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3,074,484

DRAG BLOCK AND SLIP ASSEMBLY FOR WELL PACKER OR THE LIKE

Filed May 23, 1960

4 Sheets-Sheet 1

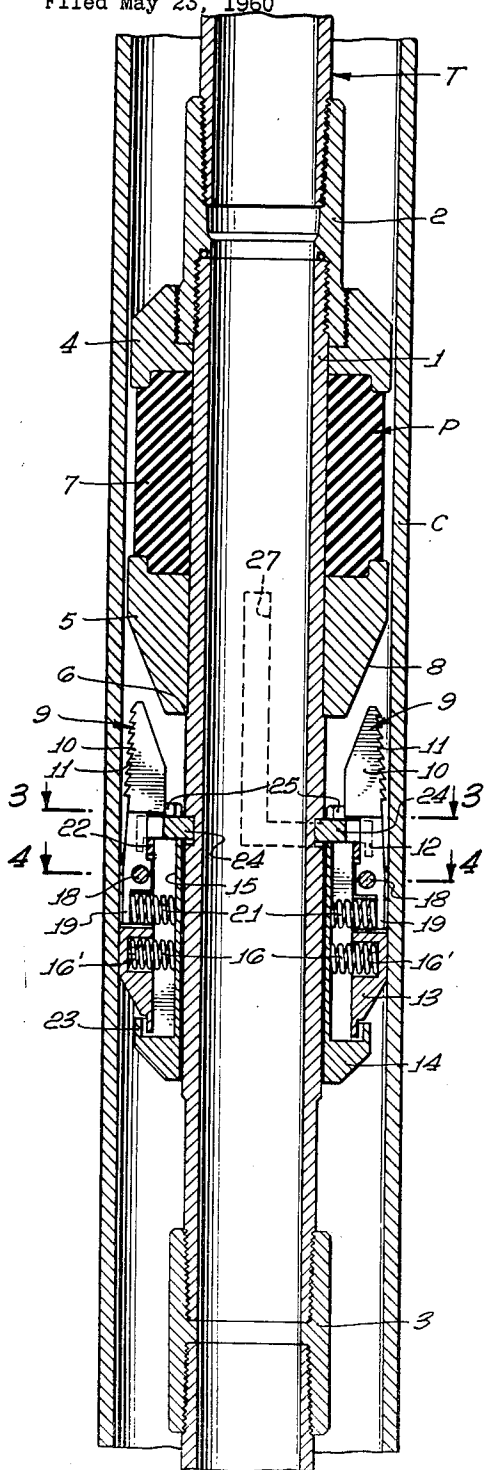


FIG. 1.

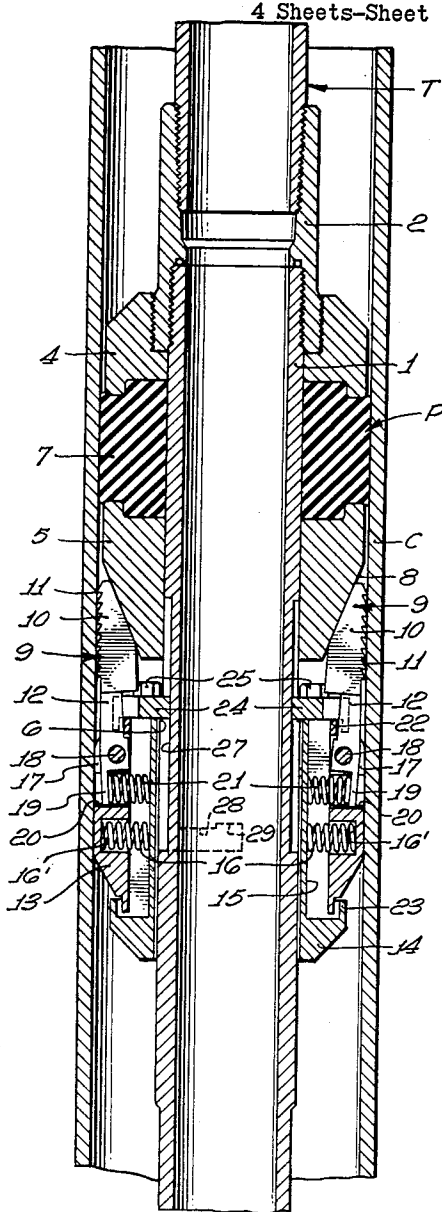


FIG. 2.

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4 Sheets-Sheet 2

FIG. 9.

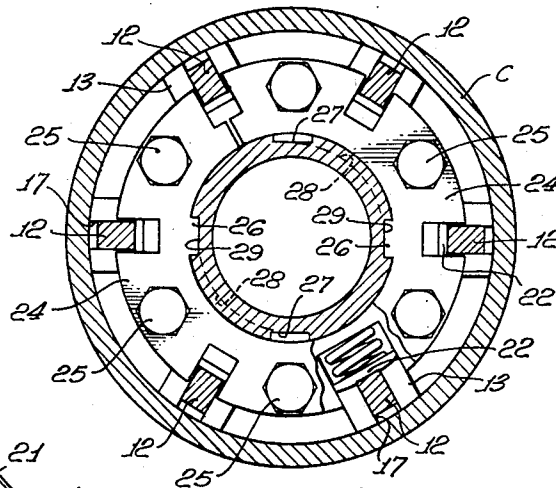
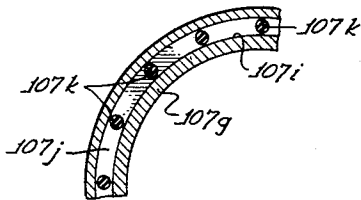


FIG. 3.

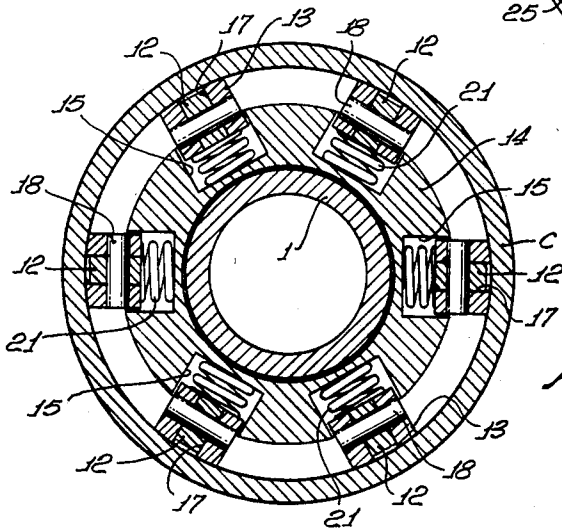


FIG. 4.

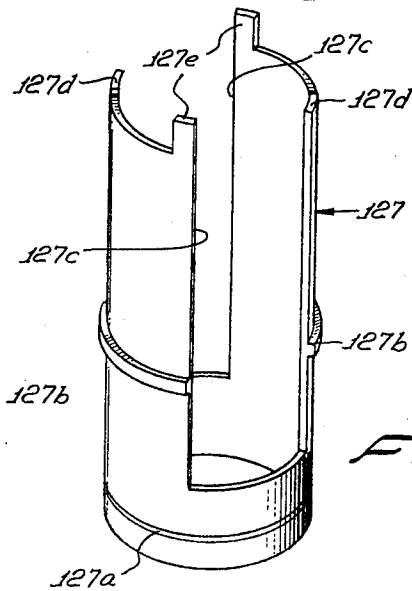


FIG. 8.

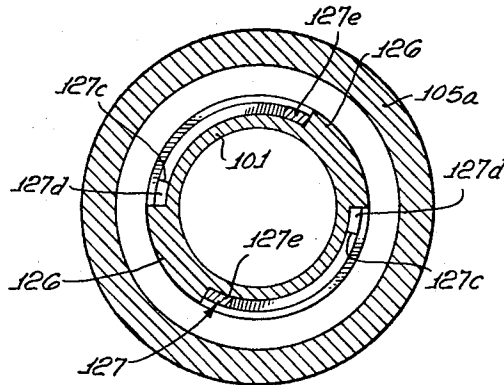


FIG. 7.

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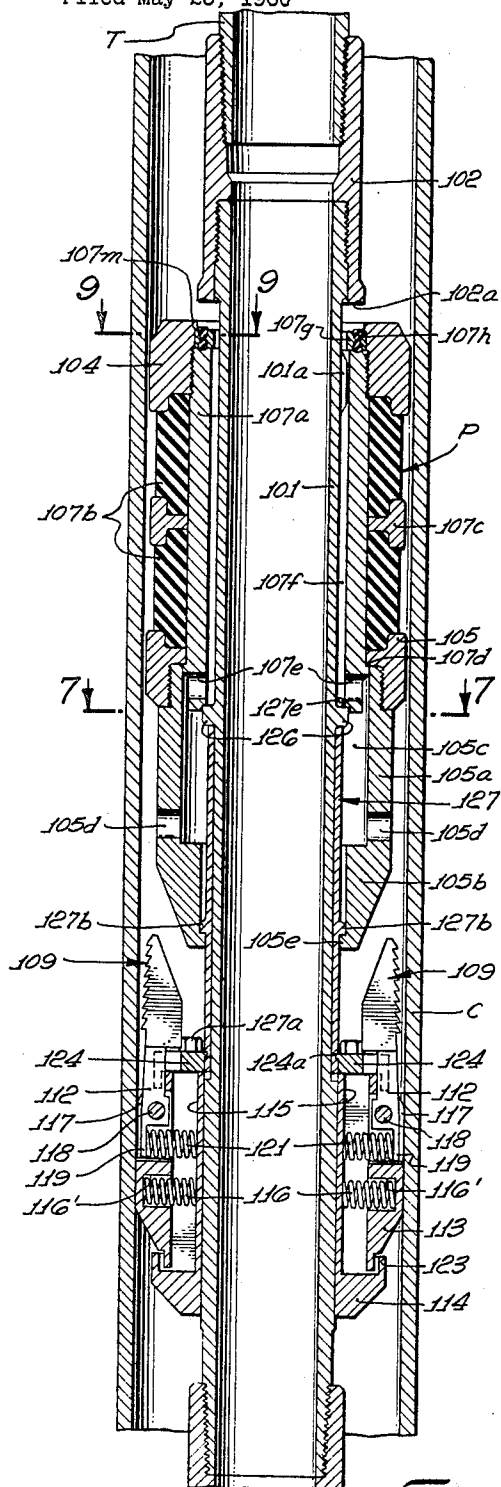
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4 Sheets-Sheet 3



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Filed May 23, 1960

4 Sheets-Sheet 4

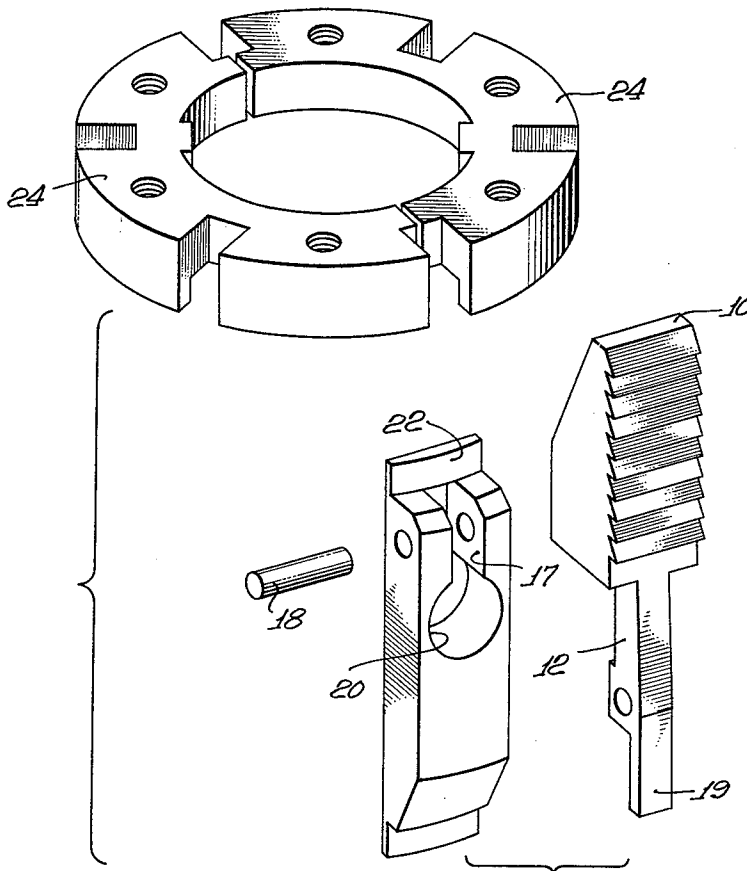


FIG. 10.

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1

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DRAG BLOCK AND SLIP ASSEMBLY FOR WELL PACKER OR THE LIKE

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10 Claims. (Cl. 166-216)

The present invention relates to well packers or the like and more particularly to a device adapted to be connected to a string of pipe so as to be run into a well in which casing has been set, and to be manipulated by the running in string of pipe so as to be anchored in engagement with the well casing. The invention as herein shown is embodied in a well packer of a type particularly adapted as a well production packer but which may be employed for other uses as well where it is desired to create a seal between the string of pipe in which the tool is disposed as, for example, well production tubing and the casing lining the well bore or the well bore itself.

An object of the invention is to provide an extremely compact and inexpensive tool which may be easily used and which is simple and inexpensive to manufacture.

Another object is to provide a novel combined slip and drag block sub-assembly for use in well packers and other tools which are adapted to be anchored in a well casing. It is the conventional practice in many types of well tools which are to be anchored in engagement with the casing to provide means frictionally engaged with the well casing but normally interlocked with the body of the tool so as to be movable along with the tool to a desired position along the well bore. This friction means is effective to hold expansible casing-engaging gripping elements or slips against further movement along the well bore with the tool body upon release of latch means normally holding the friction means to the tool body. Accordingly, upon release of the latch means an expander engaging the slip elements and movable along with the body of the tool acts to wedge the slips forcibly into engagement with the well casing so as to securely anchor the same in place.

In accordance with the present invention a very compact slip-drag block assembly is provided which is quite short longitudinally of the tool in view of the fact that the slip elements are directly pivotally connected to the drag block elements. However, the slip elements are functionally independent of the drag block elements in the sense that actuation of the slips by the expander has no effect on the function of the drag blocks by which the slips are carried.

It is a further object to provide a compact slip-drag block assembly as aforementioned, wherein a part of such assembly is employed to cooperate with the body of the tool in providing a releasable latch as aforementioned.

Yet another object of the invention is to provide a compact and inexpensive slip-drag block mechanism which is suitable for use in well tools of a wide range of sizes, this objective being attained by reason of the casing-engaging function of the slips being functionally independent of the casing-engaging action of the drag blocks.

Other objects and advantages of the invention will be hereinafter described or will become apparent to those skilled in the art, and the novel features of the invention will be defined in the appended claims.

In the accompanying drawings:

FIG. 1 is a longitudinal sectional view through an illustrative well packer embodying the invention and disposed in a well casing in condition to enable movement of the packer in the casing;

FIG. 2 is a view corresponding to FIG. 1 but showing the packer set in the casing with the slips in anchoring engagement with the casing;

2

FIG. 3 is a transverse sectional view as taken on the line 3-3 of FIG. 1; and partly broken away;

FIG. 4 is a transverse sectional view as taken on the line 4-4 of FIG. 1;

FIG. 5 is a view corresponding to FIG. 1 but showing a modified form of well packer embodying the invention; FIG. 6 is a view corresponding to FIG. 5 but showing the packer of FIG. 5 set in engagement with the well casing and the anchor slips engaged with the well casing;

FIG. 7 is a transverse sectional view as taken on the line 7-7 of FIG. 5;

FIG. 8 is a detail view in perspective of the control sleeve of the packer of FIGS. 5-7, and

FIG. 9 is a fragmentary detail view in section of the bypass valve seat of the tool of FIGS. 5-8, as taken on the line 9-9 of FIG. 5.

FIG. 10 is an exploded view showing certain parts of the drag block and slip assembly.

Like reference characters in the several views of the drawing and in the following description designate corresponding parts.

Referring first to FIGS. 1-4 the invention is embodied in a downwardly holding hook wall packer assembly generally designated P and disposed in a string of running-in pipe or tubing T.

The packer P includes a longitudinally extended body or mandrel 1 threaded to or otherwise provided with a coupling 2 at its upper end for connection to the tubing string T. The lower end of the body 1 is connected to the tubing string T as by a threaded coupling 3. Threaded to or otherwise provided on the coupling 2 is an annular flange or gauge ring 4, and in spaced relation thereto is an annular member 5 disposed about the body 1 and engaged with a shoulder 6 on the body, so as to limit movement of the member 5 along the body.

Between the gauge ring 4 and the member 5 is a resilient packer element 7, shown in FIG. 1 as in a relaxed condition and spaced from the inner wall of a well casing designated C. The member 5 is provided with a tapered expander surface 8 which is adapted to effect expansion into anchoring engagement with the well casing C of a plurality of normally retracted slip elements generally designated 9, each having an enlarged head 10 provided with a plurality of longitudinally spaced wickers or teeth 11.

Integral with the head 10 of each slip is a stem 12 adapted for pivotal connection to a casing-engaging drag block 13. These slips 9 and drag blocks 13 form a part of the novel slip-drag block assembly of the invention. This assembly includes a drag block carrier body 14 which is disposed about the mandrel 1 and slidable therealong.

Referring particularly to FIG. 4 it will be noted that the carrier body 14 is provided at angularly spaced points thereabout with longitudinally extended slots 15 in which the drag blocks 13 are radially shiftable and urged outwardly into frictional engagement with the casing C as by means of a coiled compression spring 16 seating at the base of the slots 15 and extending into spring seating recesses 16' in the respective drag blocks 13.

The stems 12 of the respective slip elements project into a slot 17 formed in the upper end of the respective drag blocks 13, the slip elements being pivotally connected to the drag blocks as by pivot pins 18 extending through the side walls of the drag blocks 13 and through the stems 12 of the slip elements.

Means are provided for normally biasing the slip heads 10 away from the well casing C, and in this connection it will be noted that there is an extension 19 formed on the inner end of each slip element and extending from the slot 17 in the respective drag blocks 13 into a bore 20 extending through the body of each drag block, there being a coiled compression spring 21 seating at the base

of the slot 15 of each drag block and extending into the bore 20 so as to engage the extension 19, thus tending to pivot the slip elements 9 about their pivotal mountings 18 in a direction to move the slip heads 10 away from the well casing. Such movement of the slip heads is limited upon engagement of the slip stems 12 with the webs 22 extending between the side walls of the slots 17 of the drag blocks 13, whereby the slip extension 19 may not be urged by coiled spring 21 into contact with the well casing C.

Outward movement of the drag blocks is of course limited by engagement with the well casing when the tool is being run in a well, but otherwise ejection of the drag blocks 13 from the carrier body slots 15 is precluded by a axially extended annular flange 23 formed at the outer periphery of the drag block carrier body 14 adjacent its lower end.

It will be noted that the drag block receiving slots 15 of carrier housing 14 are open at their upper ends and that the drag blocks 13 are retained against axial displacement from the slots 15 by a pair of arcuate plates 24, 24 removably secured to the upper end of the drag block carrier housing 14 in opposed relation by a suitable number of screws 25 (see FIG. 3) which extend through the plates and into the carrier 14.

Since the drag blocks 13 frictionally engage the well casing C it is necessary to provide control means for releasably connecting the drag block carrier housing 14 to the mandrel or body 1 of the tool in well packers and other forms of tools adapted to be anchored in well casing by slip devices. In the subject device this means includes, in part, at least one and preferably both of the arcuate collar segments 24. Each of these collar segments is provided at its inner periphery with an inwardly projecting lug 26 which upon assembly of the segments 24 on the drag block carrier housing 14 are disposed in J-slots designated 27 formed at diametrically opposite sides of the mandrel, and having as best seen in FIGS. 1 and 2, a longitudinally extended portion leading to a circumferentially extended arcuate portion 28, the latter terminating in a short longitudinally extending section 29 (see FIG. 2). With the lugs 26 of collar segments 24 disposed in the long axially extended section of the J-slot it is apparent that the mandrel or body 1 and the drag block carrier housing 14 are free for relative axial movement, whereas when the lugs 26 are disposed in the circumferentially extended section 28 of the J-slot, such relative axial movement is precluded. When the tool is in the condition shown in FIG. 1; that is, in condition for being run into a well, the lugs 26 are disposed in the short vertically extended section 29 of the J-slots and are held in this position due to the resistance to movement through the well casing of the slip-drag block assembly caused by frictional engagement of the drag blocks 13 with the casing as the tool is moved downwardly through the well bore.

Accordingly, the mandrel or body 1 may not be inadvertently rotated to the position where the lugs 26 are disposed in the long axial sections of the J slots 27. Therefore, in order to set the tool as shown in FIG. 2, the operator at the top of the well when reaching the desired depth with the tool at which it is desired to set the same, will tension the running-in string of pipe T and rotate the same in a righthand direction so as to align the lugs 26 on collar segments 24 with the long axially extended sections of the J-slots 27. Thereafter, upon lowering the tubing string T the expander surface 8 of element 5 will be moved into engagement with the slip heads 10, so as to wedge them forcibly outwardly into engagement with the well casing so that the downwardly holding wickers or teeth 11 will resist further downward movement of the member 5 and the weight of the tubing string will be imposed on the resilient packer element 7 by gauge ring 4, causing the packer element 7 to expand circumferentially into engagement with the inner wall of

the casing C to provide an effective seal between the running-in string T and the casing.

As the slips 9 during setting of the packer are pivoted outwardly about the pivot pins 18, the extensions 19 of the slip stems 12 compress springs 21. Nevertheless, the springs 21 assist springs 16 in biasing the drag blocks 13 into frictional engagement with the casing during running of the tool into the well.

Upon recovering the tool from the well it is only necessary to lift the tubing string and relieve the compressive forces on the rubber, and as the mandrel or body 1 moves upwardly through the drag block carrier housing 14 shoulder 6 on the mandrel will engage the lower inside edge of the element 5 to move it away from the slip heads 10; thus enabling the slips 9 to be swung about the pivot pins 18 by springs 21.

If it is desired to recover the packer from the well or to reset the same at a higher elevation, it is not necessary to rotate the body or mandrel to the left in order to re-engage the projections 26 of collar segments 24 in the horizontal section 28 of the J-slots 27, but if it is desired to set the packer at a lower elevation then the mandrel should be rotated to the left in order to again releasably latch the drag block carrier housing to the body or mandrel 1.

From the foregoing it will now be apparent that an extremely compact well packer of simple and inexpensive construction has been provided including a short simple slip-drag block sub-assembly of novel construction, in that the slips are directly connected to the drag blocks without the need for intervening links or the like, and the spring force for urging the drag blocks into engagement with the casing is in part derived from the springs which tend to rock the slips out of engagement with the casing.

In addition it should be observed that the collar segments 24 which retain the drag blocks in the carrier housing may be characterised as constituting a control collar forming part of a releasable latch or control means for releasably connecting the drag block carrier housing to the body during running of the tool.

Referring now to FIGS. 5-9, there is shown a modified well tool made in accordance with the invention. The well tool or packer described above is a simple form of well packer, whereas the modified device shown in FIGS. 5-9 incorporates means for enabling the bypass of fluid around the casing-engaging packing elements between the latter and the body of the tool when the tool is being run into a well and/or when differential pressures across the tool tend to prevent release of the tool from the well casing after it has been set therein.

Accordingly, the packer P in the modified embodiment includes an elongated body or mandrel 101 connected at its upper end to the running-in tubing or pipe T as by coupling 102, having at its lower extremity a radially extended face 102a. The upper flange or gauge ring designated 104 instead of being connected to the coupling as in the first described embodiment, is connected to the upper extremity of a cylindrical sleeve 107a which is slidably disposed about the mandrel 101 and held in concentric spaced relation thereto by a suitable number of outstanding annularly spaced ribs 101a. A plurality of rubber packer elements 107b are disposed about the sleeve 107a and are separated by intermediate gauge ring 107c.

The lower flange member 105 is slidable along the outer surface of the sleeve 107a in a direction to deform the rubber elements 107b. Movement of the member 105 in the opposite direction is limited by a shoulder 107d adjacent the lower end of sleeve 107a.

The member 105 is formed as a part of or connected to an elongated cylindrical section 105a, at the lower end of which is an expander section 105b engageable with slip elements 109 to shift the same into engagement with the well casing to anchor the packer assembly as will now be apparent.

Between the cylindrical section 105a and the body or mandrel 101 is an annular space 105c communicating with the space between the packer assembly and the casing C through a suitable number of radial ports 105d. In addition the sleeve 107a is provided with a suitable number of ports 107e establishing communication between the just-mentioned annular space 105c and the annular space 107f lying between sleeve 107a and the mandrel or body 101.

When the tool is being run into a well with the flange 102a in the position shown in FIG. 5, it will be noted that there is a bypass passage extending from the casing annulus between the casing and the running-in string of tubing above the tool through annular spaces 107f and 105c to the casing annulus between the casing and the lower end of the tool.

Cooperative with the shoulder 102a is a valve seat comprising a ring designated 107g which is provided with a resilient sealing element 107h engageable by the shoulder 102a upon movement of the body or mandrel 101 downwardly relative to the sleeve 107a, so as to close off the bypass passage just referred to as will be hereinafter more particularly described.

Referring to FIG. 9, the ring 107g is shown as having an annular groove 107i. In addition, there is a similar groove in the opposite face of the ring 107g, there being a web 107j between the grooves having a suitable number of circumferentially spaced openings 107k therethrough, whereby the rubber element 107h may be molded to the ring 107g with the rubber material extending through the openings 107k, filling the grooves 107i and projecting outwardly therefrom for engagement by the coupling shoulder 102a at one side, and with the upper end of the sleeve 107a at the other side of the valve seat ring. The ring shoulders at 107m with the upper gauge ring 104 as seen in FIGS. 5 and 6.

As previously mentioned, means are employed in tools of the type here involved for releasably latching the body or mandrel thereof to the friction means employed to hold the slips 109 against downward movement when it is desired to set the tool in the well. In the present embodiment, such means comprises a control sleeve 127 connected to the drag block carrier housing 114 as by the opposed plates 124, 124 which are secured to the upper end of the drag block carrier housing in the same manner as the members 24 previously described.

In this connection it will be noted in FIG. 8 particularly, that the control sleeve 127 is provided with an annular groove 127a adjacent its lower end. Into the groove 127a project radially inwardly extended inner peripheral flanges 124a on the plate segments 124. Preferably flanges 124a are of such cross-sectional area as to be shearable if desired, so that should the tool be stuck in a well, an inward pull on the body or mandrel will shear off flanges 124a and thus enable recovery of the body or mandrel, the latter being one of the most costly elements of the tool. In opposed relation to the plate segments 124, the body or mandrel 101 is provided with a pair of diametrically opposed control lugs 126 which are engageable with the upper end of the control sleeve 127 to thereby hold the body or mandrel 101 and the drag block carrier 114 in the relation shown in FIG. 5 as the tool is being run into a well. At the same time, it should be noted that the lower end of sleeve 107a abuts with the control lugs 126, while at the lower end of the expander section 105b there is an inwardly extending flange 105e which is in abutting engagement with arcuate flanges 127b on the outer periphery of the sleeve 127 between its ends, whereby the gauge ring 104 and the member 105 are maintained in the relationship shown in FIG. 5 as the tool is being run into a well.

The control sleeve 127 as shown in FIGS. 6, 7 and 8, is longitudinally slotted at diametrically opposite locations as at 127c, so that the control lugs 126 may be moved angularly relative to the control sleeve 127 from

the position shown in FIG. 5 until the lugs 126 are aligned with the slots 127c, at which location the body or mandrel 101 is freed to move longitudinally downwardly through the drag block carrier 114 to set the tool in the well casing. Preferably, however, release of the body for such downward movement is, until such time as the body has been initially elevated slightly, precluded by diametrically opposed outstanding lugs 127d at the upper end of the control sleeve 127.

Accordingly, when it is desired to set the tool in the well casing, the tubing or pipe string T is elevated slightly and rotated in a righthand direction until the control lugs 126 on the body 101 come into engagement with a second pair of upstanding diametrically opposed lugs 127e at the upper end of the control sleeve 127, any further rotation of the tubing string simply causing control sleeve 127 to rotate therewith.

Subsequent downward movement of the body or mandrel 101 will bring the coupling shoulder 102a into engagement with the valve seat 107g and force the sleeve 107a, and consequently packing elements 107b and abutment member 105, downwardly along the control sleeve 127 with the mandrel 101 so as to cause the expander section 105b to expand the slips 109 from the positions shown in FIG. 5 to the positions shown in FIG. 6, whereat they are in anchored engagement with the casing C.

Obviously, during such setting movement the flanges 105e and 127b on expander section 105b and control sleeve 127, respectively, move away from one another as shown in FIG. 6, so as to enable further movement of the body or mandrel 101 downwardly through the control sleeve 127. Thus the packer sleeve 107a is forced downwardly through the lower gauge ring or abutment 105, which has now been firmly anchored against downward movement by the slips 109, so as to load the packer elements 107b axially towards the fixed abutment 105 and deform the packer elements radially into sealing engagement with the casing C.

Except for the fact that plate segments 124 of the embodiment now being described are connected to the control sleeve 127, whereas in the embodiment first described the plate segments 24 were provided with inwardly projecting lugs 26 engageable in the J-slots 27 of the body, the slip-drag block assembly of the tool of FIGS. 5-9 is the same as that previously described.

Accordingly it will be observed that the drag block carrier housing 114 is provided with a plurality of longitudinally extended and circumferentially spaced drag block receiving slots 115 in which the drag blocks 113 are reciprocally disposed and urged outwardly by coiled compression springs 116 seating at their opposite ends in spring seats 116' in the drag blocks 113 and at the base of the respective slots 115.

Like the slips 9, the slips 109 are provided with mounting stems 112 pivotally mounted in axially extended slots 117 in the upper ends of the drag blocks 113 on pivot pins 118. Each of the slip stems 112 is also provided with a downwardly projecting extension 119 engaged by a spring 121 for rocking the slip heads 110 away from the casing. Drag blocks 113 are, as in the earlier embodiment, retained in the elongated slots 115 by an annular flange 123 projecting upwardly from the lower end of the drag block carrier.

When the tool as shown in FIG. 6 is anchored in the well and it is desired to retrieve the same, it will be noted that the mandrel or body 101 is free to move upwardly upon upward movement of the tubing string T so as to move coupling shoulder 102a upwardly away from the valve seat 107g, thus opening the above referred to bypass passage so as to balance the hydrostatic pressure across the tool and facilitate its recovery, particularly in those instances where a high hydrostatic pressure is acting upon the gauge ring 104 tending to hold the packer rubbers set. Further upward movement of the mandrel 101, of course, will bring control lugs 126 thereon into

engagement with the lower extremity of packer sleeve 107a, moving it upwardly until inwardly directed flange 105c on expander section 105b engages outstanding flanges 127b on the control sleeve 127, at which point the mandrel may be rotated in a lefthand direction so as to engage the upper end of the control sleeve 127 with the lugs 126 so that the tool may be moved downwardly through the well bore to a new location where it is to be set. Of course, if it is desired to recover the tool from the well this may also be done.

While the specific details of the invention have been herein shown and described, changes and alterations may be resorted to without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. A well tool adapted to be set in well casing, comprising an elongated mandrel, a carrier disposed on said mandrel for relative axial movement, said carrier having a plurality of radial slots therein extending longitudinally of said carrier and open at one end, a casing engaging drag block shiftably disposed in each of said slots for movement laterally of said carrier, means biasing said drag blocks laterally outward, cooperating means on the carrier and drag blocks limiting relative axial movement therebetween a slip associated with each drag block and including a head having casing engaging teeth, an integral stem on said head extending into the open end of the slot in said carrier in which the associated drag block is disposed, means pivotally connecting said stem to said drag block, and an expander on said body engageable with said slips upon movement of said mandrel in one direction relative to the carrier to move said slips into engagement with said well casing.

2. A well tool as defined in claim 1, wherein said drag blocks are each slotted at one end, said associated slip stem extending into the slot in its drag block, and the means pivotally interconnecting said stem and drag block comprising a pin extending across the slot in said drag block and through said stem.

3. A well tool as defined in claim 1, including a member at one end of said carrier, said carrier member and said mandrel having cooperative control means for releasably latching said carrier to said body against relative longitudinal movement and enabling relative longitudinal movement.

4. A well tool as defined in claim 3, wherein said control means includes a projection on said carrier member extending inwardly, said mandrel having a J-slot in which said projection is disposed to enable relative longitudinal movement of said mandrel upon release of said control means.

5. A well tool as defined in claim 3, wherein said control means includes a control sleeve disposed about said mandrel and connected to said carrier member, said control sleeve having an elongated slot therein and a circumferentially extended shoulder leading to said slot, and a projection on said mandrel movable in said slot and engageable with said sleeve shoulder.

6. A slip-drag block assembly for well tools adapted to be anchored in a well casing, comprising an annular body, said body having a plurality of axially extended slots opening radially outwardly, a drag block disposed in each slot and projecting therefrom radially of the body for engagement with the well casing, a slip associated with each drag block including a head having wickers for biting into the well casing, and a stem integral with said head, means pivotally connecting said stem to its associated drag block, a spring biasing each drag block outwardly of its slot, and a second spring engaged with each slip stem and biasing the slip head inwardly.

7. A slip-drag block assembly as defined in claim 6, wherein each slip stem includes a projection extending to the opposite side of said pivotal connecting means from the slip head, said second spring being engaged with said projection.

8. A slip-drag block assembly as defined in claim 6, wherein each slip stem includes a projection extending to the opposite side of said pivotal connecting means from the slip head, said second spring being engaged with said projection, said drag block having an abutment for limiting movement of said slip under the influence of said spring whereby said second spring also biases said drag block outwardly of its slot.

9. A slip-drag block assembly as defined in claim 6, wherein the slots in said body are open at one end and including an arcuate plate connected to said body and partially blocking said open ends of said slots, said plate having radial slots through which said slip stems extend.

10. A slip-drag block assembly as defined in claim 6, wherein said drag blocks are slotted at one end, said slip stem of the associated slip extending into said drag block slot, and a pivot pin extending through said end of each drag block and through the associated slip stem.

References Cited in the file of this patent

UNITED STATES PATENTS

2,590,502	Brown	Mar. 25, 1952
2,639,773	Webber	May 26, 1953
2,674,316	Johnston	Apr. 6, 1954
2,772,740	Edwards	Dec. 4, 1956