 may be attached for lowering the sucker rod retriever into a well bore and lifting the same therefrom. Manifestly, the retriever may be run into the well on rods or on any other suitable means but the flexible cable or wire line 22 has been found to be most convenient, it being noted that weights (not shown) may be threaded on the cable for assisting downward movement of said retriever. The fishing neck 19 has the usual diametrically opposed wrench faces 23 through which radial ports 24 (FIG. 2) extend from the bore 18, thus permitting the passage of fluid through the ports and the bores 18 and 17 as the retriever is raised or lowered in the well bore.

At its lower end, the upper housing section 11 has external screw-threads 25 and an internal, annular, downwardly convergent bowl or shoulder 26. An external, annular shoulder 27 overlies the screw-threads 25 and is abutted by the upper end of an internally screw-threaded box 28 on the upper end of the lower housing section 12 whereby said upper and lower housing sections are detachably joined together to form the composite housing 10. The interior of the lower housing section also has an annular, downwardly convergent bowl or shoulder 29 at its lower end and the lowermost extremity 30 of said housing interior may be downwardly and outwardly beveled below the bowl or shoulder 26 to facilitate the ready downward movement of the retriever over a broken sucker rod and the passage of the upper end of the broken sucker rod into the interior of the housing. Preferably, an internal, annular shoulder 31 is formed in the upper portion of the lower housing section 12 immediately below its screw-threaded box 28.

An upper primary one-piece tubular, gripping member 32 is freely movable longitudinally of the interior of the primary or upper housing section 11 and includes a relatively heavy ring 33 at its upper end forming an annular enlargement or shoulder 34 extending radially outwardly of the member. The member 32 is slotted or split longitudinally below the ring 33 to provide elongate, downwardly extending, semirigid fingers 35 of limited flexibility having internal gripping elements or teeth 36 at their lower ends which coact to form an internal annulus having a transverse dimension or diameter less than the smallest diameter of a sucker rod 37 to be retrieved (FIG. 6). Outwardly of the gripping teeth 36, the lower end portions of the fingers 35 may be tapered downwardly and inwardly to form inclined faces 38 engageable with the downwardly convergent shoulder 26 so as to prevent accidental outward flexing of said fingers and disengagement of said teeth from the sucker rod 37. Obviously, it is unnecessary for both the shoulder and the finger exteriors to be beveled or tapered and that either may be cylindrical.

As best shown in FIGS. 7, 9 and 10, each finger 35 may have a radial pin or pusher element 39 screw-threaded therein immediately above each gripping element or teeth 36 and these pusher elements are adapted to be threaded inwardly of the fingers into engagement with the sucker rod to mechanically spread said fingers and disengage the teeth from said rod so as to permit ready dislodgement of the gripping member 32 from said rod. In order to provide the desired semirigidity and/or limited flexibility of the fingers, the gripping member is formed of spring steel which is heat-treated and then stress-relieved and said fingers are of minimum quantity, three or four, so as to be of maximum strength and still have sufficient elasticity or resiliency to permit limited flexing thereof. Due to the internal diameter provided by the coaction of the teeth being less than the smallest diameter of the rod 37, it is necessary to force the fingers over said rod and, as will be explained, this requires considerable force.

When the gripping member 32 is engaged over the rod, the fingers 35 are under strong tension so as to resist spreading thereof and positively force the teeth 36 into biting engagement with said rod whereby said member can be dislodged from said rod substantially only by mechanically spreading said fingers, such as by the pusher elements 39. In fact, it is preferable for this biting engagement to be so positive that it cannot fail unless one of the fingers breaks or is flexed outwardly beyond its elastic limits or unless the lower portion of the sucker rod string is badly stuck. As will be explained hereinafter in connection with the description of the preferred embodiment of the invention shown in FIGS. 11-14, the inward tension of the fingers may be increased by holding the lower end portions thereof in engagement with one another during the heat-treating and stress-relieving of the gripping member whereby said lower end portions are permanently deformed or set inwardly and remain in abutment except when said fingers are flexed outwardly by the rod, pusher elements or other mechanical means and the annulus formed by the interior surfaces of the gripping elements is noncircular or out of round due to such abutment. Even when the lower end portions of the relaxed fingers 35 are spaced apart as shown in FIG. 8, said fingers are semirigid and are under appreciable tension when spread outwardly (FIGS. 6 and 7) by the rod 37.

A secondary lower tubular gripping member 40, somewhat similar to the primary member 32, is freely movable longitudinally in the secondary housing section 12, which may be utilized when desired, and includes an annular top ring 41 from which depend split semiflexible fingers 42, the ring forming an internal, annular shoulder 43 above the fingers. The exteriors of the lower ends of the fingers 42 may be beveled downwardly and inwardly to form tapered faces 44 for engaging the shoulder 29. An interrupted, annular, upwardly facing beveled shoulder 45 is provided at the lower ends of the interiors of the fingers immediately above the tapered faces 44 by increasing the thickness of said finger lower ends inwardly whereby the internal diameter of the shoulder is at least less than the larger diameters of the coupling or connecting element 46 (FIG. 5) of the sucker rod. The travel of the secondary gripping member 40 is limited between the shoulder 29 and the shoulder 31 of the secondary housing section or the lower end of the primary housing section 11, while the travel of the primary gripping member is limited between the shoulder 26 and the shoulder formed by the lower end of the pin 14 of the cap member 15. As will be apparent and as shown in FIGS. 11-14, a gripping member constructed in accordance with the primary member is capable of use independent of the secondary housing section 12 and member 40.

OPERATION

The operation of the retriever is believed to be obvious in that when a break or disconnection of any kind occurs in the sucker rod string, the upper portion thereof accessible at the ground surface is first removed, and then said retriever is lowered into the well bore. The tubular and open structure of the retriever together with its passages 17, 18 and 24 permit the fluid present in the well to pass readily downwardly through such fluid. The retriever is guided over and passes over the broken or disconnected upper end of the lower portion of the sucker rod string, and if the break has occurred in a rod, as shown in FIG. 6, the upper end of the rod 37 engages the lower ends of the fingers 35 of the primary gripping member 32. Since the internal diameter or transverse dimension of the lower end of this gripping member, at its gripping elements or teeth 36, is less than the smallest diameter of the rod, the retriever continues to move downwardly relative to said rod and member until the shoulder at the lower end of the thick-walled pin 14 of the cap member 15 strikes the upper end of said gripping member.

Due to the limited flexibility of the fingers 35, additional downward movement of the retriever causes spreading of said fingers and permits downward movement of the gripping

member 32 with said retriever relative to the rod 37. The gripping teeth ride over the rod into positive biting engagement therewith as a result of the inward tension of the outwardly flexed fingers, it being noted that the interiors of said fingers below said teeth are beveled or chamfered as shown at 50 to facilitate engagement of the primary gripping member over said rod. Upon upward movement of the retriever, the gripping member 32 remains stationary with the rod 37 until the shoulder 26 of the primary housing section 11 engages the inclined faces 38 at the lower end portions of the fingers 35 so as to prevent accidental outward flexing of said fingers and disengagement of the gripping teeth 36 from said rod in the event of breakage of one of said fingers.

In the event a connecting joint has broken or become unscrewed, as shown in FIG. 5, the retriever moves downwardly over the sucker rod 37 until the connector element 46 of said rod engages the lower end of the primary gripping member 32 since it is too large to pass through the gripping teeth 36. If desired, the ring 41 of the secondary gripping member 40 may be made of sufficient radial thickness so that it is engaged by the upper end of the connector element and thus limit further downward movement of the retriever. During this downward movement of the retriever relative to the connector element 46, the secondary gripping member remains stationary with the rod whereby the upper end or ring 41 of said member strikes the upper shoulder 31 of the secondary housing section 12 or the lower end of the primary housing section 11 so as to permit spreading of the fingers 42 of said member and engagement of the shoulder 45 of said member beneath said connection element. Upon withdrawal of the retriever, the lower shoulder 29 of the secondary housing section moves upwardly into engagement with the tapered faces 44 of the fingers of the gripping member 40 so as to prevent outward flexing of said fingers and disengagement of the shoulder of said member from beneath the connector element.

At the ground surface, the retriever is readily disassembled by removing the cap 15 and separating the housing sections 11 and 12 so that the primary and secondary gripping members may be removed and disengaged from the sucker rod. Due to difficulty experienced in disengaging the gripping teeth 36 from the sucker rod 37, the pusher elements 39 may be threaded inwardly against said rod to force said teeth from engagement therewith. Thereupon, the gripping member 32 may be separated readily from the rod. The rings at the upper ends of both of the gripping members permit the ready manual grasping thereof for removal from the housing sections and disconnection of the retriever from the lower portion of the sucker rod string.

DESCRIPTION OF THE MOST PREFERRED EMBODIMENT

Although subject to variation with reasonable limits, it is essential to this invention that the minimum internal diameter of the annulus formed by the coaction of the gripping teeth of the primary gripping member be less than the smallest diameter of the sucker rod since breakage of said rod, usually, is at such diameter. Due to the semirigidness and/or limited flexibility of the gripping member fingers, it is readily apparent that the minimum internal diameter or transverse dimension of the lower portion of the gripping member must be less than and vary in accordance with the size of the sucker rod which may be between one-half inch and 1½ between its end portions or enlargements. Desirably, this minimum dimension of the gripping member is one-eighth of an inch less than the smallest diameter of the rod and may be between one-sixteenth and three-sixteenths of an inch less.

Even though it is preferable to permanently deform or set the lower end portions of the gripping member fingers inwardly so as to increase the inward tension upon outward flexing of said fingers, it is pointed out that the same positive biting engagement may be approximated by varying the minimum diameter of the gripping member in accordance

with the smallest diameter of the sucker rod; however, optimum results are obtained when the lower end portions of the relaxed fingers abut one another permanently so as to amplify the inward tension thereof and thereby more positively force the gripping teeth of said fingers into biting engagement with the sucker rod.

As shown at 52 in FIGS. 11-14, the primary gripping member is preferably of slightly different construction than the gripping member 32 of FIGS. 1-10, and both members are capable of use independently of the secondary gripping member 40 and its housing section 12. The members are identical except for the relatively few differences set forth hereinafter in that the member 52 includes a relatively heavy ring 53 forming an external, annular shoulder 54 at its upper end, depending fingers 55 and internal gripping elements or teeth 56 at the lower interiors of the fingers. Also, the exterior lower portions of the fingers 55 may have downwardly tapered faces 58 for seating engagement with the lower shoulder 26 of the primary housing section 11 which may or may not have an externally screw-threaded lower end 25. Preferably, pusher elements or pins 59 are provided for mechanically spreading the fingers and releasing or retracting the teeth 56 after retrieving the lower portion of the sucker rod string as described in connection with the gripping member 32. Also, the lower extremities of the fingers 55 have internal, beveled or chamfered surfaces 60, similar to the surfaces 50 of the fingers 35, to facilitate engagement of the gripping member 52 over the broken sucker rod 37.

As pointed out hereinbefore, the lower portions of the gripping member fingers are held together during heat-treating and stress-relieving of the primary gripping member so that said finger lower end portions remain in engagement permanently except when said fingers are expanded or flexed outwardly by the sucker rod, pusher elements 59 or other mechanical means. Due to this inward deformation or performing, the fingers 55 have greater inward tension and consequent resistance to expansion or outward flexing than the fingers 35 so as to increase the positive biting engagement of the gripping teeth 56 with the rod 37. As shown at 63 in FIGS. 11, 13 and 14, the lower end portions of the slots 61 are closed by this deformation whereby the lower portions of the gripping teeth abut one another. Also, the annulus formed by the interior surfaces of the teeth 56 is noncircular or out of round (FIG. 13) due to the deformation of the fingers. It is noted, however, that the inward tension of the inwardly deformed or set fingers 55 may be approached by the proper internal dimensioning, relative to the rod diameter, of the annulus formed by the coaction of the closely spaced relationship of the lower end portions of the fingers 35 of the primary gripping member 32.

In other words, it is critical that the minimum internal transverse dimension or diameter of the portion of the primary gripping members which is supportingly connected to the retrieved sucker rods, be sufficiently less than the smallest diameter of said rod that failure of the gripping engagement of said member with said rod is virtually impossible until and unless the positive biting engagement of the teeth of said gripping member is overcome by the resistance to upward movement of the retriever, such as when the lower portion of the sucker rod string becomes stuck in the well bore, its casing or tubing. In order to minimize fatigue due to flexing of the fingers of the gripping member 52, it is customary to terminate the upper ends of the longitudinal slots 61, which form the fingers 55, in enlarged semicircular openings 62 immediately below the ring 53 so as to minimize the likelihood of fracture at these points upon outward flexing of said fingers. Preferably, the openings 62 are drilled prior to milling of the slots. Manifestly, the openings facilitate the inward bending of the lower end portions of the fingers to provide the permanent inward deformation thereof.

Sucker rods are made in several diameters with both rod portions and connector sections being of differing diameters and, obviously, other gripping members having larger or

smaller gripping diameters may be readily substituted in the same retriever housing since the upper and lower ends of the gripping members may be made of the same external diameters and configuration while the internal diameter of the gripping means or gripping elements of said members may be made of varying diameters to accommodate sucker rods of various sizes.

Although it is preferable that the lower ends of the primary and secondary gripping members be downwardly convergent and that the lower shoulders of the housing sections also be downwardly convergent or tapered and complementary to the lower ends of said gripping members, it is readily apparent that the lower ends of either or both of said gripping members may be cylindrical and employed with tapered shoulders or that the lower ends of either or both of said gripping members may be downwardly convergent and said shoulders may be conventional cylindrical internal flanges. For both gripping members, it is essential only that either the lower housing shoulder or the lower end of the gripping member be downwardly convergent since either structure would result in the contracting of the lower ends of said members upon upward movement of the retriever.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials as well as in the details of the illustrated constructions may be made without departing from the spirit of the invention.

I claim:

1. A broken sucker rod retriever including:
an elongate tubular housing adapted to be lowered into a well bore over a broken sucker rod;

upper and lower internal shoulders in the housing;
a one-piece tubular gripping member freely movable longitudinally within said housing between the shoulders;
said shoulders limiting the movement of the gripping member relative to said housing;
said gripping member being split longitudinally below its upper end to provide a plurality of semirigid fingers having limited flexibility;
gripping elements on the lower interior surfaces of the fingers which coact to form an internal annulus of less transverse dimension than the diameter of the rod to be retrieved whereby it is necessary to force said gripping member over said rod;
the limited flexibility of said fingers being sufficient only to permit spreading thereof upon engagement of the lower ends thereof with the rod and the abutment of the upper portion of said gripping member with the upper shoulder of said housing whereby said gripping elements may ride over said rod into positive biting engagement therewith;
the biting engagement of said gripping elements with the rod being so positive that said gripping member can be dislodged from said rod substantially only by mechanically spreading said fingers; and
pusher elements screw-threaded in said fingers in proximity to said gripping elements and extending radially through said fingers for engagement with a retrieved rod upon being moved inwardly so as to force said fingers outwardly and disengage said gripping elements from the rod.