Feb. 28, 1961 T. A. KENNARD 2,973,037

RETRIEVING TOOL

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Fig. 1

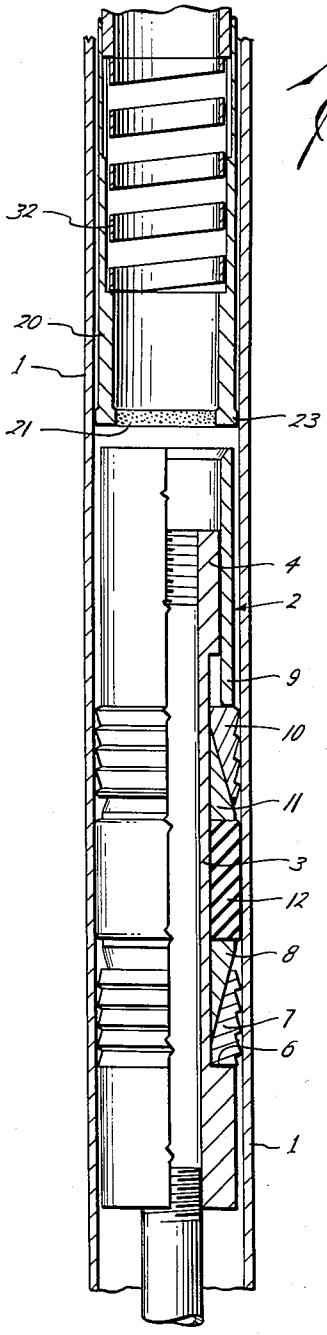


Fig. 2

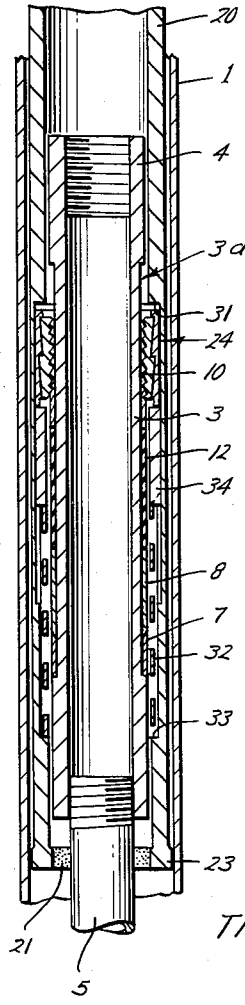
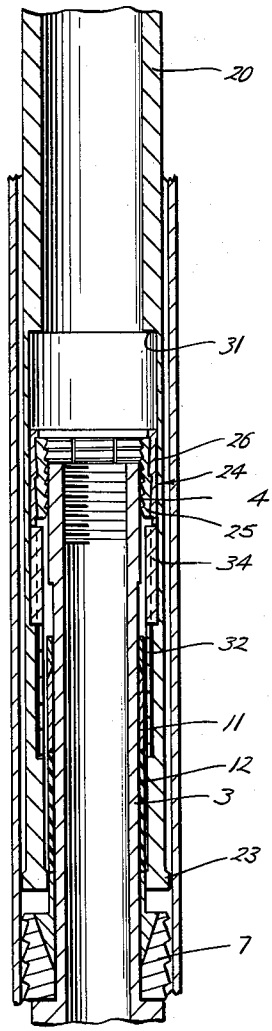


Fig. 3



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Fig. 4A

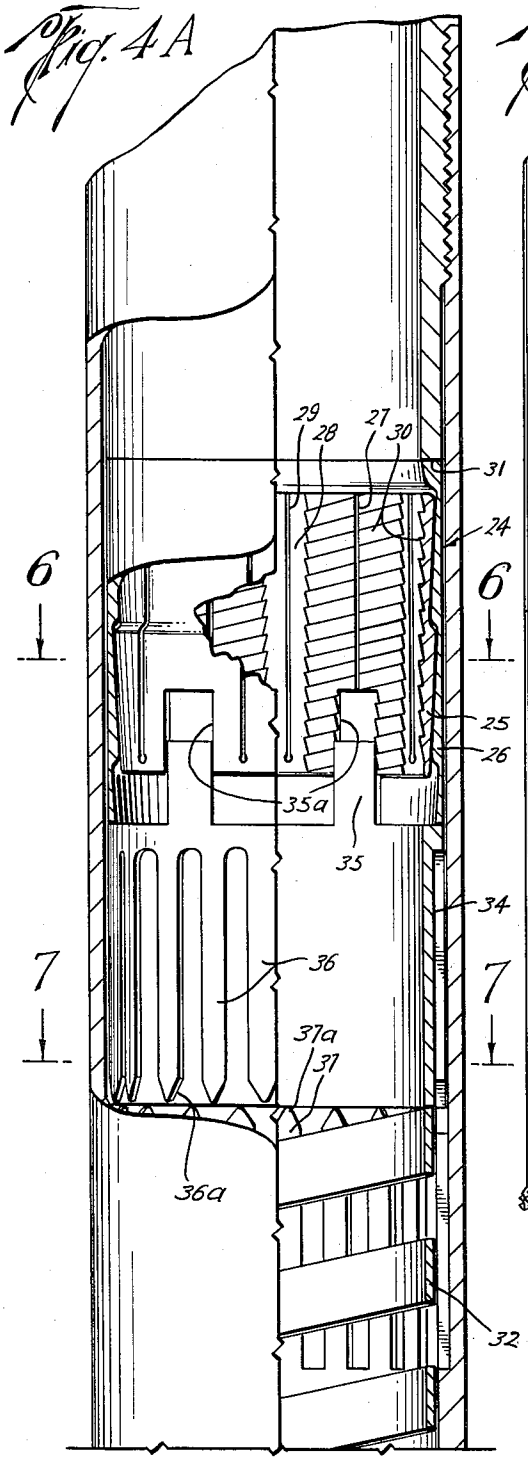
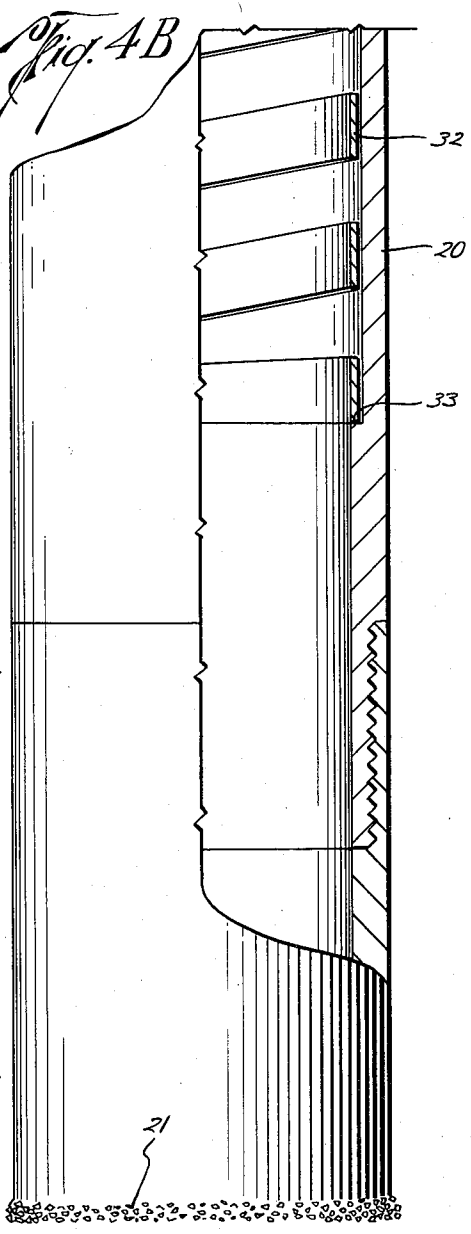


Fig. 4B



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Fig. 5

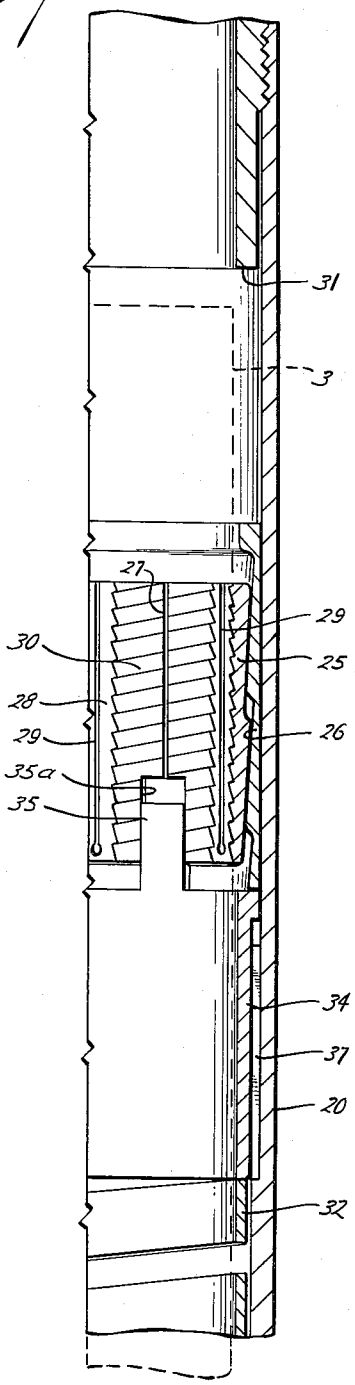


Fig. 6

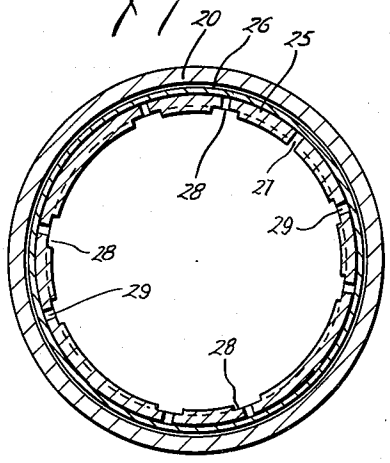
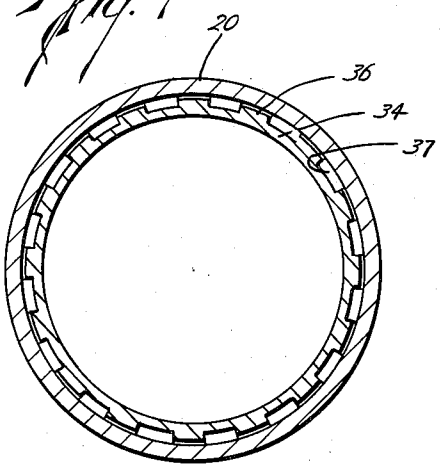


Fig. 7



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RETRIEVING TOOL

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12 Claims. (Cl. 166—55.1)

My invention relates to a retrieving tool and, more particularly, to a tool for retrieving from an oil well casing, tools and other devices permanently placed above the bottom of the casing by positive gripping devices securing it to the inner wall thereof.

In various operations designed to condition oil wells for production, it is necessary or desirable to pack-off the well casing against fluid flow at a given depth to isolate one or more geological zones for production. Well packers have been designed with serrated slips or other means adapted to grip positively the inner wall of the casing to secure the packer permanently at the selected depth. Permanent type packers, once set, are locked against upward or downward movement within the well casing in order to resist fluid pressures from either direction. As such, the permanent type well packers are designated as non-retrievable since they cannot be recovered by conventional apparatus and, should it ultimately become desirable to remove the packer, it has heretofore been necessary to mill away the entire packer and then to employ fishing devices to retrieve the broken pieces which fall to the bottom of the well.

Other retrieving tools have been devised which may be attached to the packer before commencement of the milling operations so that the bulk of the non-retrievable structure can be removed with the retriever. However, various elements of the packer, such as the slips, cone expanders and the like are merely slidably carried on the central mandrel without being positively attached thereto. Consequently, when the milling shoe cuts away restraining cages, flanges and the like, the slidable elements are free to fall to the bottom of the well where, again, conventional fishing operations must be employed for their recovery. Moreover, once attached to the packer, such retrieving tools cannot be removed should the milling shoe fail to sever the connection of the packer with the well casing.

It is, therefore, an object of my invention to provide an apparatus for removing permanent or cementing packers while preventing severed portions from falling to the bottom of the well casing.

It is a further object of my invention to provide an apparatus for the removal of permanently set well packers which substantially eliminates the necessity of fishing for broken particles of the packer.

It is a further object of my invention to provide a retrieving tool which can be operated to effect a positive gripping action upon central portions of a permanently set well packer while milling away elements thereof attaching the packer to a well casing.

It is a further object of my invention to provide a retrieving tool which effects a positive engagement with central portions severed from the well casing but which can be separated therefrom if desired.

It is a further object of my invention to provide a retrieving tool which is economical in construction and simple and efficient in operation.

My retrieving tool comprises a tubular housing having a milling shoe at the open lower end thereof which, when the housing is rotated, mills away the periphery of a well tool, such as packer gripping elements, to sever its connection with the inner wall of the well casing. As the cutting shoe moves down over the central mandrel of the packer, substantially all of the elements severed therefrom except the fine chips produced by the milling shoe, are encased within the housing and thus prevented from falling to the bottom of the well. Within the housing is an annular slip assembly of an internal diameter which permits the severed central portions of the packer to slide upwardly therethrough but which by upwardly directed teeth bite into such central portions upon any tendency thereof to move downwardly. Coupled with the natural gripping action of the upwardly directed teeth are means for constricting the slips to grip the central portions even more tightly in the event of downward movement, as when the packer is completely severed from the well casing. As a particular feature of my retrieving tool, the teeth of the gripping slips are helically disposed in the nature of internal threads. Consequently, if for any reason, complete severance of the packer gripping element is prevented, the slips may be rotated with the housing to thread them out of engagement with the partially severed central portion of the well packer.

Other objects, advantages and novel features of my invention will become apparent from the following specification when viewed in connection with the accompanying drawing wherein:

Fig. 1 is a vertical section of my retrieving tool in condition for engagement with a well packer;

Fig. 2 is a vertical section of my retrieving tool after complete severance of the packer gripping elements preparatory to removal of the packer from the well;

Fig. 3 is a vertical section of my retrieving tool conditioned for separation from the well packer;

Figs. 4A and 4B are enlarged partial section views of adjacent portions of my retrieving tool;

Fig. 5 is an enlarged view of my retrieving tool in partial section as conditioned for separation from the well packer;

Fig. 6 is a view taken along line 6—6 of Fig. 4; and

Fig. 7 is a section view taken along line 7—7 of Fig. 4.

Referring now to the drawings, reference numeral 1 designates a well casing within which a well packer 2 is permanently set against movement in either direction. While the particular means for locking the well packer in place is not material to my invention, I have shown for purposes of illustration typical structures for this purpose. In the embodiment shown, the well packer 2 includes a central mandrel 3 having a threaded box 4 at the upper end thereof for connection to a drill string or the like during lowering and positioning operations. Strainers, valves or other means for controlling the flow of fluid may be carried in an elongate body 5 attached to the lower end of the mandrel 3. The lower portion of the mandrel 3 is enlarged externally to present a radial shoulder 6 above which are slidably carried on the mandrel 3 lower slips 7 and mating frustro-conical slip expanders 8. Slidable on the upper portion of mandrel 3 is a sleeve 9 which engages upper slips 10 to force them over similar cone expanders 11. The expansible packing element 12 is carried on the mandrel 3 between the slip expanders 8 and 11. To set the packer at a selected depth within the well casing 1, the sleeve 9 is forced down over mandrel 3 to in turn force the upper slips 10 over their cone expanders 11, thus locking the packer 2 against upward movement within the casing 1. The mandrel 3 is then raised to force the lower slips 7 over their cone expanders to grip the casing wall 1 against downward movement.

With the slips 7 and 10 thus positively and securely gripping the casing 1 against movement in either direction, it is apparent that the packer 2 is, for all practical purposes, permanently set and cannot be removed by conventional retrieving devices.

My retrieving tool includes a main tubular housing 20 having coupling means (not shown) for attachment thereof to a string of drill pipe or the like. At the lower open end 21 of the housing, I provide a milling shoe 23 of Carborundum, "Carboloy" or the like. The milling shoe 23 is of such a diameter that it and the remainder of the housing 20 may be received within the well casing 1 without excess clearance that would afford undue radial play. It is apparent from the drawings that as the housing 20 is rotated, the milling shoe 23 will cut away the elements which grip the inner surface of the well casing 1, i.e. the slips 7 and 10 as well as the expansible packer 12. Since the milling shoe 23 is of substantially the same diameter as that of the well casing 1, substantially all of the larger particles on the packer mandrel 3 (Fig. 2) within the area of the open end 21 of the housing 20 will be received within the interior of the housing as they are severed from the well casing. Consequently, even though such elements are not positively engaged on the packer mandrel, they will be prevented from falling downward within the casing 1.

Slidably and rotatably carried in the housing 20 is a gripping means for internal slip assembly 24 comprising a slip sleeve 25 and a co-operating frustro-conical wedge sleeve 26. The slip sleeve 25 is split at 28 and fluted around its inner surface to provide flow passages 27 for continuous flow of circulating fluid during the retrieving operation. At regular, angularly spaced intervals around the slip section 25 are slots 29 which terminate short of the full axial length of the sleeve 25 to permit limited circumferential compression or constriction of the slips 25. Intermediate the slots 29 the arcuate sections of the slip sleeve are provided with upwardly directed teeth 30 disposed in helical paths around the inside of the slip sleeve 25 in the nature of interrupted threads for a purpose to be hereinafter described. The internal diameter of the slips is dependent upon the cutting diameter of the milling shoe 23. That is, they should be of such diameter that the severed central portions 3*a* of the packer, after penetration by the milling shoe 23, moves upwardly through the slip assembly 24 in sliding, frictional contact with the upwardly directed teeth 30 of the slips 25. It is to be noted that upward movement of the central portions would tend to carry the slip sleeve 25 upwardly into nesting relationship in the larger internal diameter of its co-operating expander sleeve 26, the upward movement of which is limited by engagement thereof with a shoulder 31 of the retrieving tool housing 20. Thus, as long as the housing 20 is moving downwardly over the severed central portion 3*a* of the packer during the milling operation, that portion will be slidably received upwardly through the slip assembly 24. If, on the other hand, the central portion 3*a* of the packer tends to fall downwardly through the housing as when severance is completed, the frictional engagement with the upwardly directed teeth will cause the teeth to bite into the outer surface of the central portion and move the sleeve 25 downwardly therewith over the wedging surfaces of the conical expander 26 to be contracted into tighter gripping relation with the central portion. Since engagement with the packer is continuous throughout the milling operation, the packer may be removed with the retrieving tool housing 20 as soon as severance is completed.

During the entire milling operation the slip assembly 24 is maintained in the elevated position shown in Fig. 4*a* in engagement with an abutment such as internal shoulder 31 of the housing by means of a powerful spring 32 asserting a compressive biasing force between a lower abutment such as internal flange 33 on the housing 20 and a splined coupling clutch sleeve 34 slidable within the housing and in engagement with the lower end of the wedging slip expander 26. Also, the coupling sleeve 34 is keyed to the slip assembly 24 by means of axially extending lugs 35 slidably engaged in aligned slots 35*a* in the slip sleeve and expander sleeve so that the slips 25 and the expander 26 will rotate with the splined coupling or clutch sleeve 34 regardless of the axial position of the slips relative to the expander sleeve 26 and, hence, the clutch sleeve 34.

A circumferential series of axial keyways or splines 36 are formed on the outer surface of clutch or coupling sleeve 34 and a corresponding circumferential series of keys or splines 37 are provided on the inner surface of housing 20. During the milling operation, spring 32 holds the clutch sleeve 34 in the position shown in Fig. 4 so that the co-operating splines are out of engagement. However, while the packer or other tool 2 is still secured within the well casing 1 and particularly when full severance from the casing is prevented, elevation of the housing 20 will move the housing splines 37 upwardly into engagement with the clutch sleeve splines 36, as shown in Figs. 3 and 5, the clutch sleeve being restrained against upward movement by continued connection of the slip assembly with the packer 2. Mating of the splines 36 and 37 is facilitated by cam surfaces 36*a* and 37*a* on the opposing ends of the splines. With the splines 36 and 37 so engaged, rotation of the housing 20 will produce concomitant rotation of the clutch sleeve 34 and, hence, through the coupling lugs 35, rotation of the slips 25.

Since the teeth 30 of slips 25 are disposed helically in the nature of internal threads interrupted by the slots 29, rotation of the slip sleeve 25 through operation of the clutch mechanism just described, will cause the teeth 30 to be threaded along the outer surface of the severed central portion 3*a* of the packer until threaded out of engagement therewith. Preferably, the teeth 30 are hardened to effect a cutting action on the outer surface of the central portion 3*a*, both to facilitate gripping and to effect a thread cutting action during rotation. After the teeth 30 are threaded off of the central portion 3*a*, the housing 20 may be raised into complete separation with the severed portions 3*a* and removed from the well. Thereafter, adjustments to the tool may be made and retrieving operations resumed if practicable.

While I have described the operation of my invention particularly in connection with efforts to retrieve permanent well packers, it is to be understood that it is applicable to any device permanently set within a well against movement in either direction.

Now, it will also be understood that various changes and modifications may be made in the apparatus described herein without departing from the spirit and scope of the invention as defined in the claims appended hereto.

Having described my invention, I claim:

1. Apparatus for retrieving a well tool secured within a well casing above the bottom thereof, said well tool including permanently set locking means positively gripping the inner surface of said casing to prevent axial movement of said well tool, said apparatus comprising a tubular housing adapted to be moved axially within said casing, an annular cutting member on the lower end of said housing adapted to engage and then to mill said locking means upon rotation of said housing, said housing being open at the lower end thereof to receive central portions of said well tool as said cutting member penetrates axially through said locking means, gripping means within said housing to engage and support said central portions, the portion of said gripping means adapted to engage said central portions being a plurality of helical threads, said gripping means being adapted to be threaded out of engagement with said central portions, said gripping means being normally rotatably carried within said housing, and coupling means operative upon predetermined axial movement of said housing relative to said gripping means to couple said gripping means and said housing for rotation together.

2. Apparatus for retrieving a well tool secured within a well casing above the bottom thereof, said well tool including permanently set locking means positively gripping the inner surface of said casing to prevent axial movement of said well tool, said apparatus comprising a tubular housing adapted to be moved axially within said casing, an annular cutting member on the lower end of said housing adapted to engage and mill said locking means upon rotation of said housing, said housing being open at the lower end thereof to receive central portions of said well tool as said cutting member penetrates axially through said locking means, annular slips having upwardly directed helical teeth rotatably carried within said housing, said slips being normally of an internal diameter to permit sliding frictional movement of said central portions upwardly therethrough, wedge members in co-operative association with said slips to constrict said slips in response to downward movement thereof, said slips being adapted to be threaded out of engagement with said central portions, and coupling means operative upon axial movement of said housing over said slips to lock said slips therein for rotation therewith.

3. Apparatus for retrieving a well tool secured within a well casing above the bottom thereof, said well tool including permanently set locking means positively gripping the inner surface of said casing to prevent axial movement of said well tool, said apparatus comprising a tubular housing adapted to be moved axially within said casing, an annular cutting member on the lower end of said housing adapted to engage and mill said locking means upon rotation of said housing, said housing being open at the lower end thereof to receive central portions of said well tool as said cutting member penetrates axially through said locking means, a slip assembly including arcuate slips rotatably carried within said housing, upwardly directed helical internal teeth on said slips, said slips being of an internal diameter to permit said central portions to slide over said teeth in an upward direction only, said teeth being adapted to be threaded out of engagement with said central portions, and coupling means operative upon predetermined axial movement of said housing over said slips to couple said slips therein for rotation therewith.

4. Apparatus for retrieving a well tool secured within a well casing above the bottom thereof, said well tool including permanently set locking means positively gripping the inner surface of said casing to prevent axial movement of said well tool, said apparatus comprising a tubular housing adapted to be moved axially within said casing, an annular cutting member on the lower end of said housing adapted to engage and mill said locking means upon rotation of said housing, said housing being open at the lower end thereof to receive central portions of said well tool as said cutting member penetrates axially through said locking means, annular slips rotatably carried within said housing, upwardly directed internal teeth on said slips, said slips being normally of an internal diameter to permit said central portions to slide over said teeth in an upward direction only, slip wedges operative to constrict said slips in response to downward movement thereof, said teeth being helically disposed to effect threaded separation thereof from said central portions upon relative rotation therewith, and coupling means operative upon upward movement of said housing over said slips to couple said slips therein for rotation therewith.

5. Apparatus for retrieving a well tool having a cylindrical body, said tool being secured within a well against axial movement by lodging means, said apparatus comprising a tubular housing adapted to be moved axially within said well, an annular cutting member on the lower end of said housing adapted to engage and mill said lodging means upon rotation of said housing, said housing being open at the lower end thereof to receive the cylindrical body of said well tool as said cutting member penetrates axially through said lodging means, an annular slip assembly including slips having upwardly directed helical teeth rotatably carried within said housing, said slips being adapted to slidably receive said cylindrical body moving in an upward direction only over said teeth, said slips being adapted to be threaded out of engagement with said cylindrical body, and coupling means operative upon predetermined axial movement of said housing over said slips to couple said slips therein for rotation therewith.

6. Apparatus for retrieving a well tool secured at its periphery to the wall of a well comprising

a tubular housing adapted to be secured on a string of pipe and moved axially within said well in either direction;

a cutter on the lower end of said housing adapted to engage and to cut said well tool in an annular path adjacent said periphery thereof so as to sever the well tool from the well wall;

said housing being open at the lower end thereof to receive the portion of said well tool within said annular cutting path as said cutter penetrates through said well tool;

a wedge sleeve within said housing;

at least one slip having helically inclined gripping edges on the gripping face thereof,

said slip being positioned radially inward of and slidable relative to said wedge sleeve,

said slip being normally free to rotate with respect to said housing;

first and second abutments in said housing spaced one from the other in a direction axial of said housing;

a resilient member engaging said slip and the first of said abutments and biasing said slip in a direction axial of said housing toward the second of said abutments, the extent of movement of the slip in that direction being limited by said second abutment, all whereby said slip normally occupies one position along the axis of said housing but is free to be moved a limited amount in a direction axial of said housing against the biasing force of said resilient member;

coupling means operable between said slip and said housing upon axial movement of said slip relative to said housing by which said slip upon movement against the biasing force of said resilient member becomes engaged with said housing and thereby precluded from rotative movement relative to said housing.

7. Apparatus for retrieving a well tool secured within a well casing above the bottom thereof, said well tool including permanently set locking means positively gripping the inner surface of said casing to prevent axial movement of said well tool, said apparatus comprising a tubular housing adapted to be selectively moved axially and rotated within said casing, an annular cutting member on the lower end of said housing adapted to engage and then to mill said locking means upon rotation of said housing, said housing being open at the lower end to receive central portions of said well tool as said cutting member penetrates axially through said locking means, gripping means in said housing including a plurality of thread-like helical grippers for frictionally engaging said central portion during relative upward movement thereof within the housing and for positively gripping said central portion during relative downward movement thereof, said gripping means being normally rotatably carried in said housing during milling of said locking means, and coupling means normally allowing said housing to be rotated relative to said gripping means during said milling, said coupling means being operative in response to upward movement of said housing relative to said central portions of the well tool to non-rotatably interconnect said housing and said gripping means so that they can be rotated together.

8. In apparatus for retrieving a well tool secured within a well casing, said well tool including permanently set

locking means positively gripping the inner surface of said casing, the combination of a tubular housing adapted to be moved axially within said casing, an annular cutting member on the lower end of said housing adapted to engage and mill said locking means upon rotation of said housing, said housing being open at the lower end to receive central portions of said well tool as said cutting member penetrates axially through said locking means, gripping means within said housing and including helical gripping edges movable between a first position wherein said edges frictionally engage said central portions and a second position wherein said edges positively grip said central portions, means biasing said gripping means towards said first position, means for moving said gripping means from said first position to said second position in response to upward movement of said housing, and coupling means normally allowing said gripping means to rotate relative to said housing in said first position and to non-rotatably interconnect said housing and said gripping means when the latter is in said second position whereby rotation of the housing can disengage said helical edges from said central portions.

9. In apparatus for retrieving from an oil well casing a permanent-type packer secured in the casing by locking means, the combination of: a tubular housing having an annular cutting member on the lower end thereof adapted to be axially moved and rotated to mill away said locking means, said housing being open at the lower end thereof to receive central portions of said packer as said cutting member penetrates axially through said locking means; gripping means carried by said housing and normally rotatable relative to said housing during milling of said locking means, said gripping means including gripping teeth operative to frictionally engage said central portions during relative upward movement thereof; wedging means operative in response to downward movement of said central portions relative to said housing to move said gripping means into positive engagement with said central portions to allow said packer to be removed from said casing after milling of said locking means; and coupling means operative in response to downward movement of said central portions relative to said housing to non-rotatably interconnect said housing and said gripping means for rotation together; said teeth being helical so that in response to rotation of said housing, after said teeth positively engage said central portions, said gripping means can be rotated to disengage the same from said central portions to allow said housing to be removed from said casing should said packer remain secured in said casing after said locking means has been milled away.

10. In apparatus for retrieving a well tool having a cylindrical body, said tool being secured within a well against axial movement by lodging means, the combination of a tubular housing adapted to be moved axially within said well, an annular cutting member on the lower end of said housing adapted to engage and mill away said lodging means upon rotation of said housing, said housing being open at the lower end to receive the cylindrical body of said well tool as said cutting member penetrates axially through said lodging means, gripping means in said housing including helical gripping edges adapted to positively grip said cylindrical body in response to downward movement of said cylindrical body relative to said housing to support said well tool after said lodging means has been milled away, and coupling means normally allowing said housing to be rotated relative to said gripping means during the milling of said lodging means, said coupling means being operative in response to upward movement of said housing relative to said cylindrical body to non-rotatably interconnect said housing and said gripping means so that they can be rotated to disengage said helical gripping edges from said cylindrical body.

11. In apparatus for retrieving a well tool secured within a well casing, said well tool including locking means positively gripping a portion of the inner surface of said casing, the combination of a tubular housing adapted to be secured on a string of pipe and moved axially within said casing in either direction, an annular cutter on the lower end of said housing adapted to engage and mill away said locking means upon rotation of said housing, said housing being open at the lower end to receive central portions of said well tool as said cutter penetrates axially through said locking means, gripping means within said housing and including helical gripping teeth operative in response to relative downward movement of said central portions relative to said housing to support said well tool in said casing after said locking means has been milled away, and coupling means operative in response to downward movement of said central portions and said gripping means relative to said housing to non-rotatably interconnect said housing and said gripping means so that said helical gripping teeth may be disengaged to allow said housing to be removed from said well casing should said well tool remain secured within said casing after said locking means has been milled away.

12. In apparatus for removing from a well casing a well tool secured within said casing by locking means, the combination of a tubular housing having an annular cutter on the lower end adapted to mill away said locking means upon rotation of said housing, said housing being open at the lower end to receive central portions of said well tool as said cutter penetrates axially through said locking means, slip means within said housing and including a plurality of helically inclined gripping edges operative to frictionally engage said central portions during upward movement thereof relative to said housing, slip wedges operatively carried by said housing and operative in response to downward movement of said central portions relative to said housing to move said gripping edges into positive engagement with said central portions to allow said well tool to be removed from said casing, coupling means including a pair of spline means normally disengaged during milling of said locking means but movable into operative engagement in response to downward movement of said central portions relative to said housing to non-rotatably interconnect said housing and said gripping means so that they can be rotated together to disengage said helical gripping teeth from said central portions, and means biasing said gripping means and one of said spline means towards the frictionally engaged position and the normally disengaged position respectively.

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