

May 14, 1963

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3,089,543

WELL CASING SUSPENDING MEANS

Filed Oct. 29, 1958

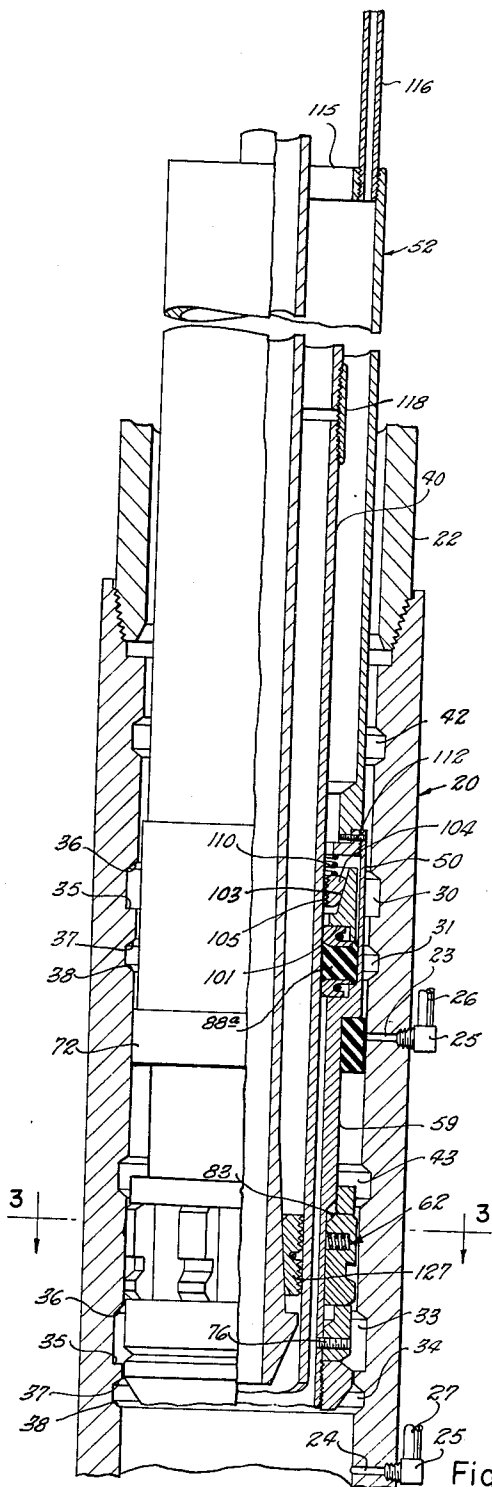


Fig. 1

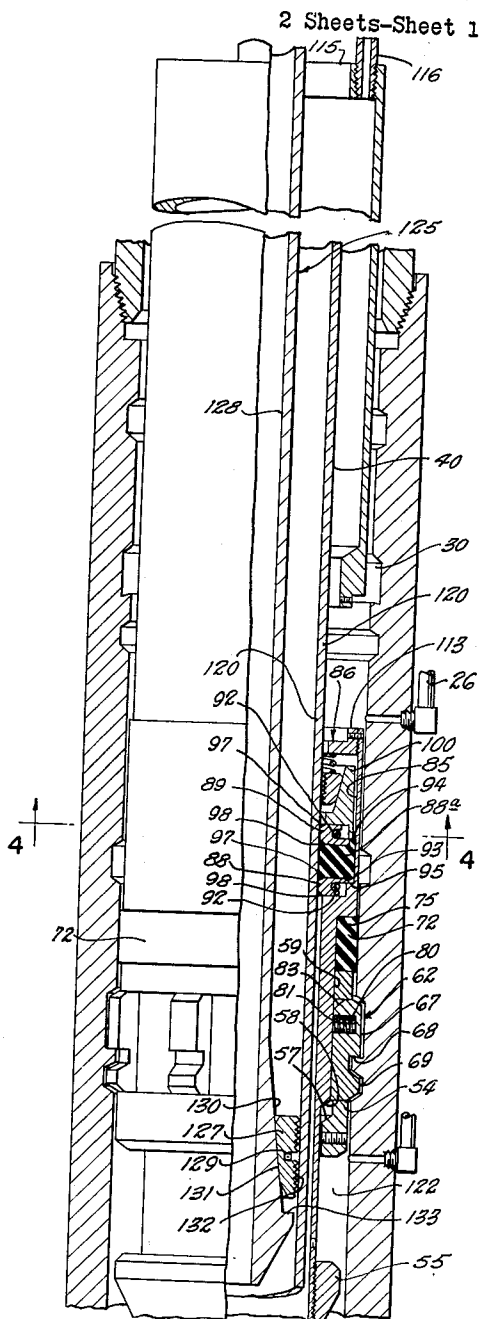


Fig. 2

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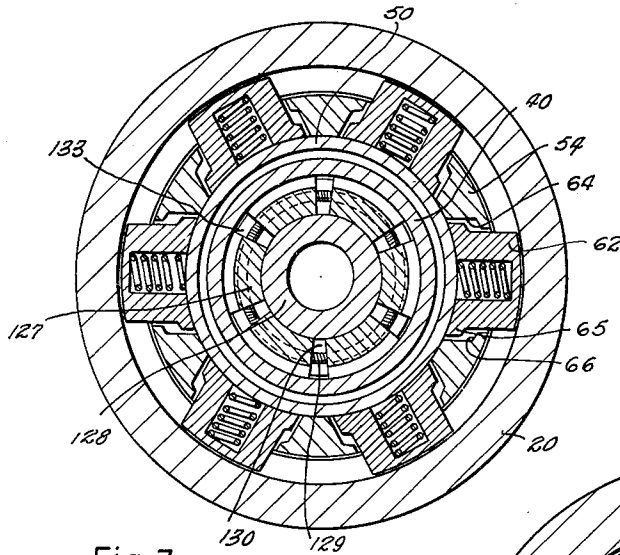


Fig. 3

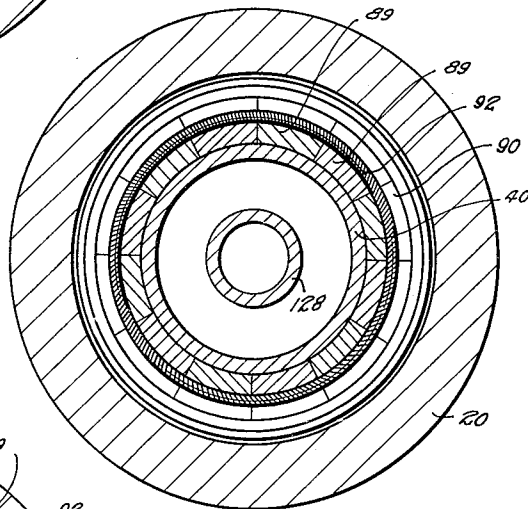


Fig. 4

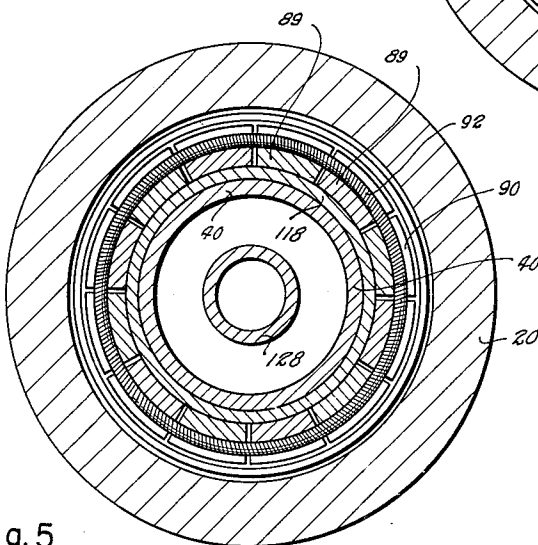


Fig. 5

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WELL CASING SUSPENDING MEANS

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20 Claims. (Cl. 166-71)

This invention relates to well tools and more particularly to means for suspending a well tool, such as a casing, in a tubular member, such as a wellhead, particularly when the casing becomes stuck in installing in (or removing same from) the well.

An object of this invention is to provide a new and improved means for suspending a well tool in a tubular member, such as a wellhead.

Another object of the invention is to provide means for suspending a casing in a preselected position in a wellhead.

Still another object of the invention is to provide a new and improved means for releasably connecting a casing to a wellhead.

A further object of the invention is to provide a hanger mandrel, which may be releasably connected at a predetermined position in the wellhead, having means for engaging a casing telescoped in the wellhead to prevent downward movement of such casing relative to the wellhead.

A still further object of the invention is to provide a hanger mandrel having selector means for selectively positioning the hanger mandrel in a predetermined position in a tubular member, and having means for engaging a well casing to prevent downward movement thereof relative to the hanger mandrel whereby the hanger mandrel may be employed to anchor the well casing against downward movement in the wellhead.

Another object of the invention is to provide a hanger mandrel, lockable in a preselected position in a wellhead, having serrated slips for engaging a well casing to prevent downward movement of the well casing relative to the wellhead.

Still another object is to provide a hanger mandrel having internal and external seal members for sealing between the mandrel and the well casing and between the mandrel and the wellhead, respectively.

Still another object of the invention is to provide a well tool for releasably suspending a well casing in a preselected position in a wellhead which is removable upwardly from the wellhead upon upward movement of the well casing.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a vertical, partly sectional view of the hanger mandrel embodying the invention as it appears being lowered into operative position in a wellhead to secure a well casing against further downward movement relative to the wellhead and illustrating a pulling tool for stretching the well casing;

FIGURE 2 is a vertical sectional view showing the hanger mandrel positioned in a preselected location in the wellhead and locking an inner well casing against further downward movement and also showing the pulling tool for moving the well casing upwardly in the wellhead;

FIGURE 3 is a sectional view taken on line 3-3 of FIGURE 1;

FIGURE 4 is a sectional view taken on line 4-4 of FIGURE 2; and

FIGURE 5 is a sectional view similar to FIGURE 4 showing the manner in which the retainers for the inter-

nal seal member of the hanger mandrel expand to permit the mandrel to pass over coupling collars of the well casing.

Referring now to the drawings, the wellhead 20 illustrated may have a lower end connected to outer well casing (not shown) and an upper end connected to a guide pipe 22, a blowout preventer or any other well tool. The wellhead 20 may be located at the bottom of a body of water and is provided with a pair of lateral ports 23 and 24 which provide communication between the interior of the wellhead and points remote from the wellhead, such as the surface of the body of water, through the fittings 25 and conduits 26 and 27, respectively.

The wellhead is provided with a plurality of sets of annular selector recesses, only two of which are shown. The upper pair of selector recesses comprises a selector key recess 30 and a lower guide recess 31 and the lower set of selector and locking recesses comprises an upper selector key recess 33 and a lower guide recess 34. The selector key recesses 30 and 33 are provided with abrupt upwardly facing stop shoulders 35 and upwardly and inwardly extending upper cam shoulders 36 while the guide recesses 31 and 34 are provided with upper and lower inwardly divergent shoulders 37 and 38. The selector key recess 30 is shorter in length or height than the selector key recess 33, which in turn would be shorter in length than any similar selector recess provided below it in the wellhead 20 for a reason to be disclosed below.

The well casing 40 ordinarily would be secured to the wellhead by any suitable locking means which may be positionable in the selector and locking recesses 30 and 31 or in the lock recesses 42 or 43 of the wellhead. In the event, however, that the well casing 40 becomes stuck for one reason or another in the well so that it can be neither raised nor lowered prior to reaching its proper position in the well bore, the usual means for securing it to the wellhead cannot be employed. The hanger mandrel 50 is then lowered into the well, telescoping about casing 40, by means of a suitable running tool 52 to lock the stuck well casing against downward movement relative to the wellhead.

The mandrel 50 is provided on its lower end with key cage or carrier sleeve 54 which is mounted on the lower end of the hanger mandrel for limited longitudinal movement thereon. The hanger mandrel is provided at its lower end with a retainer ring 55 which is threaded on the lower end thereof, or in the alternative, may be welded thereon, to limit downward movement of the key carrier sleeve 54 thereon. Upward movement of the key carrier sleeve 54 on the hanger mandrel is limited by the engagement of the shoulders 57 and 58 of the key carrier sleeve and the mandrel, respectively. The downwardly facing shoulder 58 of the mandrel is provided by the enlarged portion 59 of the hanger mandrel which also serves as a locking means for holding the keys 62 in expanded position against inward movement towards retracted positions.

The selector keys 62 are disposed in circumferentially spaced apertures 64 of the key carrier sleeve and are provided with lateral flanges 65 which abut the shoulders 66 adjacent the sides of the apertures 64 to limit outward movement of the keys relative to the key carrier sleeve. Each of the selector keys is provided with an upper selector boss 67 which has a downwardly facing abrupt shoulder 68 which is receivable in the selector recess 33 and with a guide boss 69 which is receivable in the guide recess 34 of the wellhead. The selector bosses 67 are of such length or longitudinal dimensions that they will not enter into the lock recess 30 being larger than such recess 30 but will enter into the selector recess 33 whereupon the stop shoulders 35 and 68 engage to limit further downward movement of the key carrier sleeve in the wellhead. It will thus be seen that the selector keys constitute lock-

ing means which limit downward movement of the key carrier sleeve, and therefore of the mandrel 50 in the wellhead.

A resilient packing 72 is disposed about the enlarged portion 59 of the hanger mandrel above the key carrier sleeve 54 which seals between the hanger mandrel and the wellhead above the selector key recess 33 and between the lateral ports 23 and 24 of the wellhead. When the hanger mandrel is in the casing supporting position illustrated in FIGURE 2, upward movement of the packing 72 on the hanger mandrel is limited by the annular downwardly facing shoulder 75 of the hanger mandrel.

The key carrier sleeve is initially held in the lower position illustrated in FIGURE 1 by a shear screw 76 which extends through aligned threaded bores of the key carrier sleeve and of the hanger mandrel. The selector keys 62 are biased outwardly towards extended positions by biasing springs 80, the springs having opposite ends bearing against the keys and the outer surface of the mandrel. The keys are also provided with inwardly downwardly extending cam shoulders 83 which are adapted to be engaged by the similarly extending annular shoulder 58 of the hanger mandrel which forces the keys into fully extended position upon downward movement of the hanger mandrel relative to the key carrier sleeve and therefore to the keys.

The hanger mandrel is provided at its upper end with an enlarged internal bore 85 which is partially closed at its upper end by a retainer ring 86 threaded or otherwise rigidly secured to the upper end of the hanger mandrel. The resilient packer seal 88a is disposed in the bore 85 between a plurality of upper and lower back-up members 89 and 88, respectively. The back-up members are arranged in circular fashion and have external slots 90 in which are received the garter springs 92 which bias the back-up members inwardly toward the casing 40. The back-up members have outer ends 93 which bear against upper and lower annular flanges 94 and 95, respectively, of the seal member 88a. The back-up members are also provided with beveled shoulders 97 and 98, respectively, which cam the back-up members, and therefore the seal member 88a outwardly upon meeting either downwardly or upwardly facing obstructions during vertical movements of the hanger mandrel in the well.

A cam ring 100 is also disposed in the enlarged bore 85 of the hanger mandrel and has a downwardly facing shoulder 101 which bears against the upper back-up members 89 and an internal upwardly and outwardly extending annular cam surface 103. A plurality of slips 104 having outer surfaces, which extend upwardly and outwardly in the same manner as the cam surface 103 of the cam ring, and serrations or teeth 105 on their inner surfaces which are adapted to bite or dig into the outer surface of the well casing 40, are disposed in the cam ring. The slips thus constitute gripping or lock means for engaging the well casing 40. The slips 104 are biased downwardly, and therefore toward casing engaging positions, by a resilient spring 110 which bears against the upper ends of the slips 104 and against the lower surface of the retainer ring 86. It will be apparent that upon downward movement of the slips 104 relative to the retainer ring 100, the slips are forced inwardly into tight gripping or biting engagement with the well casing 40 due to the camming action of the cam surface 103 of the cam ring and the outer surfaces of the slips 104.

The upper end of the hanger mandrel may be releasably secured to the lower end of the running tool 52 by means of a shear screw 112 which extends through aligned threaded bores in the lower end of the running tool and in the upper ends of the mandrel and upper annular flange 113 of the retainer ring 86. The upper end of the running tool may be provided with an internal flange 115 having a threaded bore for receiving the lower end of a running pipe 116. The internal flange 115 of the running tool may have an internal diameter larger than the external diameter of the casing 40 and of the coupling collars 118

thereof whereby the running tool and the hanger mandrel 50 may be telescoped over the well casing 40, if necessary, and lowered thereabout into the wellhead 20. Normally, the upper end of the running tool does not pass over the casing as explained below. The beveled shoulders 92 of the back-up members 89 and 88 cam the back-up members and the resilient seal member 88a outwardly upon encountering the upper shoulders of the coupling collars or other obstructions on the well casing during downward movement of the hanger mandrel relative to the well casing 40. The slips 104 similarly move upwardly and outwardly relative to the cam ring 100, against the force exerted by the spring 110, upon meeting such upwardly facing obstructions of the well casing 40 whereby the teeth 105 of the slips do not prevent downward movement of the hanger mandrel on the well casing 40.

In use, the intermediate casing 40 is lowered by conventional means into the well through the wellhead 20. If the casing 40 becomes stuck in the well for any reason whatsoever it is necessary that it be rigidly secured to the wellhead by the hanger mandrel to prevent the well casing from buckling under its own weight since the conventional means which are ordinarily attached to the top end of the well casing 40 cannot now be employed to secure it in the wellhead 20. Accordingly, upper portions of the well casing are cut off by suitable cutting means above the wellhead after the lifting tool 125 is lowered to the well casing to exert an upward pull thereon. The lifting tool is provided with a plurality of slips 127 circumferentially spaced about its tubular shank 128 which are held thereon by means of a garter spring 129 extending through suitable external transverse slots of the slips. The lower end of the tubular member 128 is provided with a downwardly and outwardly tapered cam surface 130 upon which the similarly inclined inner surfaces 131 of the slips ride whereby the slips are forced outwardly upon upward movement of the tubular member relative to the slips. The slips of course are provided with serrations or teeth 132 which engage or bite into the internal wall surface of the tubular casing 40 upon outward movement of the slips in the well casing 40. Downward movement of the slips 127 is limited by an external upwardly facing shoulder 133 provided on the lower end of the tubular member 128. It will be apparent that the tubular member is lowered into the well casing with the slips 127 held above the cam surface 130 and therefore out of engagement with the internal well surface of the casing. When the lower end of the pulling tool 125 has reached the desired location in the casing, upward jars are imparted to the lifting tool to cause upward movement of the cam surface 130 relative to the slips 127 which are thus forced into gripping engagement with the internal surface of the well casing 40. An upward pull then exerted on the upper end of the tubular shank 128 of the removing tool 125 causes the well casing to move upwardly. The hanger mandrel 50 is lowered into the well by means of the running tool 52 which is releasably secured to the mandrel by means of the shear screw 76. The hanger mandrel moves downwardly through the wellhead, the beveled shoulders of the guide bosses 69 of the selector keys biasing the keys inwardly upon meeting upwardly facing obstructions in the guide pipe or in the wellhead. Similarly, the back-up members 88 and 89 move outwardly against the resistance of the garter springs 92 upon meeting such obstructions as the collars 118 of the well casing 40 although the number of such collars past which the mandrel must move is reduced by cutting off the upper portions of the well casing. The slips 104 also move outwardly and upwardly against the resistance of the spring 110 in the cam ring 100 whenever they meet such obstructions. The upper selector key bosses 67 do not permit outward movement of the key into the upper selector recesses, such as the selector recess 30, since the length or height of this recess is shorter than the length or height of the selector

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bosses 67. When the selector bosses 67, however, reach and register with the selector recess 33, the springs 80 bias the selector keys outwardly into the selector recesses 33 and 34 whereupon the engagement of the abrupt downwardly facing shoulder 68 of the keys with the upwardly facing abrupt shoulder 35 of the wellhead arrests further downward movement of the key carrier sleeve 54 relative to the wellhead. Downward blows are then imparted, by means of the running pipe or conduit 116, to the running tool 52 to cause the shear screw 76 to shear and as a result the mandrel is freed to move downwardly relative to the key carrier sleeve and to the keys. Such further downward movement of the mandrel caused by the running tool 52, causes the cam shoulders 58 of the hanger mandrel to engage the upper inner shoulders 83 of the keys and move the keys outwardly into expanded positions. At the same time the lock surface 59 of the hanger mandrel moves behind or inwardly of the inner surfaces of the selector keys and locks them in their expanded positions in the recesses 33 and 34.

An upward force is then imparted to the casing 40 by means of the lifting tool so as to cause it to stretch until it has stretched through a sufficient distance so that when the upper end is again released a predetermined portion of the weight of the casing will be supported and suspended from the hanger mandrel 50. When the upward force on the upper end of the well casing 40 is released the upper portions of the casing will tend to move downwardly and as a result the slips 112, whose serrations 105 engage and bite into the well casing 40, move downwardly therewith a predetermined distance until the inwardly camming action of the cam surface 103 of the cam ring 100 prevents further downward movement of the slips and of the well casing.

A predetermined portion of the weight of the well casing is now supported by the cam ring 100 which in turn rests upon and is supported by the inner resilient seal member 88a which is thus compressed and forced to seal effectively between the mandrel and the well casing. Similarly a downward force is imparted through the mandrel to the external seal member 72 which is similarly compressed between the upper end of the key carrier sleeve and the downwardly facing shoulder 75 of the hanger mandrel so that an effective seal is established between the mandrel and the wellhead 20 above the selector recess 33 and between the lateral ports 23 and 24 of the wellhead.

Upward jars are then imparted to the running tool to cause the shear screw 112 to shear whereupon the running tool is freed for removal from the well bore. After the running tool 52 is removed from the well bore, the lifting tool is moved downwardly, the slips 127 moving inwardly on the shank out of engagement with the well casing due to the action of the grater spring 129 when the cam surface 130 moves downwardly relative to the slips. If necessary, downward jars are imparted to the shank to cause the cam surface to move downwardly relative to the slips. After the slips are moved to their retracted positions they are held there by the action of the garter spring so that the lifting tool may now be removed upwardly out of the well casing.

A suitable well casing cutting tool is then lowered into the well casing until it reaches a point above the hanger mandrel, such as the point 120, to cut the well casing at such point so that the severed upper portions of the well casing can then be removed. Suitable well completing operations may then be performed on the well casing which may be packed off and cemented in place in the usual manner.

It will be apparent that the upper lateral port 23 of the wellhead then communicates with the interior of the well casing 40 and the conduit 26 whereby well fluids may be transmitted between the interior of the casing 40 and a point remote from the wellhead. Similarly fluids

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may flow between the annular flow passage 122 formed by the well casing and the wellhead, which of course is provided with a suitable dependent outer well casing, and the conduit 27.

Should it thereafter become desirable to remove upper portions of the well casing 40, a suitable cutting tool is lowered into the well casing 40 below the hanger mandrel to whatever depth may be desired and the well casing then cut thereby. The lifting tool 125 is then lowered into the well casing. Upward jars are imparted thereto to cause the slips to move downwardly over the cam surface 130 and outwardly into engagement with the well casing. Upward movement of the lifting tool then causes upward movement of the casing. Such upward movement of the well casing may be resisted by the engagement of the slips 112 which are held in place by the force of the resilient spring 110. As a result further upward movement of the well casing 40 causes the hanger mandrel 50 to move upwardly therewith. The key carrier sleeve 54, however, is prevented from moving upwardly due to engagement of the locking surface 59 with the inner surfaces of the keys until the lock surface 59 is moved upwardly to a point where the shoulder 58 of the mandrel is disposed above the selector keys 62. Further upward movement of the mandrel now causes the retainer ring 55 to engage the lower end of the key carrier sleeve and impart an upward movement thereto. The selector keys thereupon are forced inwardly due to the camming action of the upper shoulders of their bosses 67 and 69 which engage the downwardly and outwardly beveled shoulders 36 and 37 of the recesses 33 and 34, whereupon the hanger mandrel may be removed with such severed upper portions of the well casing leaving the wellhead free to receive such further tools as may be desired.

In the event the well casing 40 is removed from the wellhead by means of the lifting tool 125 without the hanger mandrel moving therewith, which may occur if the keys 62 become firmly lodged in the selector recesses or if the springs 110 fail to provide the necessary downward force on the slips 104. In such event, once the lifting tool has removed the severed portions of the well casing 40 from the well, a suitable running tool may be lowered into the well to engage the lower end of the mandrel whereby a strong upward pull exerted on the lower end of the mandrel will cause it to move upwardly relative to the key carrier sleeve until the locking surface 59 thereof is moved above the keys which are then subjected to a strong camming force which moves them inwardly toward retracted positions whereby the mandrel may be removed with the carrier sleeve out of the wellhead.

The above described method could be used whether the casing became stuck before or after the standard hanger had been made up on the casing string. If the hanger had been made up on the casing 40 and the casing 40 becomes stuck with the hanger between the surface and the wellhead, the above procedure may be used. The casing 40 would, of course, be cut off below the hanger and the hanger removed.

If, however, the casing became stuck before the standard wellhead had been made up on the casing 40, the hanger mandrel 50 could be stripped over the stuck casing 40, lowered, and set without the use of the lifting tool 128, and without the necessity of cutting the stuck casing 40 until after it had been hung and the running tool released. In this case, of course, the bore of the internal flange 115 of the running tool would be large enough to pass over the collars of the stuck casing 40. The necessary amount of pull to stretch the casing in order to place a portion of the casing weight on the hanger and seals would be accomplished simply by picking up on the casing 40 at the surface.

It will now be seen that a new and improved well tool for securing well tools, such as casing, in a well-

head has been illustrated and described which includes a hanger mandrel provided with selector keys which engage in only a preselected recess of a tubular member, such as a wellhead, to suspend the well casing from such preselected position in the wellhead.

It will further be seen that the hanger mandrel is provided with an internal recess in which are provided slips for engaging a tubular member, such as well casing, to limit downward movement of such well casing relative to the hanger mandrel.

It will further be seen that the means for gripping the well casing includes a plurality of slips mounted circumferentially in a cam ring having an inwardly and downwardly sloping cam shoulder whereby the wedging action between such cam surface and the correspondingly shaped outer surfaces of the slips causes the slips to be moved into gripping engagement with the well casing whereby the well casing is suspended from the wellhead.

It will further be seen that the hanger mandrel is provided with a resilient seal member disposed below the cam ring which is longitudinally movable in the hanger whereby suspension of the well casing on the cam ring causes compression of the internal seal member whereby an effective seal is secured between the well casing and the hanger mandrel.

It will further be seen that the selector and locating means comprise a plurality of keys mounted in a key carrier sleeve which is longitudinally movable on the mandrel.

It will further be seen that the mandrel is provided with a downwardly facing shoulder above the key carrier sleeve and that an external seal member 72 is disposed thereon so that the weight of the well casing suspended on the mandrel causes the external seal member also to be placed into compression whereby an effective seal is secured between the hanger mandrel and the wellhead.

It will further be seen that the selector keys of the key carrier sleeve are provided with selector bosses which are receivable only in a preselected selector recess of the wellhead which is provided with a plurality of longitudinally spaced selector recesses.

It will further be seen that the mandrel is removably positioned in the wellhead since upward movement of the well casing ordinarily will cause the mandrel to move upwardly relative to the selector keys whereby the selector keys are freed for inward movement from their expanded positions toward their retracted positions where-in they offer no obstruction to the upward movement of the mandrel in the wellhead.

It will further be seen that the wellhead is provided with suitable longitudinally spaced lateral ports and that the internal and external sealing members 88 and 72 seal between the hanger and the well casing and the wellhead between such ports.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A well tool for suspending an inner tubular member in an outer tubular member, comprising: a tubular hanger mandrel telescopically receiving said inner tubular member; locking means mounted externally on said mandrel for engagement with the outer tubular member for limiting downward movement of the mandrel in the outer tubular member; an internal lock means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of said inner tubular member in the mandrel, said mandrel having an internal recess in its bore, said internal lock means including a cam ring mounted in said recess for limited

longitudinal movement in said mandrel, and gripping means in said cam ring movable inwardly by said cam ring into engagement with said inner tubular member for limiting downward movement of said inner tubular member relative to said mandrel, said gripping means having internal serrations for biting into the external surface of said inner tubular member; internal seal means carried by the mandrel on a shoulder in the internal recess and compressible between said cam ring and said shoulder of said mandrel for sealing between the mandrel and the inner tubular member; and external seal means on said mandrel for sealing between said mandrel and said outer tubular member.

2. A well tool for use with inner and outer tubular members comprising a mandrel having a longitudinal bore adapted to telescope said inner tubular member; locking means movably mounted exteriorly on said mandrel for movement longitudinally thereon and laterally thereof between inner retracted positions and outer expanded positions for limiting downward movement of the mandrel in the outer tubular member upon meeting a preselected upwardly facing obstruction of the outer tubular member; means biasing said locking means to said outer position; external seal means mounted on said mandrel between said mandrel and said locking means and compressible upon longitudinal movement of said locking means relative to said mandrel for sealing between the mandrel and the outer tubular member; gripping means mounted in the bore of said mandrel for longitudinal movement therein, said gripping means being movable inwardly to engage the inner tubular member when said mandrel is telescoped over the inner tubular member; and internal seal means carried in said mandrel between said gripping means and said mandrel and compressible upon longitudinal movement of said gripping means relative to said mandrel for sealing between said inner tubular member and said mandrel.

3. A well tool for use with inner and outer tubular members comprising: a mandrel having a longitudinal bore adapted to telescope said inner tubular member; locking means longitudinally movably mounted externally on said mandrel and biased outwardly thereof for movement between inner retracted position and outer expanded position for limiting downward movement of the mandrel in the outer tubular member upon meeting a preselected upwardly facing obstruction of the outer tubular member; means on said mandrel engageable with said locking means to hold said locking means in said expanded position in engagement with said obstruction; external seal means mounted on said mandrel for sealing between the mandrel and the outer tubular member; gripping means mounted in the bore of said mandrel and movable inwardly to engage the inner tubular member when said mandrel is telescoped over the inner tubular member; said gripping means comprising a cam ring having an internal downwardly and inwardly extending cam surface, a plurality of slips engaged by said cam surface, and resilient means biasing said slips downwardly relative to said camming surface and inwardly toward the inner tubular member; and internal seal means carried by said mandrel in its bore for sealing between said inner tubular member and said mandrel.

4. A well tool for suspending an inner tubular member in an outer tubular member comprising: an outer tubular wellhead member; a hanger mandrel having a longitudinal bore therein adapted to telescope said inner tubular member; locking means mounted externally on said mandrel for engagement with the outer tubular wellhead member for limiting downward movement of the mandrel in said wellhead member; means biasing said locking means outwardly of said mandrel into engagement with said outer tubular member for limiting downward movement of said mandrel in said outer tubular member; means on said mandrel engageable with said locking means to hold said locking means in said out-

ward position in engagement with said outer tubular wellhead member for preventing longitudinal movement of said hanger mandrel in either longitudinal direction relative to said wellhead member; an internal lock means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of said inner tubular member in the mandrel; and seal means carried by the mandrel for sealing between the mandrel and the inner tubular member and said wellhead member.

5. A well tool for suspending an inner tubular member against downward movement in an outer tubular member comprising: a tubular wellhead member adapted to be connected to said outer tubular member; a mandrel having a longitudinal bore therein adapted to telescope said inner tubular member; a carrier sleeve mounted externally on the mandrel for limited longitudinal movement thereon; outwardly biased locking means carried by the sleeve engageable with said tubular wellhead member for limiting downward movement of the sleeve in said wellhead member; and internal gripping means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of the inner tubular member in the bore of said mandrel.

6. A well tool for suspending an inner tubular member against downward movement in an outer tubular member comprising: a tubular wellhead member adapted to be connected to said outer tubular member and having an internal stop recess therein; a mandrel having a longitudinal bore therethrough adapted to telescope over said inner tubular member; a carrier sleeve mounted externally on the mandrel for limited longitudinal movement thereon; locking means carried by the sleeve engageable with said stop recess in the bore of said wellhead member for limiting downward movement of the sleeve in said wellhead member; said locking means being movable to retracted position when the sleeve is in a lowermost position on said mandrel; internal gripping means carried by said mandrel in its bore engageable with said inner tubular member for limiting downward movement of said inner tubular member in said mandrel; and means releasably holding the sleeve in the lowermost position on said mandrel to facilitate downward movement of the mandrel in said wellhead member.

7. A well tool for suspending an inner tubular member against downward movement in an outer tubular member comprising: an outer tubular wellhead member adapted to be connected to the upper end of the outer tubular member and having an internal stop recess in its bore; a mandrel having a longitudinal bore therein adapted to telescope said inner tubular member; a carrier sleeve mounted externally on the mandrel for limited longitudinal movement thereon; locking means carried by the sleeve engageable with said stop recess in the bore of said wellhead member for limiting downward movement of the sleeve in said wellhead member; internal gripping means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of the inner tubular member in the mandrel; a lock surface on said mandrel engageable with said locking means to hold said locking means in expanded position when said sleeve is in its uppermost position on said mandrel, said locking means being movable to retracted position when the sleeve is in a lowermost position on said mandrel; and means resiliently urging said locking means toward expanded position.

8. A well tool for suspending an inner tubular member against downward movement in an outer tubular member comprising: an outer tubular wellhead member adapted to be connected to the upper end of the outer tubular member and having an internal stop recess in its bore; a mandrel having a longitudinal bore therein adapted to telescope said inner tubular member; a carrier sleeve mounted externally on the mandrel for limited longitudinal movement thereon; locking means carried by

the sleeve engageable with said stop recess in the bore of said wellhead member for limiting downward movement of the sleeve in the outer tubular member; means carried by the mandrel engageable with the inner tubular member for limiting downward movement of the inner tubular member in the mandrel; a lock surface on said mandrel engageable with said locking means to hold said locking means in expanded position when said sleeve is in its uppermost position on said mandrel, said locking means being movable to retracted position when the sleeve is in a lowermost position on said mandrel; means releasably holding the sleeve in the lowermost position on said mandrel to facilitate downward movement of the mandrel in said wellhead member; and means resiliently urging said locking means toward expanded position.

9. A well tool for suspending an inner tubular member against downward movement in an outer tubular member comprising: an outer tubular wellhead member adapted to be connected to the upper end of the outer tubular member and having an internal stop recess in its bore; a mandrel having a longitudinal bore therein adapted to telescope said inner tubular member; a carrier sleeve mounted externally on the mandrel for limited longitudinal movement thereon; locking means carried by the sleeve engageable with said stop recess in the bore of said wellhead member for limiting downward movement of the sleeve in said wellhead member, said locking means being movable to retracted position when the sleeve is in a lowermost position on said mandrel, said mandrel having an external lock surface engageable with said locking means upon downward movement of said mandrel relative to said sleeve to lock said locking means in expanded position; and internal gripping means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of said inner tubular member in said mandrel.

10. A well tool for suspending an inner tubular member against downward movement in an outer tubular member comprising: a tubular wellhead member having an internal stop recess therein; a tubular mandrel; a carrier sleeve mounted externally on the mandrel for limited longitudinal movement thereon; locking means carried by the sleeve engageable with said stop recess of said wellhead member for limiting downward movement of the sleeve in said wellhead member, said locking means being movable to retracted position when the sleeve is in a lowermost position on said mandrel; means resiliently urging said locking means toward expanded position, said mandrel having a locking surface exteriorly thereon engageable with said locking means upon downward movement of said mandrel relative to said sleeve to lock said locking means in expanded positions; and internal gripping means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of the inner tubular member in said mandrel.

11. A well tool for suspending an inner tubular member against downward movement in an outer tubular member comprising: an outer tubular wellhead member; a tubular mandrel; a carrier sleeve mounted externally on the mandrel for limited longitudinal movement thereon; locking means carried by the sleeve engageable with said outer tubular wellhead member for limiting downward movement of the sleeve in said outer tubular wellhead member; internal gripping means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of the inner tubular member in the mandrel, said locking means being movable to retracted positions when the sleeve is in a lowermost position on said mandrel; means releasably holding the sleeve in the lowermost position on said mandrel to facilitate downward movement of the mandrel in the outer tubular wellhead member; and means resiliently urging said locking means toward expanded position, said mandrel having an external lock surface engageable with said locking

means upon downward movement of said mandrel relative to said sleeve to lock said locking means in expanded positions.

12. A well tool for suspending an inner tubular member in an outer tubular member comprising: an outer tubular wellhead member adapted to be connected to said outer tubular member; a hanger mandrel having a bore therein adapted to receive said inner tubular member, said hanger mandrel being telescopable into said outer tubular wellhead member; locking means mounted exteriorly on said mandrel for engagement with the outer tubular wellhead member for limiting downward movement of the mandrel in the outer tubular wellhead member; an internal lock means carried by the mandrel in its bore engageable with the inner tubular member disposed therein for limiting downward movement of said inner tubular member in the mandrel; and seal means carried by the mandrel for sealing between the mandrel and the inner and outer tubular members, said seal means comprising a first seal member disposed between said locking means and a downwardly facing shoulder of said mandrel for sealing between said mandrel and said outer tubular wellhead member, and a second seal member disposed between said external lock means and an upwardly facing shoulder in the bore of said mandrel for sealing between said mandrel and said inner tubular member.

13. A well tool for suspending an inner tubular member in an outer tubular member comprising: a tubular hanger mandrel having a bore therein adapted to slidably receive said inner tubular member; locking means mounted externally on said mandrel biased outwardly for engagement with the outer tubular member for limiting downward movement of the mandrel in the outer tubular member; means on said mandrel engageable with said locking means for holding the same in supporting engagement with said outer tubular member to prevent longitudinal movement of said mandrel in either direction relative to said outer tubular member; an internal lock means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of said inner tubular member in the mandrel; said mandrel having an internal recess, said internal lock means including a cam ring mounted in said recess for limited longitudinal movement in said mandrel and gripping means in said cam ring movable inwardly by said cam ring into engagement with said inner tubular member for limiting downward movement of said inner tubular member relative to said mandrel; and seal means carried by the mandrel for sealing between the mandrel and the inner and outer tubular members.

14. A well tool for suspending an inner tubular member in an outer tubular member comprising: a tubular hanger mandrel having a bore therethrough adapted to slidably receive said inner tubular member; locking means mounted exteriorly of said mandrel biased outwardly for engagement with the outer tubular member for limiting downward movement of the mandrel in the outer tubular member; means on said mandrel engageable with said locking means for preventing inward movement of said locking means from supporting engagement with said outer tubular member; an internal lock means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of said inner tubular member in the mandrel; said mandrel having an internal recess in its bore, said internal lock means including a cam ring mounted in said recess for limited longitudinal movement in said mandrel and gripping means in said cam ring movable inwardly by said cam ring into engagement with said inner tubular member for limiting downward movement of said inner tubular member relative to said mandrel, said gripping means and said cam ring having inwardly and downwardly inclined abutting cam surfaces whereby downward movement of the said gripping means causes said gripping means to

be moved inwardly into gripping engagement with said inner tubular member; first seal means carried by the mandrel in said internal recess for sealing between the mandrel and the inner tubular member and compressible to sealing position by longitudinal movement of said cam ring in said mandrel; and second seal means carried by said mandrel exteriorly thereon for sealing between said mandrel and said outer tubular member.

15. A well tool for suspending an inner tubular member in an outer tubular member comprising: a tubular hanger mandrel having a bore longitudinally therethrough adapted to slidably receive said inner tubular member; locking means mounted externally on said mandrel for engagement with the outer tubular member for limiting downward movement of the mandrel in the outer tubular member; means biasing said locking means outwardly of said mandrel; means on said mandrel engaging said locking means in their outer position to prevent inward movement of the same from such outer position; means on said mandrel engageable with said external locking means for preventing inward movement of said locking means from supporting engagement with said outer tubular member; an internal lock means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of said inner tubular member in the mandrel; said mandrel having an internal recess in its bore, said internal lock means including a cam ring mounted in said recess for limiting longitudinal movement in said mandrel, and gripping means in said cam ring movable inwardly by said cam ring into engagement with said inner tubular member for limiting downward movement of said inner tubular member relative to said mandrel, said gripping means and said cam ring having inwardly and downwardly inclined abutting cam surfaces whereby downward movement of said gripping means causes said gripping means to be moved inwardly into gripping engagement with said inner tubular member, and resilient means carried by said mandrel for urging said gripping means downwardly on said cam surface; internal seal means carried by the mandrel for sealing between the mandrel and the inner tubular member, said seal means being compressed into sealing engagement with said mandrel and said inner tubular member by longitudinal movement of said cam ring in said internal recess in said mandrel.

16. A well tool for suspending an inner tubular member in an outer tubular member comprising: a tubular hanger mandrel telescopable over said inner tubular member; locking means mounted externally on said mandrel for engagement with the outer tubular member for limiting downward movement of the mandrel in the outer tubular member; an internal lock means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of said inner tubular member in the mandrel, said mandrel having an internal recess, said internal lock means including a cam ring mounted in said recess for limited longitudinal movement in said mandrel and gripping means in said cam ring movable inwardly by said cam ring into engagement with said inner tubular member for limiting downward movement of said inner tubular member relative to said mandrel; an internal seal mounted in said recess between an upwardly facing shoulder of said mandrel and said cam ring for sealing between said mandrel and said inner tubular member; and external seal means carried by the mandrel for sealing between the mandrel and the outer tubular member.

17. A well tool for suspending an inner tubular member in an outer tubular member comprising: a tubular hanger mandrel adapted to telescope over said inner tubular member; locking means mounted externally on said mandrel for engagement with the outer tubular member for limiting downward movement of the mandrel in the outer tubular member; an internal lock means carried by

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the mandrel in its bore engageable with the inner tubular member for limiting downward movement of said inner tubular member in the mandrel, said mandrel having an internal recess in its bore, said internal lock means including a cam ring mounted in said recess for limited longitudinal movement in said mandrel and gripping means in said cam ring movable inwardly by said cam ring into engagement with said inner tubular member for limiting downward movement of said inner tubular member relative to said mandrel; an internal seal mounted in said recess between an upwardly facing shoulder of said mandrel and said cam ring for sealing between said mandrel and said inner tubular member, circumferentially arranged back-up members disposed on opposite sides of said seal member, said back-up members being provided with cam shoulders whereby said back-up members are moved outwardly upon engagement of the cam shoulder with obstructions to prevent undue wear and tear on said seal members; and external seal means carried by the mandrel for sealing between the mandrel and the outer tubular member.

18. A well tool for suspending an inner tubular member against downward movement in an outer tubular member comprising: an outer tubular wellhead member having a plurality of longitudinally spaced sets of internal selector recesses in its internal bore wall; a mandrel having a bore therein adapted to receive said inner tubular member; a carrier sleeve mounted externally on the mandrel for limited longitudinal movement thereon; locking means carried by the sleeve engageable with a selected one of said internal selector recesses in the bore of said well head member for limiting downward movement of the sleeve in said wellhead member, said locking means being movable to retracted position when the sleeve is in a lowermost position on said mandrel, said locking means comprising selector keys extendable into a preselected selector recess of said outer tubular member, said selector recess and said selector keys having complementary abrupt upwardly and downwardly facing stop shoulders for limiting downward movement of said carrier sleeve in said outer tubular member; and internal gripping means carried by the mandrel in its bore engageable with the inner tubular member for limiting downward movement of the inner tubular member with respect to said mandrel.

19. A well tool for suspending an inner tubular member in an outer tubular member including: a mandrel having an internal bore adapted to receive said inner tubular member; locking means on the exterior of said mandrel engageable with said outer member for limiting downward movement of the mandrel in the outer member; means on said mandrel biasing said locking means outwardly of said mandrel into engagement with said outer member; means on said mandrel engageable with said locking means when said locking means is in such

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outer position and in engagement with said outer tubular member to prevent inward movement of said locking means from such outer tubular member to lock said mandrel in position in said outer tubular member; internal lock means carried by the mandrel in its bore for engaging the inner tubular member for limiting downward movement of the inner tubular member relative to said mandrel; internal seal means carried by said mandrel and disposed between said mandrel and said internal lock means and compressible by longitudinal movement of said internal locking means relative to said mandrel into sealing engagement between said mandrel and said inner tubular member; and seal means carried externally by said mandrel and compressible between said mandrel and said outer exterior locking means on said mandrel for sealing between said mandrel and said outer tubular member.

20. A well tool for use with inner and outer tubular members comprising: an outer tubular housing having an internal upwardly facing obstruction in its bore; a mandrel having a longitudinal bore adapted to receive said inner tubular member; locking means longitudinally movably mounted externally on said mandrel and biased outwardly thereof for movement between inner retracted position and outer projecting position and engageable with said upwardly facing obstruction of said outer tubular housing for limiting downward movement of said mandrel in said outer tubular housing; means on said mandrel engageable with said locking means upon longitudinal movement of said mandrel relative to said locking means to hold said locking means in said expanded position in engagement with said upwardly facing obstruction of said outer tubular housing; external seal means mounted on said mandrel for sealing between the mandrel and said outer tubular housing; gripping means mounted in the bore of said mandrel and movable inwardly thereof to engage said inner tubular member when said inner tubular member is disposed in the bore of said mandrel to hold said inner tubular member against downward movement relative to said mandrel; and internal seal means carried in said mandrel for sealing between said mandrel and said inner tubular member.

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