Aug. 25, 1959 J. C. WEBBER 2,901,046

HOLD-DOWN DEVICES FOR WELL PACKERS

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Fig. 1

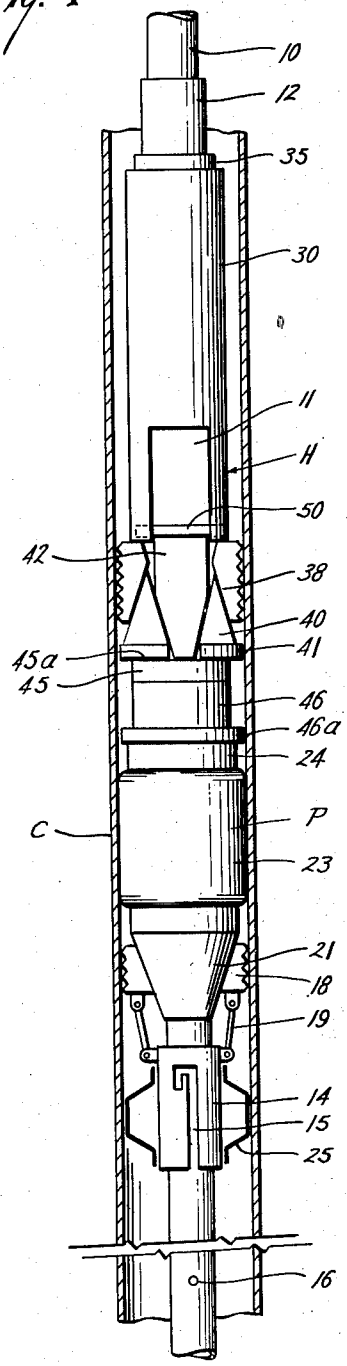

Fig. 4

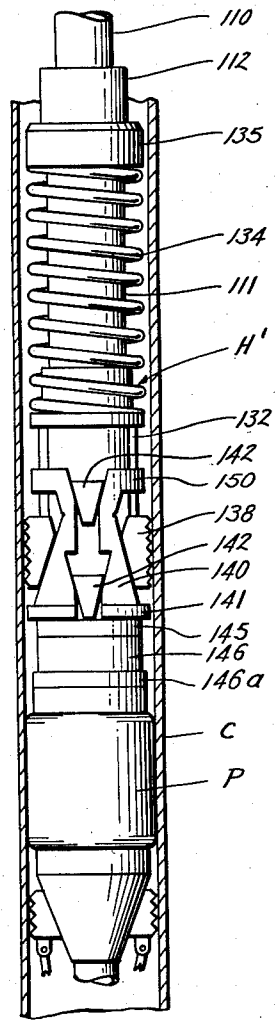

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Fig. 2

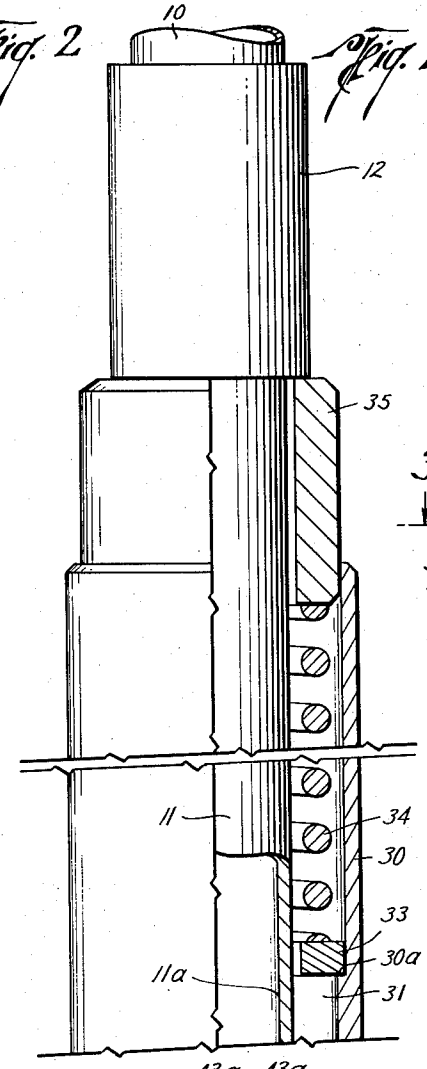

Fig. 2A

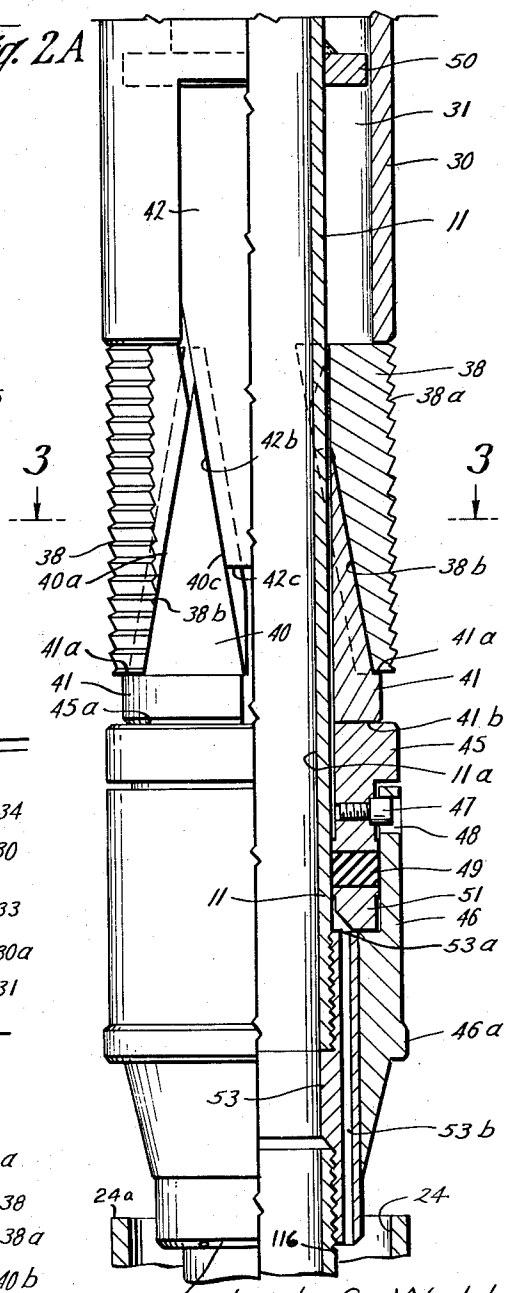

Fig. 3

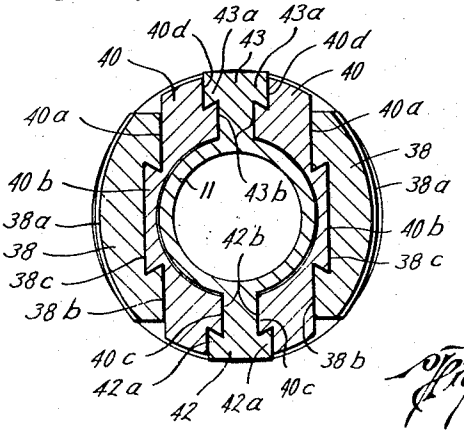

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Fig. 5

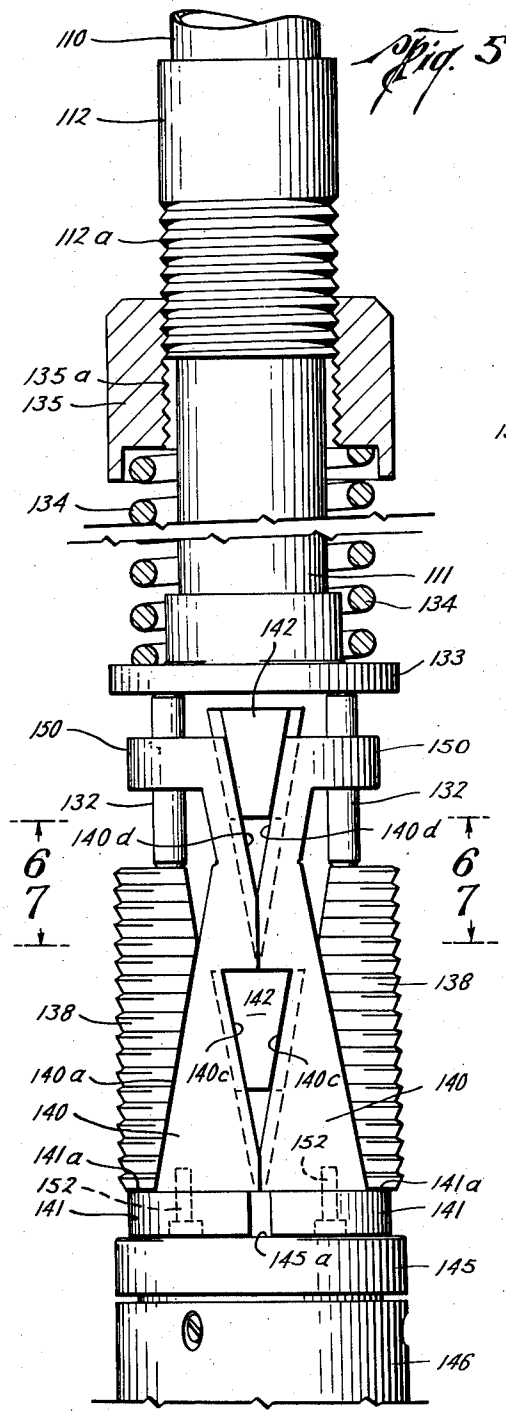


Fig. 6

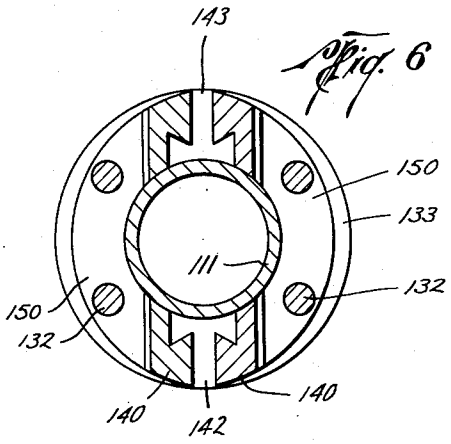
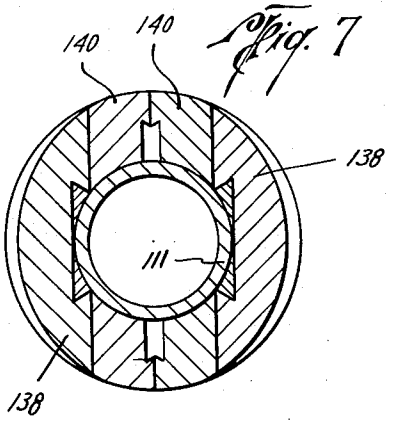


Fig. 7



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HOLD-DOWN DEVICES FOR WELL PACKERS

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Application May 27, 1954, Serial No. 432,691

4 Claims. (Cl. 166—134)

This invention relates to new and useful improvements in hold-down devices for well packers.

An object of this invention is to provide a new and improved mechanical hold-down device for use with conventional types of well packers wherein such device is adapted to prevent a conventional packer from becoming unset or released from its set position in a well pipe when the fluid pressure in the well pipe below the well packer exceeds the fluid pressure thereabove to such an extent that such fluid pressure differential tends to unset or release the packer from its set position in the pipe.

An important object of this invention is to provide a hold-down device for maintaining a well packer in a set position in a well casing, wherein the hold-down device has slips which are set in engagement with the well casing upon a lowering of a slip expander means relative to the slips, and wherein upward movements of the packer by reason of a differential well fluid pressure acting thereon are transmitted to the slip expander to urge the slips into tight gripping contact with the casing, whereby said hold-down device is effective to maintain the packer in its set position even when extremely high fluid pressure differentials exist across the packer.

Another object of this invention is to provide a new and improved hold-down device for well packers wherein said device is completely mechanical in operation whereby leakage and other defects in devices operated by fluid pressure are avoided, and wherein said device is set automatically with the setting of the packer and is released automatically with the release of the packer whereby special manipulation of the hold-down device is unnecessary in order to actuate the same.

Another object of this invention is to provide a new and improved hold-down device for well packers whereing the full internal tubing diameter is obtained through said device to permit the passage therethrough of well swabs and other well tools.

Still another object of this invention is to provide a new and improved hold-down device for use with a well packer of the conventional type, wherein the device is positioned above the packer and has no fluid communication with the fluid inside of the tubing whereby the hold-down device of this invention is in a stagnant fluid area so that there is no constant renewal of corrosive fluids, and wherein said device is so constructed that even if corrosion occurs, such corrosion cannot prevent the device from being released from its set position in the well pipe or casing even when the device has been left in the well for long periods of time.

A further object of this invention is to provide a new and improved hold-down device for well packers of the conventional type wherein said device includes extremely large pipe gripping slips to carry any upward force from the packer, said slips distributing the upward force from the packer over a large area of the well pipe or casing so as to prevent any possible damage to a weak spot in the casing.

The construction designed to carry out the invention

will be hereinafter described together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is a view, partly in elevation and partly in section, illustrating the hold-down device of this invention in use with one type of conventional well packer, with the hold-down device and the packer being shown in the set position.

Figures 2 and 2–A are views, partly in section and partly in elevation, which together illustrate the hold-down device of this invention in detail, such device being shown in an unset or released position.

Figure 3 is a horizontal sectional view taken on line 3—3 of Figure 2–A and illustrates particularly the relationship of the slips and the means for actuating the same.

Figure 4 is a view, partly in elevation and partly in section, illustrating a modified form of the hold-down device of this invention as used in conjunction with a well packer, such device and packer being illustrated in the set position.

Figure 5 is a view, partly in elevation and partly in section, illustrating the modified hold-down device of Figure 4 in detail, and such device is shown in position prior to the setting thereof.

Figure 6 is a horizontal sectional view taken on line 6—6 of Figure 5.

Figure 7 is a horizontal sectional view taken on line 7—7 of Figure 5.

In the drawings, the letter H indicates generally the hold-down device of this invention which is adapted to be used with a well packer P of conventional construction for holding the packer P in a set position in a well pipe or casing C. The hold-down device H and the packer P are lowered into the casing C and are manipulated by a tubing 10 or other tubular support which extends to the surface of the well. The tubing 10 has connection with a mandrel 11 by a coupling 12, and such mandrel 11 extends through the hold-down device H and through the packer P with its open lower end extending below the packer P. The bore 11*a* (Figures 2 and 2A) is of the same or substantially the same diameter as the bore of the tubing or other tubular support 10 so that there is no restriction through the hold-down device or through the packer less than the size of the opening through the tubing whereby swabs and other well tools can be lowered through the tubing 10 and the mandrel 11 with equal facility.

The well packer P shown in Figures 1 and 4 illustrates one type of conventional packer which may be used with the hold-down device H of this invention. As shown in the drawings, the packer P includes a collar 14 which surrounds the mandrel 11 and which has a J-slot 15 therein for receiving a pin 16 on the mandrel 11 to connect the mandrel 11 to the collar 14 for lowering and raising the packer P with the lowering and raising of the mandrel 11. Casing gripping slips 18 are pivotly connected to the collar 14 through pivoted links 19, whereby the slips 18 are adapted to be moved into gripping contact with the well casing C upon a downward movement of a slip expander or cone 21 which also is slidably mounted on the mandrel 11 and surrounds same. A sealing member 23 formed of elastic material such as rubber is connected to the upper end of the cone 21 and a retaining collar 24 is positioned at the upper end of such sealing member 23. It will be evident that when the pin 16 on the mandrel 11 is in the upper curved end of the J-slot 15, the packer is con-

nected to such mandrel **11** for movement therewith, but upon a turning and lowering of the mandrel **11** relative to the packer P, the pin **16** moves downwardly below the J-slot **15** (Figure 1), the friction springs **25** on the collar **14** serving to hold the packer P in the casing C during such relative movement and prior to the setting of the slips **18** and the sealing member **23**.

One form of the hold-down device H of this invention is shown in detail in Figures 2, 2A and 3. Figure 2 shows the upper portion of the hold-down device while Figure 2A shows the lower portion thereof, with the parts being illustrated in the position prior to the setting of the device in the well casing C. Such device includes a tubular body or housing **30** which surrounds the mandrel **11** near its upper end and which is spaced from such mandrel **11**, leaving an annular space **31** therebetween. A shoulder **30***a* which is annular and extends radially inwardly on the inside of the body **30** provides a seat for a retaining ring **33** upon which rests the lower end of a spring **34**. The upper end of the spring **34** contacts and acts against a slideable sleeve **35** so that the spring **34** is confined between the sleeve **35** and the retaining ring **33**.

The upper end of the sleeve **30** extends above the lower end of the sleeve **35** so as to guide the longitudinal movement of the sleeve **35** relative to the body **30** upon compression of the spring **34**, as will be explained. The lower end of the body **30** is in contact with the upper ends of slips **38**, each of which has pipe gripping teeth **38***a* on its external surface for engaging the inside of the well pipe or casing C.

The inner surface **38***b* of the slips **38** is downwardly and outwardly inclined (Figure 2–A) and is formed with a dove-tailed recess **38***c*.

In order to move the slips **38** radially or to expand the same into gripping contact with the well casing C, a radially expansible and contractible slip expander or wedge member **40** is interfitted with each of the slips **38**. Means is provided for expanding and contracting the slip expander with movement of the mandrel **11** in opposite directions. In Figure 2A wedge members **40** co-act with oppositely disposed wedge members **42** and **43** carried by the mandrel **11** and the latter members provide the means for expanding and contracting the slip expander.

Each wedge member **40** has its outer surface **40***a* inclined at the same or substantially the same angle as the rear surface **38***b* of the slips **38** and each wedge member **40** has a flared projection **40***b* which fits within the recess **38***c* of each of the slips **38** to thereby lock the wedge members **40** to the slips **38**. The rear surface **40***c* of each of the wedge members **40** is inclined downwardly and inwardly and each of said rear surfaces **40***c* is formed with recesses **40***d* for receiving flared projections **42***a* and **43***a* on the wedge members **42** and **43**, respectively. Each of the wedges or wedge members **42** and **43** has a pair of inclined surfaces **42***b* and **43***b*, respectively, which have the same or substantially the same inclination or taper as the inner inclined surfaces **40***c* of the wedge members **40**. Thus, the slips **38** are connected to the wedge members **40** by dove-tailed joints and the wedge members **40** are connected by dove-tailed joints to the wedge members **42** and **43** which are attached to the mandrel **11**, so that the slips **38** are actually mounted on the mandrel **11**. However, the wedge members **42** and **43** are adapted to be moved with the mandrel **11** longitudinally relative to the wedge members **40** and the slips **38** to effect a movement of such slips **38** laterally or radially into engagement with the well casing C.

The lower end of each of the wedge members **40** has therewith an arcuate radially extending flange **41** which has a shoulder **41***a* formed on its upper surface upon which the slips **38** seat. The lower surface **41***b* of each of the flanges **41** rests upon the upper end **45***a* of a support ring **45** which is connected to a ring **46** therebelow by one or more pins **47** in the ring **45** which extend into corresponding slots **48** in the ring **46**. A seal ring **49** of resilient elastic material such as rubber is confined between an annular retainer member **51** and the lower end of the ring **45**. The ring **45** has an upper laterally extending shoulder **45***a* upon which the lower ends of the flanges **41** are adapted to seat. An enlarged tubular adapter section **53** has its upper end connected to the lower end of the mandrel **11** and its lower end connected to the lower extension of the mandrel **11** identified by the numeral **11***b* (Figure 2A) and such section **53** also has an annular shoulder **53***a* formed on its upper end upon which the retaining member **51** rests. The adapter section **53** is surrounded by the lower portion of the ring **46** and as can be seen, the upper end **53***a* of the adapter **53** supports member **51**, seal ring **49**, ring **45** and ring **46**, but when the ring **46** is supported against downward movement by contact with the collar **24**, the adapter **53** is slidable downwardly with the mandrel **11** relative to the ring **46** and the other parts connected therewith. One or more longitudinal ports **53***b* extend through the wall of the adapter to establish fluid communication between the upper and lower ends of the adapter **53** whereby the fluid pressure above and below the adapter is equalized to prevent the upward urging of the adapter **53** by fluid pressure therebelow. In other words, in the absence of the ports **53***b*, the fluid pressure would act on the entire lateral area **53***c* to transmit an upward force to the mandrel which would be undesirable since it would tend to release the compression of the spring **34** when the device is set (Figure 1). When using the apparatus in small diameter casing such as five inch casing, the adapter wall is usually thin and the port **53***b* can be eliminated. The lower end of the ring **46** includes an annular radially extending flange **46***a* which is adapted to rest upon the collar **24** of the packer P during the setting of the packer P and the setting of the hold-down device H. Thus, when the packer P has been partially set in position in the well casing C to prevent further downward movement of the slips **18**, the shoulder **46***a* is resting upon the collar **24** and, therefore, the rings **45** and **46**, the wedge members **40**, the slips **38** and the housing or body **30** will be held against downward movement. It will be appreciated though that the mandrel **11** is free to move downwardly with respect to the packer P and the rings **45** and **46**, the slips **38** and the housing **30** of the hold-down device H, whereby the wedge members **42** and **43** may be moved downwardly relative to such parts, including slips **38** for expanding same. In order to prevent large particles such as might be present in the well bore from falling into the slip mechanism, an annular shield **50** is welded or otherwise secured to the mandrel **11** above the expander **42**.

In the operation or use of the hold-down device H illustrated in Figure 1–3, the hold-down device H and a packer such as the packer P are lowered together into the well casing or other well pipe C on the tubing **10**. During such lowering operation, the pin **16** on the mandrel **11** is in the upper curved end of the J-slot **15** of the packer P so that the packer P is held against setting prematurely during the lowering operation. Also, the upper shoulder **24***a* of the collar **24** of the packer P is spaced below the shoulder **46***a* on the hold-down device H (Figure 2A) to prevent prematurely setting the hold-down device H during the lowering operation. When the hold-down device H and the packer P have been lowered to the desired depth in the well casing C, the tubing **10** is turned to release the pin **16** from curved portion of the J-slot **15** and then the tubing **10** is lowered relative to the packer P, with the friction springs **25** holding the slips **18** against downward movement after the pin **16** has been released. The shoulder **46***a* moves

into contact with the upper shoulder 24*a* of the collar 24 of the packer P during the lowering of the tubing 10 and thus the weight of the tubing is placed upon the packer P to move the cone 21 downwardly with respect to the slips 18 of the packer so that the slips 18 are thereby set in gripping contact with the casing. The ring 45 is also moved downwardly relative to the ring 46 to place the seal ring 49 under compression to form a fluid tight seal with the mandrel 11.

The packing sleeve 23, being of conventional construction, ordinarily requires about 10,000 pounds tubing load to fully expand same into full sealing engagement with the casing C, but the spring 34 is of such strength that it will be compressed upon the application thereto of about 1,000 pounds tubing load. At any rate, the spring 34 is compressed by a much smaller force than that required to fully expand the packing sleeve 23, so that after the slips 18 are set, a continued lowering of the tubing 10 compresses the spring 34 and moves the mandrel 11 downwardly relative to the slips 38, rings 45 and 46, and housing 30, but the packing sleeve 23 is not expanded to any appreciable extent.

As the mandrel 11 is thus lowered relative to the slips 38, the wedge members 42 and 43 are moved downwardly relative to the slips 38 and to the wedge members 40 to thereby urge the wedge members 40 and slips 38 radially outwardly to cause the slips 38 to engage the casing C. Such engagement of the casing C by the slips 38 occurs before the lower end 42*c* of the wedge member 42 and the similar lower end (not shown) of the wedge member 43 engage the upper lateral surface or shoulder 45*a* of the ring 45, but upon continued lowering of the mandrel 11, the wedge members 42 and 43 continue to move downwardly relative to the slips 38 and at the same time, the wedge members 40 are moved downwardly and outwardly relative to the slips 38 due to the fact that the slips 38 are in contact with the casing C. Initially the slips 38 merely slidably engage the casing C before the packing sleeve 23 is expanded, such sliding contact resulting from the fact that teeth 38*a* are upwardly directed. The wedge members 40 are thus moved downwardly and outwardly relative to the slips 38 until the lower ends of the wedge members 42 and 43 contact the upper shoulder 45*a* of the ring 45.

Thereafter, as the mandrel is continued in its lowering movement, the full weight applied to the mandrel 11 and the tubing or support pipe 10 is applied to the rings 45 and 46 to thereby urge the collar 24 downwardly to effect a full expansion of the packing sleeve 23 of the packer P. During such downward movement of the rings 45 and 46 and the collar 24 to expand the packing sleeve 23, the wedge members 42 and 43 and the wedge members 40 move downwardly as a unit and therefore the wedge members 40 tend to move downwardly below the slips 38 without moving outwardly relative thereto so that the inclined surfaces 40*a* of the wedge members 40 tend to move below and away from the inclined surfaces 38*b* and 38*c* of the slips 38, but since the spring 34 is highly compressed at the time of such tendency of the wedge members 40 to move downwardly and away from the slips 38, the slips 38 actually are forced downwardly and follow the wedge members 40. Therefore, the slips 38 remain in the same position with respect to the wedge members 40, 42 and 43 as they are in when the wedge members 42 and 43 initially contact the ring 45, although of course, the slips 38, and wedge members 40, 42 and 43 are all displaced downwardly the distance required to fully expand the packing sleeve 23. The final set position of both the hold-down device H and the packer P is shown in Figure 1.

So long as the weight on the tubing 10 is maintained, on the hold-down device H, the slips 38 will remain in gripping engagement with the casing. Thus any tendency of the fluid pressure below the packer P to urge such packer upwardly will result in an upward force being exerted on the rings 46 and 45 which will be transmitted to the wedge members 40 and wedge members 42 and 43. Such upward urging on the wedge members causes them to tend to move upwardly as a unit or block whereby the slips 38 are urged radially into a more firm gripping contact. Therefore, any tendency of the packer P to move upwardly results in a firmer or tighter gripping by the hold-down device so that the release of the slips 18 of the packer and the sealing element 23 of the packer is prevented. It should be noted that by having the teeth 38*a* on the slips 38 inclined upwardly a more effective resistance to upward movement results.

When it is desired to remove the hold-down device and the packer P, or to release the hold-down device from its engagement with the casing, the weight of the tubing 10 is released by lifting upwardly on such tubing, whereby the spring 34 is released and the wedge members 42 and 43 are moved upwardly relative to the wedge members 40 to permit a retraction of the slips 38. The lifting of the tubing is continued until the pin 16 is positioned in the J-slot 15, whereupon the packer P is released from its set position by a continued lifting upwardly with the tubing 10. In some cases the release of the packer can be facilitated by pumping fluid downwardly through the tubing 10 below the packer P to force the sleeve 23 and the cone 21 to move upwardly relative to the slips 18, thereby assisting the upward force applied by the lifting on the tubing 10.

A modified form of the hold-down device H is shown in Figures 4–7. Such modified form is designated by the letter H′ and includes many parts which are identical to those of Figures 1–3. A mandrel 111 extends through the hold-down device H′ and the packer P′ which is identical with and has the same structure as the packer P illustrated in Figure 1. The upper end of the mandrel 111 is connected to a support pipe or tubing 110 which extends to the surface of the well, said connection being formed with a coupling 112. A collar or sleeve 135 is threaded on the coupling 112 by the engagement of threads 135*a* with threads 112*a*, whereby the collar 135 is longitudinally adjustable to adjust the compression of a coil spring 134 below the collar 135. The coil spring 134 is thus positioned below the sleeve 135 and rests upon an annular retaining ring 133 which surrounds the mandrel 111, but is not connected thereto whereby relative longitudinal movement between the mandrel 111 and the retaining ring 133 may be effected. The retaining ring 133 rests upon longitudinally extending pins 132 which in turn are seated upon the upper ends of the pipe gripping slips 138. The pins 132 extend through arcuate radially extending flanges 150 attached to each of the wedge members 140. The lower end of the wedge members 140 have connected thereto arcuate flanges 141 which are preferably secured thereto by bolts 152 for providing a shoulder 141*a* upon which each of the slips 138 rests. The flanges 141 rest upon the upper end of ring 145 which is connected to a ring 146 in the same manner as rings 45 and 46 of Figure 2–A. The ring 145 is formed with a shoulder 145*a* similar to the shoulder 45*a* (Figure 2–A).

The wedge members 140 serve the same purpose as the wedge members 40 of Figures 1–3 in that they both are in engagement with the slips and are urged outwardly for expanding the slips into contact with the casing C. The wedge members 140 are provided with two inner inclined surfaces which are designated 140*c* and 140*d* and they are adapted to co-act with similarly inclined surfaces on two pairs of oppositely disposed wedge members 142 and 143 which are connected to the mandrel 111 (Figure 6). Thus, there is an upper wedge member 142 and a lower wedge member 142 (Figure 5) on the same side of the mandrel 111 and a similar upper wedge member 143 and a lower wedge member 143 (not shown) disposed on the opposite side of the mandrel 111. The lower wedge member 143 is diametrically

position opposite the lower wedge member 142 and is constructed in the same manner as the upper wedge member 143, which is positioned diametrically opposite the upper wedge member 142. As can bes een in Figures 6 and 7, the slips 138, the wedge members 140 and the other wedge members 142 and 143 are connected to each other by dove-tailed points similar to the connection of the slips 38, wedge members 40 and wedge members 42 and 43 in the form of the invention shown in Figures 1–3, whereby the slips 138 and the wedge members 140 are moved laterally or radially for moving the slips 138 into gripping contact with the well casing C upon a longitudinal downward movement of the wedge members 142 and 143 relative to the wedge members 140 and the slips 138. Such downward longitudinal movement of the wedge members 142 and 143 is obtained upon the lowering of the mandrel 111.

The operation of the form of the hold-down device H' shown in Figures 4–7 is substantially the same as the operation of the hold-down device H shown in Figures 1–3. The hold-down device H' and the packer P' are lowered on the support pipe or tubing 110 with the pin 16 in the J-slot 15, thus holding the packer P' spaced below the hold-down device H' during the lowering operation. When the desired depth in the well pipe or casing C has been reached, then the pin 16 is released from the J-slot 15 and the mandrel 111 is lowered to initially set the slips 18 of the packer P' in the same manner as the setting of the slips 18 of packer P in Figure 1. When the packer P' has been set with the slips 18 in engagement with the casing C, then the hold-down device H' is supported on the collar 24 of the packer P' and is adapted to be actuated upon a lowering of the support pipe or tubing 110. As the tubing 110 is lowered, the spring 134 is compressed between the sleeve 135 and the retaining ring 133 and the wedge members 142 and 143 are carried downwardly relative to the slips 138 and the wedge members 140 to radially or laterally expand the slips 138 into gripping engagement with the casing C. Initially the slips 138 merely slidably engage the casing C before the packing sleeve is expanded, such sliding contact resulting from the fact that the teeth on the slips are upwardly directed. After the slips 138 are set, the wedge members 142 and 143 are continued in their downward movement to move the wedge members 140 downwardly and outwardly with respect to the slips until the lower ends of the lower wedge members 142 and 143 contact the upper shoulder 145*a* of the ring 145. Continued lowering of the mandrel 111 effects a full expansion of the packing sleeve 23 of the packer P' and a following downwardly of the slips 138 with the wedge members 140, 142 and 143, in the same manner as described in connection with Figures 1–3. With the hold-down device H' and the packer P' thus set, when the well fluid pressure below the packer P' tends to urge the packer P' upwardly, the upward force is transmitted through the rings 145 and 146 to the wedge members 140 and wedge members 142 and 143 which all move as a unit to urge the slips 138 into a more firm gripping contact with the casing C. It will thus be evident that the hold-down device H' functions to retain the packer P' in its set position in the same manner as the hold-down device H functions to hold the packer P in its set position.

It should be pointed out that both hold-down devices H and H' are positioned above the packer P and P', respectively, and are located in a stagnant fluid area of the casing C when the packers are in a set position so that they are not subject to contact by a new or fresh corrosive fluid either from the casing area or the inside of the tubing. This reduces the corrosion of the parts of the hold-down devices so that they may be left in the well casing for long periods of time without becoming so corroded that they will not function properly. Additionally, there are no radial openings in the mandrels 11 and 111 or the tubing strings supporting same whereby there is no possibility of sand or other foreign matter within the tubing or mandrel entering the hold-down mechanism to interfere with the operation of same.

It will also be evident that no particular or unusual manipulation of the tubing is required in order to place the hold-down devices into their set position or to release them from such set position, because the setting of the hold-down device occurs during the continued lowering of the tubing for the initial setting of the packer and the release of the hold-down device occurs by the usual lifting of the tubing to release the packer. The hold-down device of this invention broadly provides for the setting of the slips thereof by a lowering of the tubing supporting same while at the same time providing for an urging of the slips into gripping contact with the well casing by the transmitting of any tendency of the packer to move upwardly to the slip expanders rather than to the slips. The particular construction of the hold-down devices of this invention also eliminates the disadvantages of hydraulic action since they are entirely mechanical in construction and they are so constructed that the mandrel which extends through the device is of substantially the same internal diameter as the internal diameter of the tubing supporting same whereby the full open diameter for bore through the hold-down device and packer is provided so that well swabs and other well tools may be lowered therethrough

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention

What is claimed is:

1. A hold-down device for use in locking a well tool against upward movement in a well casing including, a mandrel, a slip expander having upwardly and inwardly inclined wedge surfaces, means mounting the slip expander on the mandrel for both radial and longitudinal movement with respect to the mandrel, the downward movement of the slip expander being arrested by its engagement with the well tool when the mandrel and slip expander are lowered into the well casing, whereby the mandrel may thereafter be moved in a longitudinal direction relative to said expander, slips positioned about the mandrel, means mounting the slips for both radial and longitudinal movement with respect to the slip expander, said slips having surfaces cooperable with the wedge surfaces of the expander when said expander and slips are moved longitudinally relative to each other for moving the slips laterally of the mandrel, means on the mandrel co-acting with the slip expander to move the slip expander radially outwardly when the mandrel is moved downwardly relative to the expander and to move the slip expander radially inwardly upon upward movement of the mandrel relative to said expander, a coiled spring surrounding the mandrel above the slips, a sleeve enclosing the coiled spring and having its lower end engaging the slips, and abutments on the interior of the sleeve and the exterior of the mandrel between which the coiled spring is confined to constantly urge the slips downwardly relative to the expander.

2. A hold-down device for use in locking a well tool against upward movement in a well casing including, a mandrel, an annular support slidably surrounding the mandrel and supported against downward movement on the mandrel, said support having a bearing surface engageable with a well tool within the casing to arrest its downward movement whereby the mandrel may thereafter be moved downwardly with respect to the support, the support also having an upwardly facing bearing surface, a slip expander having upwardly and inwardly inclined wedge surfaces and having a downwardly facing bearing

surface engageable with the upwardly facing surface on said support whereby any upward thrust on said support is transmitted directly to the expander through the engaged bearing surfaces, means mounting the expander on the mandrel for lateral movement relative to the mandrel, slips slidably mounted on the slip expander and having surfaces cooperable with the wedge surfaces of the expander for moving said slips laterally of the expander when said expander and slips are moved longitudinally with respect to each other, means on the mandrel co-acting with the slip expander to move the slip expander radially outwardly when the mandrel is moved downwardly relative to the slip expander and the support and to move the slip expander radially inwardly upon upward movement of the mandrel relative to said expander and support, and a resilient means acting upon the slips to constantly urge said slips downwardly relative to the slip expander.

3. A hold-down device for a well packer of the type which is set by the weight of a tubing string comprising, a mandrel connected in a tubing string, an annular support slidable on the mandrel and supported against downward movement on the mandrel, said support having a bearing surface engageable with the upper end of the set well packer whereby the mandrel may thereafter move downwardly relative to the support, said support also having an upwardly facing bearing surface, a radially expansible and retractable slip expander slidable on the mandrel and having a downwardly facing bearing surface engageable with the upwardly facing surface on the annular support whereby any upward thrust on said support is transmitted directly to the expander through the engaged bearing surfaces, said slip expander having upwardly and inwardly inclined wedge surfaces, slips slidably mounted on the expander and having surfaces cooperable with said wedge surfaces upon relative movement of the expander and slips for moving the slips radially of the expander, cooperable means on the mandrel and slip expander for moving the slip expander radially outward upon downward movement of the mandrel relative to the expander and the annular support and radially inward upon upward movement of the mandrel relative to said expander and support, resilient means acting upon the slips to constantly urge the slips downwardly relative to the expander, and abutment means secured to the mandrel and engageable with the annular support upon continued downward movement of the mandrel relative to the slips after the slip expander has been moved radially outward for imposing the weight of the tubing string directly upon the support and upon the well packer which is engaged by said support.

4. A hold-down device for a well packer of the type which is set by the weight of a tubing string comprising, a mandrel connected in a tubing string, an annular support slidable on the mandrel and supported against downward movement on the mandrel, said support having a bearing surface engageable with the upper end of the set well packer whereby the mandrel may thereafter move downwardly relative to the support, said support also having an upwardly facing bearing surface, a radially expansible and retractable slip expander slidable on the mandrel and having a downwardly facing surface engageable with the upwardly facing surface on the annular support whereby any upward thrust on said support is transmitted directly to the expander through the engaged bearing surfaces, said slip expander having upwardly and inwardly inclined wedge surfaces, slips slidably mounted on the expander and having surfaces cooperable with said wedge surfaces upon relative movement of the expander and slips for moving the slips radially of the expander, a wedge element on the mandrel having an inclined surface co-acting with an inclined surface on the slip expander when the mandrel is moved downwardly relative to the expander and the annular support, the co-acting inclined surfaces of the wedge element and the expander being so formed that initially the wedge element moves downwardly relative to the expander to move the expander radially outwardly after which continued downward movement of the wedge element results in said wedge element and expander moving together whereby sufficient downward motion of the expander relative to the slips occurs to permit the wedge element to again move downwardly with respect to the expander until said element engages the annular support, engagement of the wedge element with the support allowing the desired weight of the tubing string to be imposed upon the well packer through said annular support, and resilient means acting upon the slips to constantly urge the slips downwardly relative to the expander.

References Cited in the file of this patent

UNITED STATES PATENTS

2,280,076	Mullinix	Apr. 21, 1942
2,379,394	Young	June 26, 1945
2,570,565	Lamb	Oct. 9, 1951
2,632,514	Fitzpatrick	Mar. 24, 1953