

Sept. 22, 1953

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2,652,894

HOLD-DOWN SLIP ASSEMBLY FOR WELL PACKERS

Filed Aug. 9, 1948

3 Sheets-Sheet 1

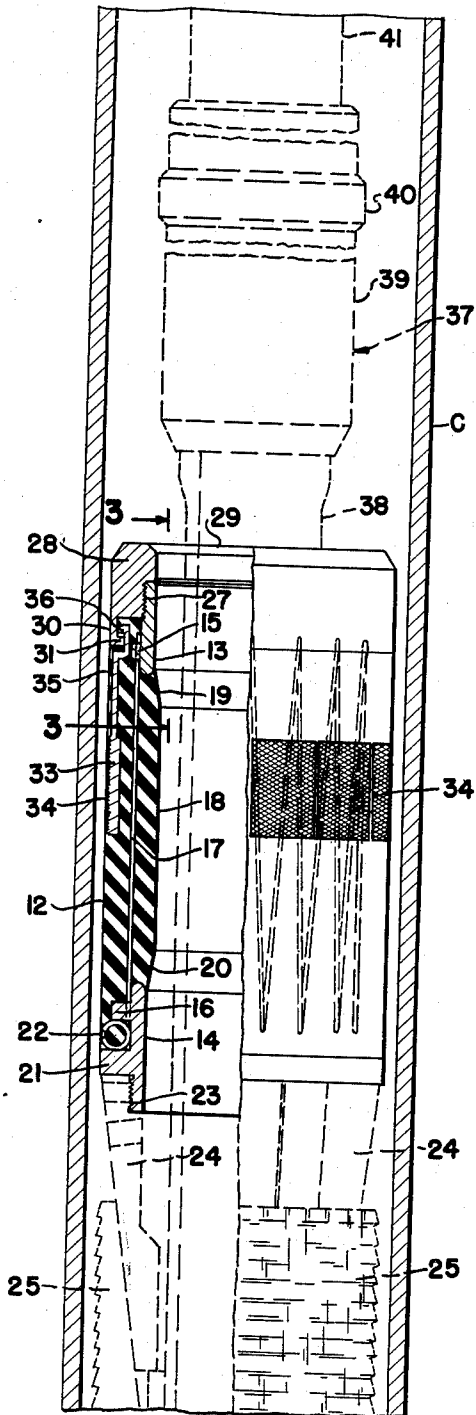


FIG. 1

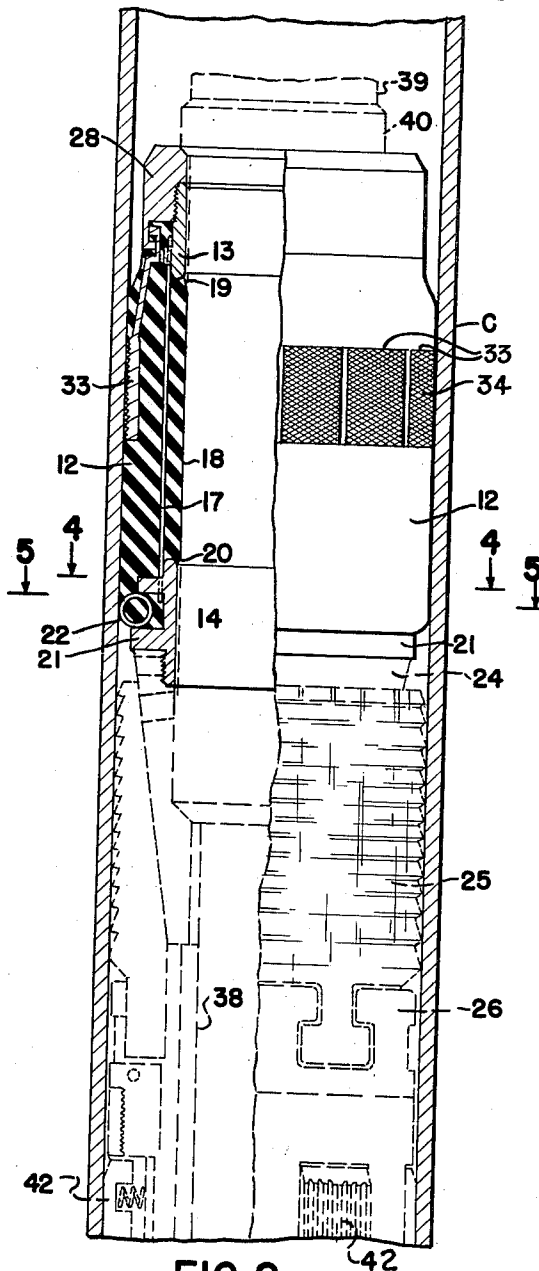


FIG. 2

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3 Sheets-Sheet 2

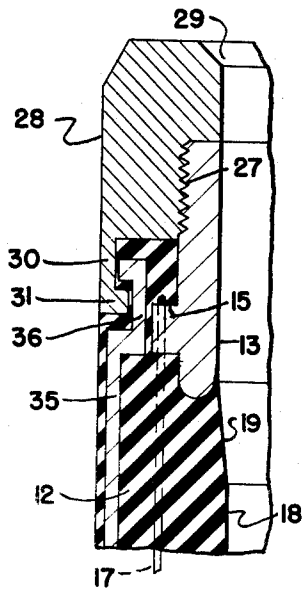


FIG. 3

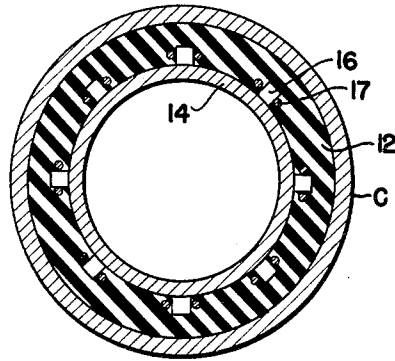


FIG. 4

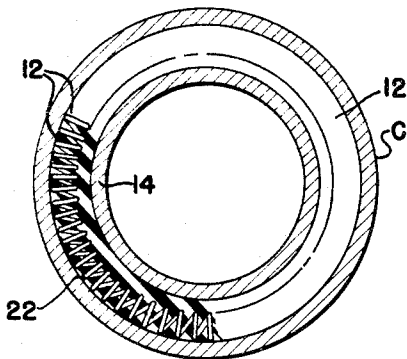


FIG. 5

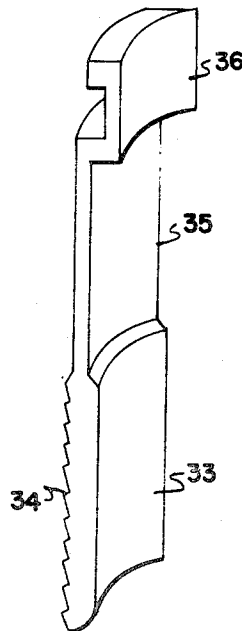


FIG. 6

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3 Sheets-Sheet 3

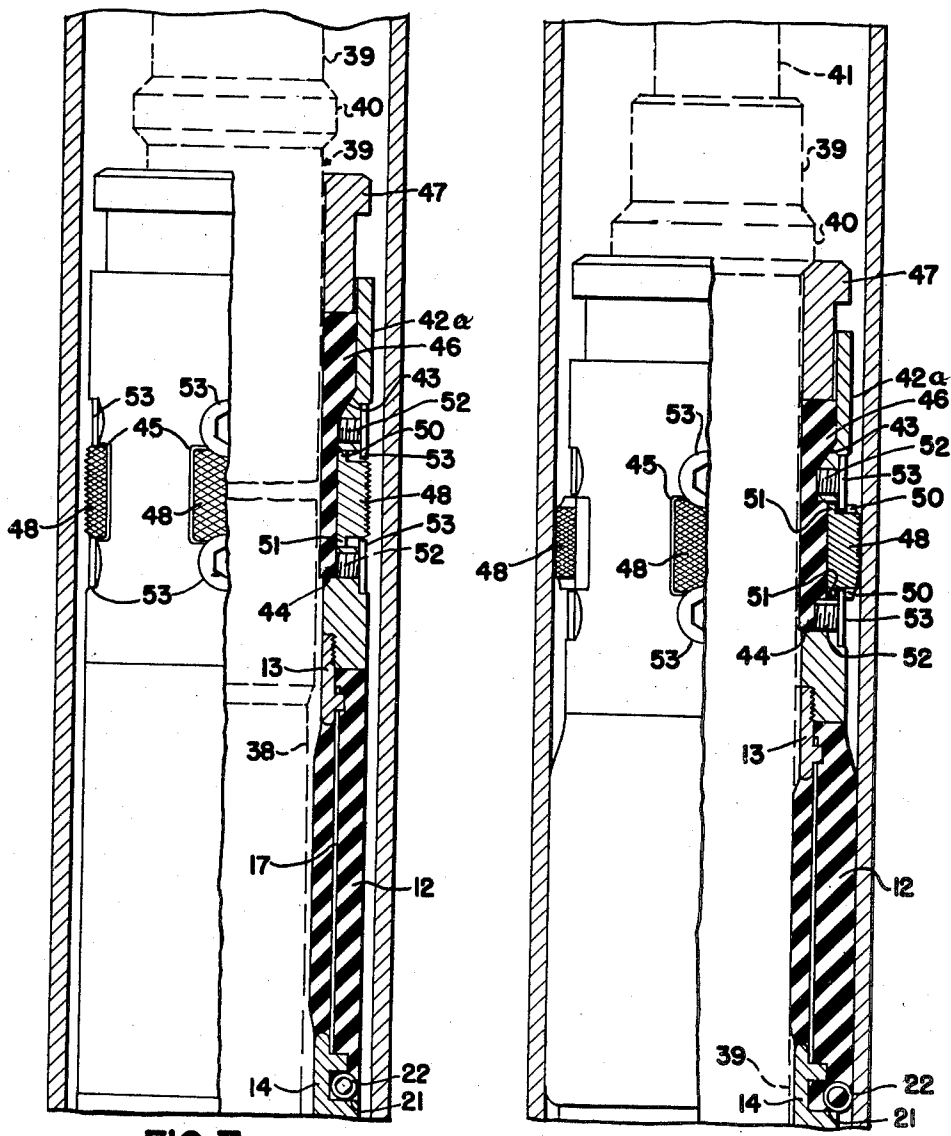


FIG. 7

FIG. 8

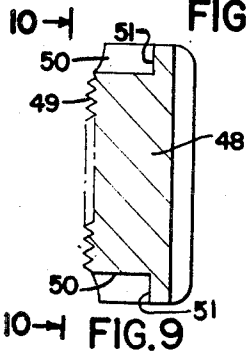


FIG. 9

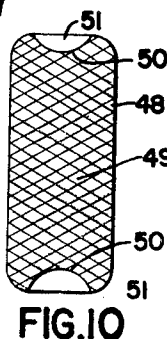


FIG. 10

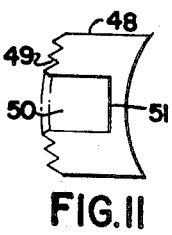


FIG. 11

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2,652,894

HOLD-DOWN SLIP ASSEMBLY FOR WELL PACKERS

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8 Claims. (Cl. 166—12)

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This invention relates to a hold-down slip assembly for well packers, and particularly to a slip assembly for holding down the packer against pressures exerted upwardly thereon.

Conventional packers employ a tubular sealing sleeve of resilient material, such as rubber or rubber composition, which is expandible radially by end-wise compression into sealing engagement with the well casing. Such sleeves normally have their lower ends connected to a downwardly directed conical expander engageable with a set of pipe-gripping slips which, under downward pressures applied to the upper end of the sealing sleeve, are radially expanded into gripping engagement with the casing by the corresponding downward movement of the expander. Setting of these slips into the casing provides a stationary base against which the sealing sleeve may be compressed by the downwardly applied pressure to effect the requisite radial expansion thereof for sealing the casing.

Packers of this type are commonly called "hook-wall" packers and depend upon weight applied from above to drive the slips outwardly into gripping engagement. Accordingly, they are normally released by applying an upward pull to the slip expander. Such packers, therefore, when subjected to high pressures from below, and particularly when subjected to surges of pressure from the well, as commonly occur, may be accidentally released by such upwardly directed pressures and driven upwardly in the casing, often resulting in undesirable leakage of well fluids past the packer and sometimes serious damage to the packer and the well by the pressures thus released.

In an attempt to overcome this difficulty many different structures have been designed. Principal among these have been the provision of a so-called "hold-down" slip assembly which generally consists of a second set of slips, having upwardly facing teeth, mounted on a conical expander facing in the upward direction, this structure being mounted above the sealing sleeve. Such packers, besides being relatively expensive to construct because of the duplication of parts, require relatively complicated setting mechanisms, are difficult to release when it is desired to withdraw the packer, and have proven generally unsatisfactory and impractical in use.

Accordingly, this invention has for its principal objects the provision of a novel hold-down slip assembly for packers; which is of very simple form and relatively cheap to construct; which may be used with various conventional packers;

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which serves very effectively to hold down the packer while forming an efficient seal; which is easily set and released by the same conventional operations employed in setting and releasing the more conventional types of packers; and which, in general, overcomes or obviates the several disadvantages common to more conventional packers.

Other and more specific objects and advantages of this invention will become apparent from the following, detailed description when read in conjunction with the accompanying drawings which illustrate useful embodiments in accordance with this invention.

In the drawings:

Fig. 1 is a quarter-sectional elevational view of one embodiment of the slip assembly in accordance with this invention, in which the slips are combined with the main casing sealing structure of the packer, the structure being shown in a well casing with the parts in their positions prior to setting, and the more conventional parts of the packer structure being illustrated in broken lines;

Fig. 2 is a view similar to Fig. 1, the parts being shown in their positions after setting;

Fig. 3 is an enlarged fragmentary sectional view taken along line 3—3 of Fig. 2;

Fig. 4 is a cross-section along line 4—4 of Fig. 2;

Fig. 5 is a cross-section along line 5—5 of Fig. 2;

Fig. 6 is a perspective view of one of the hold-down slips forming a part of the assembly of Figs. 1 and 2;

Fig. 7 is a quarter-sectional elevation of another embodiment of a slip assembly in accordance with this invention, showing the parts thereof before setting;

Fig. 8 is a view similar to Fig. 7 showing the position of the parts after setting in a well casing;

Fig. 9 is a longitudinal sectional view of one of the slips forming a part of the structure illustrated in Figs. 7 and 8; and

Figs. 10 and 11 are a front elevation and an end-view, respectively, of the slip illustrated in Fig. 9.

Referring to the drawings, the embodiment illustrated particularly in Figs. 1 to 6, inclusive, comprises a generally tubular sealing sleeve 12 constructed of a flexible, resilient rubber or rubber-like composition conventionally used for such sealing sleeves. It will be understood that sleeve 12 may have molded therein layers of fabric or other material suitable for strengthening

the sleeve under the forces to which it will normally be subjected. Upper and lower metallic collars 13 and 14, respectively, are connected to the opposite ends of sleeve 12, and made integral therewith by being vulcanized thereto during the molding of the sleeve. The exteriors of collars 13 and 14 are provided with a plurality of angularly spaced radially extending studs 15 and 16, respectively, between and about which may be stretched a metal wire reinforcing cable 17 for increasing the tensile strength of the sleeve, the wire being incorporated therein during the molding of the sleeve. The intermediate portion 18 of the wall of sleeve 12 is made somewhat thicker than the ends thereof to thereby reduce the diameter of the bore of sleeve 12 relative to its ends and oppositely tapering surfaces 19 and 20, respectively, extend from the ends of intermediate portion 18 to the adjacent ends of the sleeve, to form smoothly tapering surfaces therebetween.

An annular flange 21 is provided on the exterior of collar 14 spaced below studs 16, the external diameter of flange 21 being made such that its outer periphery will be substantially flush with the exterior of sleeve 12 when the latter is in its normal unexpanded position, as illustrated particularly in Fig. 1. The upper face of flange 21 will thus form the metallic base to receive the end-wise thrust of sleeve 12 when the latter is longitudinally compressed to effect radial expansion thereof. A circular coil spring 22, commonly termed a "garter-spring" is embedded during the molding of sleeve 12 in the lower end thereof so as to encircle the portion of the periphery of collar 14 between studs 16 and the upper face of flange 21. The lower end of collar 14 is externally threaded at 23 for attachment to the usual conical slip expander 24, the latter carrying the usual segmental casing-gripping slips 25, hingedly connected to a conventional cage 26 (Fig. 2), and other parts of a more or less conventional packer structure. Since this slip expander assembly forms no part of the present invention, and may be of any more or less conventional construction, these parts are indicated in broken lines in their normal operative relationship to the sealing elements constituting the present invention.

The upper end of collar 13 is externally threaded at 27. A metallic seat ring 28, having an inwardly tapered seat 29 about its upper edge is screwed over the upper end of collar 13 and is dimensioned so that its bore will be substantially flush with that of collar 13 and its outer periphery will be substantially flush with that of sleeve 12 in the latter's unexpanded condition. Ring 28 is provided with a downwardly extending peripheral skirt 30 having an inwardly extending lip 31, the inner end of which is spaced from the exterior surface of collar 13.

A plurality of pipe gripping slips 33, having upwardly facing teeth 34 on their exterior surfaces, are embedded in the exterior surface of sleeve 12. Slips 33 are preferably cut from a circular collar of substantially the same external diameter as that of sleeve 12 in its unexpanded state, so as to form a substantially solid ring about the sleeve, which because of its segmental form will be expandible with the sleeve with a minimum of spacing between the segments when the sleeve is expanded. Each of the slips 33 is provided with an elongated shank 35, the upper end of which is provided with an outwardly facing generally C-shaped head 36 adapted to enclose lip 31 and form therewith a loose hinge con-

nection between ring 28 and each of the slips. It will be understood that in assembling the sealing structure, slips 33 will usually be connected to ring 28 by hooking heads 36 over lip 31 and then collar 13 will be screwed into ring 28 to hold these elements in their relative positions for insertion into a mold for molding sleeve 12 thereto.

In the molding operation, the material forming sleeve 12 will enter all of the free spaces between and about the described hinge connection so that all of the parts of this structure become, for all practical purposes, integral parts of the sealing sleeve, slips 33 being so disposed that teeth 34 will be substantially flush with periphery of sleeve 12.

The above described sealing assembly, when installed as a part of a conventional packer structure, is employed in the following manner: As noted previously, the sealing assembly will be connected to the usual conical slip expander 24 on which are slidably mounted slips 25 arranged to expand in response to downward movement of expander 24 to engage a well casing C to hold the packer structure against downward movement in the casing. A conventional packer setting tool, indicated generally by the numeral 37, is shown in broken lines, being shown in Fig. 1 in its position prior to setting of the packer and in Fig. 2 after setting of the packer. Setting tool 37 includes a tubular stem 38 which is movable axially of the packer. It will be understood that the usual releasable connection (not shown) is provided between stem 38 and the packer structure for holding these elements against relative longitudinal movement while the packer is being run in the well, and which, upon release, permits the setting tool to be moved axially relative to the packer. The upper end of stem 38 is provided with the usual tubular setting mandrel 39 of a diameter adapted to radially expand sleeve 12 when forced through the bore of intermediate portion 18. Mandrel 39 has mounted thereon the usual annular valve 40 which is adapted to engage the upper edge of seat ring 28 and to exert thereon the weight of the usual pipe string 41 which is connected to the upper end of the setting tool 37 and extends to the top of the well from which it is suitably manipulated to set or release the packer in the conventional manner. It will be understood that cage 26 carries conventional friction elements, illustrated fragmentarily at 42 (Fig. 2), to hold the slip and cage assembly stationary, while setting tool 37 is rotated sufficiently to effect release thereof from the slip assembly in order that the setting tool may be moved axially of the packer for effecting setting or release of the packer.

With setting tool 37 thus released it will be lowered by lowering operating pipe 41 at the top of the well until valve 40 engages the top of seat ring 28 whereupon the weight of the operating pipe, being thus applied to the top of the packer structure will begin to compress the latter. The end thrust on sleeve 12 drives expander 24 down inside slips 25 and forces them outwardly into tight gripping engagement with casing C, stopping the downward movement of expander 24. This will, of course, stop further downward movement of collar 14 and flange 21 and the continued application of the weight of the operating pipe will now serve to further compress sleeve 12 and cause its expansion radially into tight-sealing engagement between the wall of casing C and mandrel 39 which will have been inserted through the restricted bore of intermediate por-

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tion 18 and will act thereon to intensify the outward expansion of sleeve 12. The foregoing operations are generally conventional in all respects and will be clearly understood by those skilled in the art.

As sleeve 12 is thus compressed and expanded, slips 33 will be forced outwardly thereby into tight gripping engagement with the wall of casing C and, by virtue of their upwardly facing teeth 34, will lock the packer against upward movement relative to casing C. (See Fig. 2.) At the same time, under the compressive force applied to sleeve 12, garter spring 22 will expand radially with the lower end of the sleeve and will move radially along the upper face of flange 21 into tight sealing contact with the wall of casing C, to thereby form what becomes, in effect, a metal-reinforced resilient seal for the space between the periphery of flange 21 and the wall of casing C. The diameter of the coils forming spring 22 will normally be dimensioned to be somewhat more than twice the width of the annular space between the periphery of flange 21 and the wall of casing C. Accordingly, when garter spring 22 has expanded to the maximum extent permitted by casing C, less than half of its diameter will extend over the outer edge of flange 21 and thereby prevent extrusion of any of the sleeve material into the space between flange 21 and casing C and will thus form a trap for the sleeve material. With this arrangement, it will be seen that the sleeve material will be substantially entirely confined within the annular sealing area defined by the wall of casing C and mandrel 39 and a bottom closure formed by garter spring 22, so that despite the very great pressures often applied to the sleeve by the weight of the operating pipe, and by the column of fluid commonly present in wells, the sleeve material cannot escape from the sealing area and will, therefore, provide maximum sealing efficiency for the packer. At the same time, the greater the compressive force applied to the sealing sleeve, the tighter will slips 33 be forced into gripping engagement with casing C, and the more positive will become the hold-down action of the slips on the packer. When the packer is to be released in the usual manner by withdrawal of mandrel 39 from the interior of the sleeve, the resulting contraction of the sleeve will automatically retract slips 33 from their engagement with the casing. The continued upward movement of the sealing stem is then employed in the conventional manner to effect retraction of slips 25 and permit the entire packer to be withdrawn from the well.

Figs. 7 to 11, inclusive, illustrate another embodiment of a hold-down slip assembly in accordance with this invention. In this embodiment, the hold-down slip assembly is arranged as a unit separate from the main sealing assembly of the packer but is operable, as in the previous described embodiment, for setting and release by the same operations employed in setting and releasing the main packer structure.

In this embodiment a tubular metallic sleeve 42a is internally threaded at its lower end for connection to threads 27 of collar 13 in place of seat ring 28 of the previously-described embodiment. Sleeve 42a is counter-bored from its upper end to provide a first internal shoulder 43 adjacent its upper end which tapers downwardly and inwardly and a second flat shoulder 44 adjacent its lower end, the internal diameter of shoulder 44 being somewhat smaller than that

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of shoulder 43 and substantially equal to the internal diameter of collar 13. The wall of sleeve 42a is provided with a plurality of angularly spaced apertures 45 of generally rectangular shape which are positioned between shoulders 43 and 44. A tubular resilient sleeve 46 is inserted in the bore of sleeve 42a and has a smooth internal bore of substantially the same diameter as that of shoulder 44 and collar 13 so as to be substantially flush therewith. The exterior surface of sleeve 46 is shaped to complement the shape of the inner wall of sleeve 42a, as illustrated in Fig. 7, so that it will fit snugly in the bore of sleeve 12 with its lower end resting on shoulder 44. The length of sleeve 46 is somewhat less than that of the bore of sleeve 42a above shoulder 44 so that its upper end terminates somewhat below the upper edge of sleeve 42a. An annular seat ring 47 is slidably inserted in the upper end of sleeve 42a in compressive relationship with the upper end of resilient sleeve 46, forming a packing gland for the upper end of sleeve 42a. The bore of seat ring 47 is made substantially flush with that of resilient sleeve 46. A plurality of slip elements 48, having teeth or wickers 49 on their outer faces are installed in the several apertures 45. Slip elements are of the same general configuration as apertures 45 and of slightly smaller dimensions so that they are freely movable radially in apertures 45. In transverse section, slip elements 48 are arcuate in order to fit snugly against the outer surface of resilient sleeve 46 and will normally be cemented to the latter. A pair of guideways 50 are cut in the opposite ends of each of the slip elements 48 and extend from the front faces thereof to a point just short of the rear faces thereof to thereby form oppositely extending lugs 51 on the upper and lower ends of the slip elements. Threaded studs 52 are screwed into the outer wall of sleeve 42 just above and below the ends of the slip elements, so that the heads 53 of the studs will extend into guideways 50 and form abutments cooperating with lugs 51 to limit the outward movement of slip elements 48 in apertures 45.

As will be seen from Figs. 7 and 8, when the sealing stem is manipulated in the conventional manner to set the packer structure, valve 40 will engage seat ring 47 and will apply the weight of the operating pipe to the upper end of resilient sleeve 46. The pressure will be transmitted through the latter to set the main slips 25 (Figs. 1 and 2) and compress sealing sleeve 12 in the usual manner to form the desired seal between the well casing C and mandrel 39. At the same time, resilient sleeve 46 will be compressed, and being confined against inward expansion by mandrel 39 and against longitudinal expansion by shoulder 44, sleeve 46 can only expand radially outwardly through apertures 45. This expansion will force slip elements 48 outwardly into tight wall gripping engagement with casing C. When slip elements 48 have been thus engaged with the casing, an upwardly directed pressure against the bottom of the packer structure will be opposed by the weight of the operating string on resilient sleeve 46 and will only serve to increase the compression on the latter with the result that slip elements 48 will be forced even more tightly against casing C and thereby effectively resist any tendency of the packer structure to be forced upwardly in the casing. In this embodiment the lower end of sealing sleeve 12 may be provided with garter spring 22, as in the previously-

described embodiment, to perform the functions previously described. Release of the hold-down slips and the main packer structure will be effected by the same conventional operations previously described.

It will be understood that various alterations and changes may be made in the details of the exemplary structures herein described without departing from the scope of the appended claims but within the spirit of this invention.

What we claim and desire to secure by Letters Patent is:

1. In well packers, a supporting base adapted to be anchored to the wall of a well casing against downward movement therein, a hold-down slip assembly mounted on said base, comprising, a resilient sleeve member supported at its lower end by said base and radially expandible by axial compression thereof against said base, a compression member axially slidable through the bore of said sleeve member, laterally extending external abutment means mounted on said compression member and movable therewith into axial engagement with the upper end of said sleeve member, to axially compress and radially expand said sleeve member, and a plurality of toothed slip elements circumferentially arranged on and secured to the periphery of said sleeve member movable into and out of gripping engagement with said well casing coincident with the radial expansion and contraction of said sleeve member.

2. In well packers, a supporting base adapted to be anchored to the wall of a well casing against downward movement therein, a hold-down slip assembly mounted on said base, comprising, a resilient sleeve member supported at its lower end by said base and radially expandible by axial compression thereof against said base into sealing engagement with said well casing, a compression member axially slidable through the bore of said sleeve member, laterally extending external abutment means mounted on said compression member and movable therewith into axial engagement with the upper end of said sleeve member, to axially compress and radially expand said sleeve member, and a segmental metallic casing-gripping element circumferentially disposed on and secured to the periphery of said sleeve member, said element being radially expandible and contractible into and out of gripping engagement with said casing coincident with the corresponding movements of said sleeve member.

3. In well packers, a supporting base adapted to be anchored to the wall of a well casing against downward movement therein, a hold-down slip assembly mounted on said base, comprising, a resilient sleeve member supported at its lower end by said base and radially expandible by axial compression thereof against said base into sealing engagement with said well casing, compression means axially engageable with the upper end of said sleeve member, to axially compress and radially expand said sleeve member, a segmental metallic casing-gripping element circumferentially disposed on and secured to the periphery of said sleeve member, said element being radially expandible and contractible into and out of gripping engagement with said casing coincident with the corresponding movements of said sleeve member, and a resilient radially expandible ring-shaped metallic retaining element circumferentially embedded in the lower end of said sleeve member.

4. In well packers including a supporting base adapted to be anchored in a well casing against downward movement therein, a hold-down slip assembly, comprising, a resilient sleeve member supported by said base and radially expandible by axial compression thereof against said base into sealing engagement with said well casing, a metallic collar mounted on the upper end of said sleeve member and axially movable therewith, and a segmental metallic casing-gripping element circumferentially arranged on the periphery of said sleeve member having radially hinged connection to said collar, said element being radially expandible and contractible into and out of gripping engagement with said casing coincident with the corresponding movements of said sleeve member.

5. In well packers including a supporting base adapted to be anchored in a well casing against downward movement therein, a hold-down slip assembly, comprising, a resilient sleeve member supported by said base and radially expandible by axial compression thereof against said base into sealing engagement with said well casing, a metallic collar mounted on the upper end of said sleeve member and axially movable therewith, a segmental metallic casing-gripping element circumferentially arranged on the periphery of said sleeve member having radially hinged connections to said collar, said element being radially expandible and contractible into and out of gripping engagement with said casing coincident with the corresponding movements of said sleeve member, and a resilient radially expandible ring-shaped metallic retaining element circumferentially embedded in the lower end of said sleeve member.

6. A hold-down slip assembly for well packers, comprising, a generally tubular resilient sleeve member radially expandible by axial compression thereof, a metallic collar carried by the upper end of said sleeve member and axially movable therewith, and a plurality of metallic casing gripping elements circumferentially disposed on the periphery of said sleeve member having radially hinged connection to said collar, said elements being radially expandible and contractible coincident with the corresponding movements of said sleeve member.

7. A hold-down slip assembly for well packers, comprising, a generally tubular resilient sleeve member radially expandible by axial compression thereof, a metallic collar carried by the upper end of said sleeve member and axially movable therewith, a plurality of metallic casing gripping elements circumferentially disposed on the periphery of said sleeve member having radially hinged connection to said collar, said elements being radially expandible and contractible coincident with the corresponding movements of said sleeve member, and a resilient radially expandible ring-shaped metallic retaining element circumferentially embedded in the lower end of said sleeve member.

8. A hold-down slip assembly for well packers, comprising, a generally tubular resilient sleeve member radially expandible by axial compression thereof, upper and lower metallic collars carried by the opposite ends of said sleeve member, the upper one of said collar members being axially movable with said sleeve member, a plurality of metallic casing-gripping elements circumferentially disposed on the periphery of said sleeve member having radially hinged connection to the upper one of said collars, an annular

flange on the exterior of the lower one of said collars forming a base for the lower end of said sleeve member, and a resilient radially expandible ring-shaped metallic retaining element circumferentially embedded in the lower end of said sleeve member contiguous to said flange, said casing gripping elements and said reinforcing element being radially expandible and contractible coincident with the corresponding movements of said sleeve member.

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