Aug. 27, 1957 F. L. LE BUS, SR 2,804,151

DRILL COLLAR RETRIEVING MECHANISM

Filed Nov. 23, 1953 4 Sheets-Sheet 1

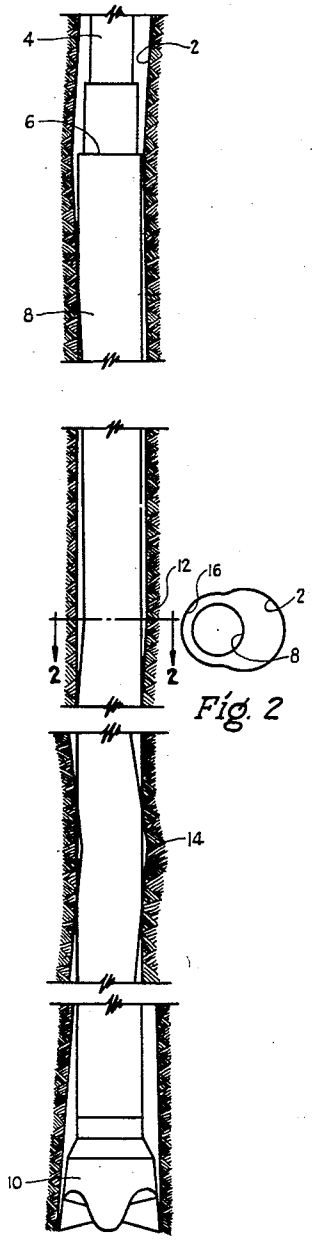

Fig. 1

Fig. 2

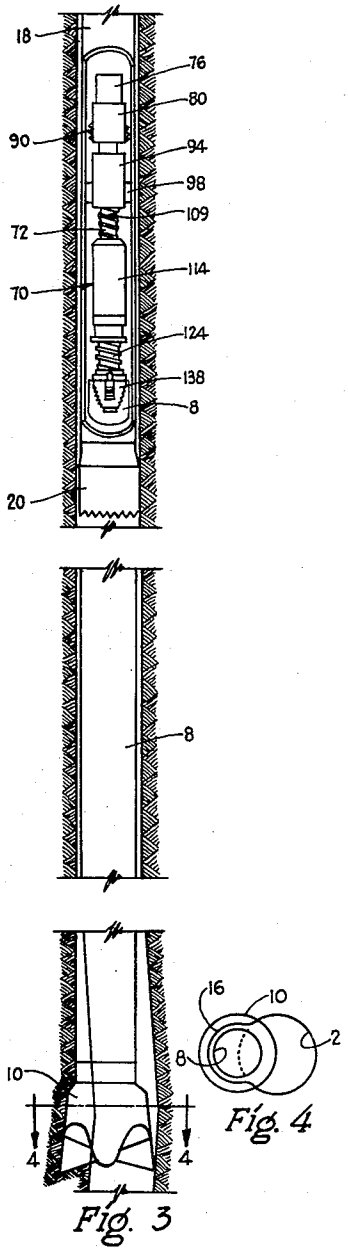

Fig. 3

Fig. 4

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DRILL COLLAR RETRIEVING MECHANISM

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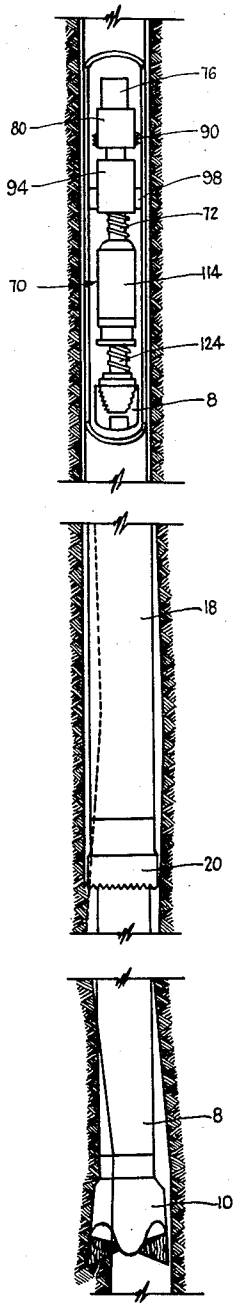

Fig. 5

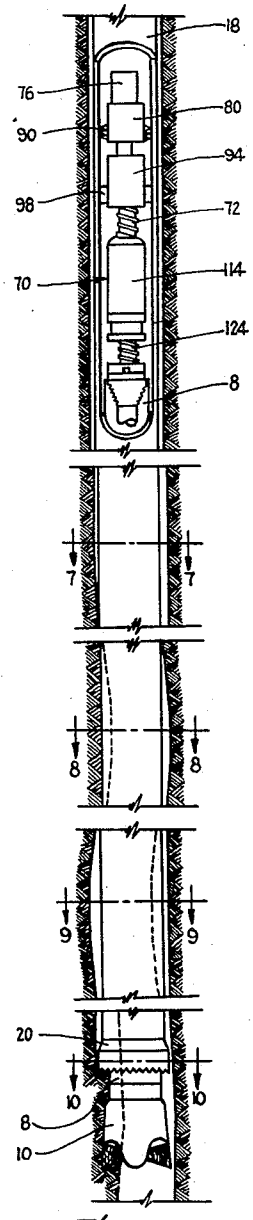

Fig. 6

Fig. 7

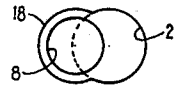

Fig. 8

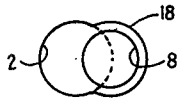

Fig. 9

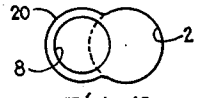

Fig. 10

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DRILL COLLAR RETRIEVING MECHANISM

Filed Nov. 23, 1953 4 Sheets-Sheet 3

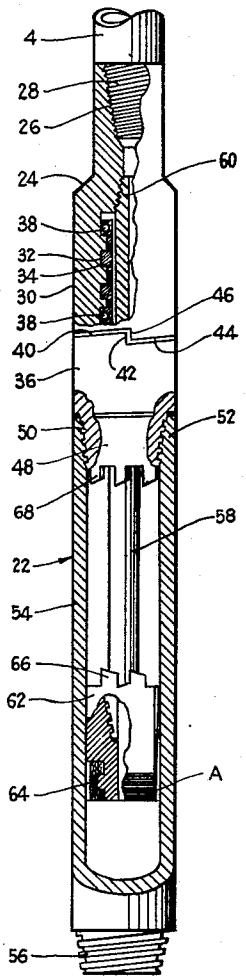

Fig. 11

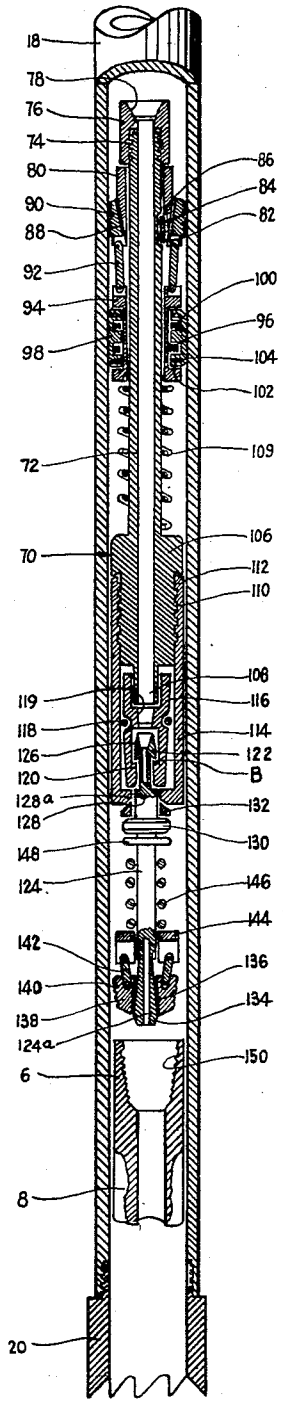

Fig. 12

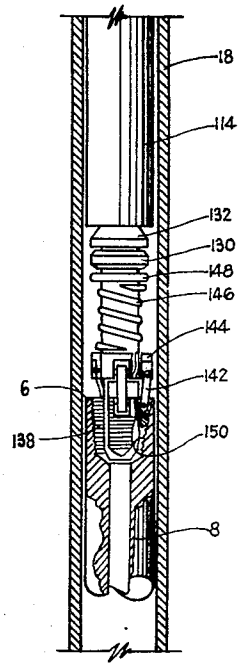

Fig. 13

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DRILL COLLAR RETRIEVING MECHANISM

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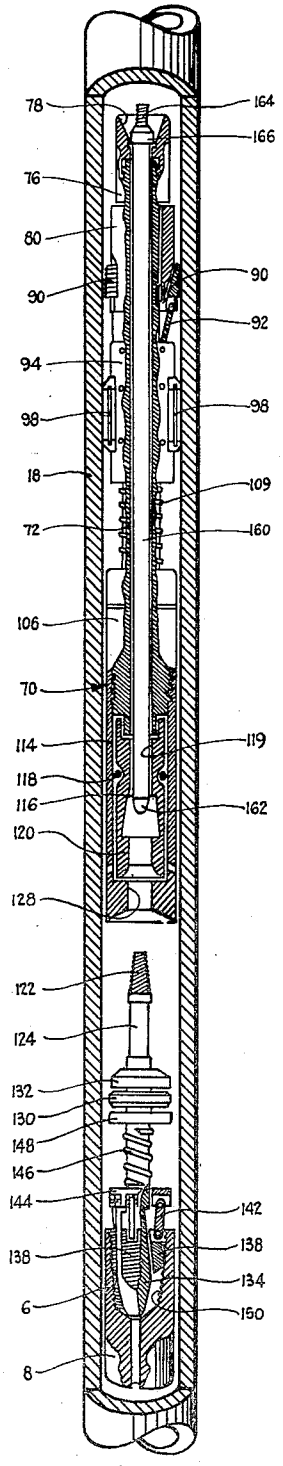

Fig. 14

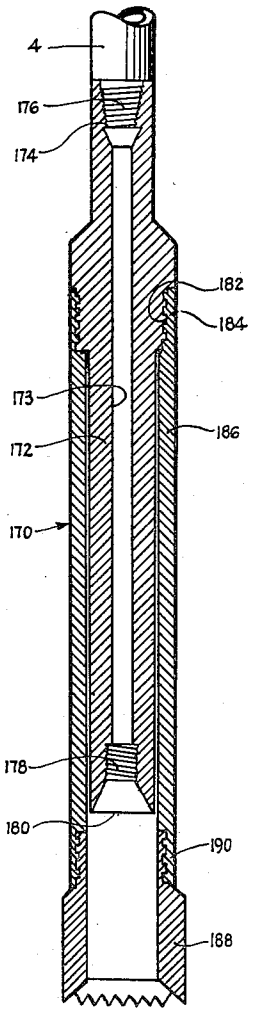

Fig. 15

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United States Patent Office 2,804,151 Patented Aug. 27, 1957

2,804,151

DRILL COLLAR RETRIEVING MECHANISM

Franklin L. Le Bus, Sr., Longview, Tex., assignor to The Wash Overshot and Spear Engineers, Incorporated, Longview, Tex., a corporation of Texas

Application November 23, 1953, Serial No. 393,711

14 Claims. (Cl. 166—103)

This invention relates to improvements in drill collar recovery mechanisms and more particularly, but not by way of limitation, to a mechanism for simultaneously dislodging stuck drill collars in a well bore and holding the drill collars for subsequent removal from the well bore. This application is a continuation-in-part of applicant's co-pending application Serial No. 341,979 filed March 12, 1953, for "Method and System of Retrieving Stuck Pipe Joints in Well Bores."

In the drilling of wells by the rotary drilling method, and particularly deep oil wells, the well bore frequently deviates from the true vertical. Such deviations are ordinarily caused by the drill bit contacting slanting geological structures and being forced from its true vertical course. When drilling a deep oil well by the rotary method, the drill bit is secured to the lower end of one or more drill collars and the drill collars are in turn suspended from a long string of drill pipe. The drill collars are tubular members, usually approximately thirty feet in length, and are substantially heavier and more rigid than the regular drill pipe. In the event the drill bit is forced from a true vertical direction during the drilling operation, the drill collars will contact the side of the well bore and tend to remain in a vertical position. When this occurs, continued rotation of the drilling string will cause the drill collars to rub the side of the well bore and form a smaller bore in the earth slightly off-set from the well bore formed by the drill bit. These off-set bores formed by the drill collars are commonly known as "key-seats."

When a drill bit is being removed from a well bore containing one of these key seats, the bit frequently becomes lodged therein to prevent immediate removal of the complete drilling string from the well bore. The usual practice, when such a condition occurs, is to disjoint the drill pipe and a portion of the drill collars for removal from the well bore, while leaving the drill bit and one or more drill collars lodged in the key seat. Subsequently, a string of wash-over pipe of larger diameter than the drill collars and having a reamer on the lower end thereof is run into the well bore over the remaining drill collars. The wash-over pipe is rotated and moved downwardly over the drill collars to ream out the key seat and free the drill bit. Usually the drill bit and connected drill collars then fall to the bottom of the well bore, causing excessive damage both to the drill bit and drill collars. This, of course, requires a subsequent "fishing" operation to remove the damaged drill collars and drill bit.

The present invention contemplates a novel mechanism for reaming out key seats and simultaneously clamping the lodged drill collars. The present mechanism engages the uppermost drill collar prior to the reaming of the key seat. Thus, when the key seat is reamed out and the drill bit is dislodged, the drill collars and drill bit are held in the well bore and prevented from falling to the bottom of the well. Subsequently, the drill collars and drill bit may be conveniently removed from the well bore. In the event the crooked well bore unduly restricts upward movement of the previously dislodged drill bit and drill

collars, the drill collars and bit may be lowered to the bottom of the well bore and the retrieving mechanism disconnected and removed from the well bore. A stronger drill collar retrieving tool may then be run into the well bore for removing the dislodged drill collars and bit.

The present invention also contemplates a novel slip joint apparatus for use in combination with the drill collar dislodging and retrieving mechanism. The slip joint apparatus permits a continuous reaming action for dislodging a stuck drill bit during the connection of additional drill pipe to the reaming string without the loss of previously obtained footage.

An important object of this invention is to provide an improved drill collar recovery mechanism for dislodging stuck drill collars and drill bits while simultaneously preventing downward movement of the lodged collars and bit.

Another object of this invention is to provide an improved mechanism for continuous reaming around lodged drill collars in a well bore during the addition of drill pipe to the reaming string.

Another object of this invention is to provide a novel mechanism for dislodging stuck drill collars and bits in well bores and for lowering the dislodged drill collars and bits to the bottom of the well bore without damage.

A further object of this invention is to provide a mechanism for retrieving stuck drill collars from a key-seated recess of a well bore and catching and holding the drill collars substantially in position as they are loosened during the retrieving operation.

A still further object of this invention is to provide a mechanism for remaining around a stuck drill bit in a well bore and catching the drill bit when it becomes dislodged by the reaming operation.

An additional object of this invention is to provide a mechanism for reaming around a drill bit lodged in a key-seated recess of a well bore and lowering the dislodged drill bit to the bottom of the well bore, which may be efficiently and simply disconnected from the drill bit at the bottom of the well bore.

Other objects and advantages of the invention will be evident from the following detailed description, read in conjunction with the accompanying drawings, which illustrate my invention.

In the drawings:

Figure 1 is a sectional elevational view of a typical well bore having a drilling string therein.

Figure 2 is a cross sectional view taken along lines 2—2 of Fig. 1.

Figure 3 is another vertical sectional view of a typical well bore having a drill bit lodged therein and illustrating an early step in the reaming operation for dislodging the drill bit and collars.

Figure 4 is a cross sectional view taken along lines 4—4 of Fig. 3.

Figure 5 is a view similar to Fig. 3 illustrating a continuation of the action of reaming around a lodged drill bit and drill collars.

Figure 6 is a view similar to Fig. 5 illustrating a still further step in the reaming operation.

Figure 7 is a cross sectional view taken along lines 7—7 of Fig. 6.

Figure 8 is a cross sectional view taken along lines 8—8 of Fig. 6.

Figure 9 is a cross sectional view taken along lines 9—9 of Fig. 6.

Figure 10 is a cross sectional view taken along lines 10—10 of Fig. 6.

Figure 11 is a vertical sectional view of a novel slip joint utilized in the present recovery mechanism.

Figure 12 is a vertical sectional view of a wash-over

pipe and novel means for engaging a drill collar lodged in the well bore.

Figure 13 is a vertical sectional view of the engaging means shown in Fig. 12 coupled to a drill collar.

Figure 14 is a vertical sectional view illustrating the separation of the drill collar engaging means to permit removal of the wash-over pipe, with certain parts depicted larger for clarity.

Figure 15 is a vertical sectional view of a retrieving mechanism for recovering a portion of the drill collar engaging means.

Referring to the drawings in detail, and particularly Figs. 1 to 4, reference character **2** designates a typical well bore having a string of drill pipe **4** disposed therein. The drill pipe **4** is coupled at **6** to a string of drill collars **8** which in turn have a drill bit **10** secured on the lower end thereof. The drill collars **8** are rigid tubular members and tend to remain vertical in the well bore **2**, whereas the drill pipe **4** will tend more to conform to the contour of the well bore **2**. The number of drill collars **8** will vary with the depth of well being drilled, as well as the type of formation encountered, and frequently will attain an accumulated length of six hundred feet or more. The well bore **2** is preferably vertical, but as set forth above, it frequently deviates from the vertical when the drill bit **10** encounters tilted geological formations. Typical variations in the well bore **2** are shown at **12** and **14**. When the well bore **2** deviates from the vertical, the drill collars **8** will rub against the side of the well bore **2** and form an off-set recess such as that shown at **16** in Fig. 2. The off-set recess or key-seat **16** communicates with the well bore **2** and is of smaller diameter than the well bore **2**. Thus, when the drill bit **10** is being removed from the bore **2**, it will frequently become lodged in the key-seat **16** in the manner illustrated in Fig. 4 and the lower portion of Fig. 3. When the drill bit **10** becomes lodged in this manner, it is prevented from being removed from the well bore **2**. It then becomes necessary to disconnect the drill pipe **4** from the drill collars **8** and remove the drill pipe **4** from the well bore **2**. Access may then be gained to the drill collars **8** and drill bit **10** for reaming out the key-seat **16** and dislodging the drill bit **10** by use of a suitable wash-over string.

In the present invention, a string of wash-over pipe **18**, having a greater diameter than the drill collars **8** and having a suitable reamer **20** on the lower end thereof, is run into the well bore **2** for dislodging the drill bit **10**. The wash-over pipe **18** is coupled to the lower end of a string of drill pipe **4** by means of a novel slip joint mechanism generally indicated at **22** and shown in detail in Fig. 11. As is well known in rotary drilling, drilling fluid is circulated from the top of the well through the drilling string to assist in removing the cuttings made by the drill bit at the end of the drill string through the annulus between the drilling string and the well bore. In utilizing a wash pipe in a fishing operation of a stuck drill collar, fluid is circulated through the drilling string and wash pipe and discharged therefrom at the reaming shoe in order to assist the reaming action and wash away or dispose of the key seat recess and thereby loosen the stuck drill collars. The use of a slightly larger pipe for reaming a stuck drill collar in conjunction with fluid circulating therethrough has been termed a "washed-over pipe or string" and is well known in the oil industry.

The slip joint mechanism **22** comprises an upper tubular sub **24** having internal threads **26** in the upper end thereof to receive the pin **28** of the lowermost drill pipe joint **4**. The lower portion **30** of the sub **24** is enlarged and provided with large internal threads **32** to receive the upper threaded end **34** of a connecting member **36**. The central portion of the connecting member **36** is of the same external diameter as the lower portion **30** of the upper sub **24** and the upper end **34** is of reduced diameter for entering the sub **24** and engaging the threads **32**. Suitable spaced packing rings **38** are provided in the outer

periphery of the upper end **34** to contact the opposite ends of the threads **32** and prevent the entrance of flushing fluid to the threads **32**. The shoulder **40** on the connecting member **36** at the lower end of the portion **34** is tapered to provide a vertical projection **42**. The lower face **44** of the upper sub **24** is tapered in a similar manner to provide an opposite facing shoulder **46** to engage the shoulder **42**. It will be apparent that the shoulders **42** and **46** will limit the extent to which the connecting member **36** may be threaded into the upper sub **24**. The shoulders **42** and **46** are located in such a manner as to retain the member **34** loosely threaded into the threads **32** for purposes as will be hereinafter set forth. The lower end **48** of the connecting member **36** is also reduced in diameter and provided with external threads **50** for connecting with the upper internally threaded end **52** of a sleeve member **54**. The sleeve **54** extends downwardly from the connecting member **36** and is provided with external threads **56** on the lower end thereof for connection with the wash-over pipe **18**.

A tubular mandrel **58** extends partially through the slip joint **22** and is threadedly connected at its upper end **60** to an intermediate portion of the upper sub **24**. The mandrel **58** extends downwardly through the upper sub **24** and connecting member **36** into the sleeve member **54**. A head **62** is threadedly secured on the lower end of the mandrel **58**. The outer diameter of the head **62** is substantially equal to the inner diameter of the sleeve **54** to provide a sliding fit. A packing ring **64** is secured in the outer periphery of the head **62** adjacent the lower end thereof to provide a seal between the head **62** and the inner periphery of the sleeve **54**. The packing ring **64** prevents passage of flushing fluid upwardly around the head **62** and into the threads **50** of the connecting member **36**. Projections **66** extend upwardly from the upper end of the head **62**, and mating projections **68** extend downwardly from the lower portion **48** of the connecting member **36**. The projections **66** and **68** are adapted to engage one another upon operation of the slip joint **22** as will be hereinafter set forth.

The wash-over pipe **18** extends downwardly from the slip joint **22** and has a spear mechanism generally indicated at **70** (see Fig. 12) in the lower portion thereof immediately above the reamer **20** for engaging the upper end of the drill collars **8**. The spear **70** comprises a tubular mandrel **72** disposed concentrically in the wash-over pipe **18**. The upper end **74** of the mandrel **72** is externally threaded to receive a cap **76**. A downwardly and inwardly tapered bore **78** is provided in the top of the cap **76** in alignment with the mandrel **72**.

A tubular slip shoe **80** is loosely disposed on the mandrel **72** immediately below the cap **76**. A vertical slot **82** is provided in the inner periphery of the slip shoe **80** at the lower end thereof and a mating slot **84** is provided in the outer periphery of the mandrel **72** to receive a key **86**. The key **86** thus prevents rotative movement of the shoe **80** relative to the mandrel **72** and contacts the upper end of the slot **82** to prevent downward movement of the shoe **80**. The cap **76** limits the upward movement of the shoe **80**. A plurality of downwardly and inwardly tapered surfaces **88** are provided on the outer periphery of the slip shoe **80** to receive serrated slips **90**. The slips **90** and tapered surfaces **88** are preferably provided with the usual dove-tail groove and key (not shown) to retain the slips **90** in a vertical position on the surfaces **88** and to permit vertical movement of the slips **90** over the surfaces **88**.

A suitable link **92** is pinned to the lower end of each slip **90** and extends downwardly therefrom along the mandrel **72**. Each link **92** is in turn pinned at its lower end to a tubular cage member **94**. The cage member **94** is loosely disposed on the mandrel **72** and is provided with a plurality of circumferentially spaced vertical slots **96** in the outer periphery thereof. Each slot **96** contains a friction dog or friction shoe **98** for contacting the inner

periphery of the washover pipe **18**. Suitable helical springs **100** are provided in each slot **96** to continuously urge the respective friction dog **98** outwardly into contact with the wash-over pipe **18**. Transverse retaining pins **102** are provided in the upper and lower ends of each slot **96** and extend through longitudinal slots **104** in the friction dogs **98** to retain the dogs **98** in the slots **96**.

The mandrel **72** extends on downwardly beyond the cage member **94** and has a head **106** thereon adjacent the lower end **108**. A weak helical spring **109** is disposed on the mandrel **72** between the cage **94** and head **106** to support the cage **94** and assist in the actuation of the slips **90** as will be more fully hereinafter set forth. External threads **110** are provided on the head **106** to receive the upper threaded end **112** of a lower tubular shaped cage member **114**. A plurality of dogs **116** are retained in the cage **114** by a circular contraction spring **118**. Each dog **116** has an inwardly projecting shoulder **119** substantially opposite the spring **118** extending inwardly beyond the inner diameter of the mandrel **72** and having its inner face tapered downwardly and inwardly. The dogs **116** are adapted to expand the contraction spring **118** and each dog is provided with an upwardly and inwardly projecting seat **120** on the lower end thereof to engage the head **122** of a spear **124**. The spear head **122** normally extends into the dog members **116** as shown in Fig. 12 and the upper end thereof is provided with external left hand threads **126** for purposes as will be hereinafter set forth.

The spear **124** extends downwardly from the dog members **116** through an aperture **128** provided in the lower end of the cage member **114**. The aperture **128** communicates with a flared opening **128***a* provided on the bottom face of the cage member **114** to guide and facilitate ease of entry of the spear head **122** into the cage member **114**. The spear **124** is provided with a central bore **124***a* extending longitudinally therethrough and communicates with the aperture provided by the shoulders **119** in the dogs **116**, and the central bore **108** of the apertured mandrel **72** in order to maintain fluid circulation through the retrieving tool. A thrust bearing **130** is provided on the spear **124** slightly below the cage member **114** to accommodate vertical thrusts on the spear **124** during the recovery operation. An annular guard **132** is loosely disposed on the spear **124** between the thrust bearing **130** and the lower end of the cage member **114** to protect the thrust bearing **130**. The lower end **134** of the spear **124** is provided with a plurality of circumferentially spaced tapered surfaces **136** to receive slip members **138**. The tapered surfaces **136** extend downwardly and outwardly to urge the slips **138** outwardly when moved in a downward direction. The tapered surfaces **136** and slip members **138** are preferably provided with the usual interfitting dove tail key and groove (not shown) to retain the slips **138** in position. Right hand threads **140** are provided on the outer surface of the slip members **138** for connection with the upper end **6** of the upper drill collar **8** as will be hereinafter set forth.

Suitable links **142** are pinned to the upper end of each slip member **138** and extend upwardly therefrom. The upper end of each link **142** is pinned to a ring or collar **144** loosely disposed on the spear **124**. The collar **144** is provided to align the links **142** and to distribute any downward force imposed thereon equally between the slip members **138**. A helical compression spring **146** surrounds the spear **124** above the collar **144**. The spring **146** is anchored at its lower end to the collar **144** and at its upper end to a circumferential shoulder **148** which is rigidly secured on the spear **124**. The length of the spring **146** is such that the spring constantly urges the collar **144** and slips **138** in a downward direction. It will be apparent that the thrust of the spring **146** urges the slips **138** constantly downward and it is not necessary that the slips **138** be rotatably threaded into the box **150**, but may be thrust therein by continued downward movement of the slips **138** into the box **150**, thereby providing the make-up connection with the drill collars **6**.

Operation

With the slip joint **22** interposed between the drill pipe **4** and wash-over pipe **18**, and the joint spear mechanism **70** in the lower portion of the wash-over pipe **18**, the entire wash-over string is rotated clockwise and lowered in the well bore **2** toward the stuck or lodged drill collars **8** and drill bit **10**. Up until the time the reamer **20** reaches the top of the uppermost drill collar **8**, the friction dogs **98** (Fig. 12) are engaged with the inner surface of the washover pipe **18** and provide a simultaneous rotation of the spear mechanism **70** and the wash-over pipe **18**. The slips **90** are engaged with the wash-over pipe **18** when the wash-over string is run into the well bore **2**. The reamer **20** is only slightly larger than the diameter of the well bore **2** and will move readily through the well bore **2** to envelop the drill collars **8**.

During the initial movement of the wash-over pipe **18** and reamer **20** over the top **6** of the uppermost drill collar **8**, the threaded slips **138** at the lower end of the spear mechanism **70** will engage the usual threaded box **150** of the drill collar **8**. The entire wash-over string is rotating in a clockwise direction at this time and the downward force of the wash-over pipe **18** being transmitted through the friction dogs **98**, dog cage **94**, links **92**, slips **90**, key **86**, mandrel **72**, cage member **114** and guard **132** to the thrust bearing **130** will tend to rotate the spear **124** (and hence the slips **138**) until the slips **138** become threaded snugly into the box **150** as shown in Fig. 13. This provides a connection between the threaded segmental slips **138** acting as a pin member and the box **150** of the drill collars **8** to provide a quick connection therebetween. This is commonly termed in the oil industry a make up connection or grappling connection. When the slips **138** have been completely threaded into the drill collar box **150**, the cage member **114** and dogs **116** will rotate around the spear **124**, thereby obtaining a swivel action. This swivel action will permit rotation of the cage **114** around the spear **124** which is now stationary due to its connection with the lodged drill collar box **150**.

During this threading operation, the wash-over pipe **18** continues moving downward over the drill collars **8**, and the friction dogs **98** will move upward relative to the wash-over pipe **18** while simultaneously rotating with the wash-over pipe **18**. The downward force thus imposed on the friction dogs **98** will retain the upper slips **90** in a retracted position on the slip shoe **80** and out of engagement with the inner surface of the wash-over pipe **18**. However, should the drill collars **8** become free and tend to fall in the well bore **2**, the movement thereof would be transmitted through the slips **138**, spear **124**, dogs **116**, cage member **114**, and mandrel **72** to the upper slip shoe **80**. Since the upper slips **90** are held by the friction dogs **98** and the dogs **98** are in turn frictionally engaged by the wash-over pipe **18**, the slip shoe **80** would move downwardly through the slips **90** and move the slips **90** outward into engagement with the wash-over pipe **18**. Thus, the drill collars **8** would be stopped in their downward movement and prevented from falling to the bottom of the well bore **2**.

The drill collars **8**, as previously noted, are frequently as much as six hundred feet in length and may be lodged at extreme depths, therefore several joints of drill pipe **4** and wash-over pipe **18** must be utilized to move the reamer **20** over the complete length of the drill collars **8**. The slip joint **22** (Fig. 11) facilitates the addition of drill pipe **4** to the wash-over string and permits retention of the footage drilled or reamed, as will now be shown.

When an additional joint of drill pipe **4** is required, the wash-over string is stopped from rotating in a clockwise direction and then rotated a few turns counter-clockwise,

whereupon the kelly (not shown) at the top of the well bore 2 is raised through the rotary table (not shown) by means of the usual rotary drilling apparatus (not shown). The counter-clockwise rotation of the kelly is transmitted down through the drill pipe 4 to the upper sub 24 of the slip joint 22. Simultaneously, the reamer 20 will be more or less embedded in the walls of the well bore 2, thereby resisting rotative movement. Thus, the reamer 20, wash-over pipe 18, and sleeve 54 and connecting member 36 of the slip joint 22 will tend to remain stationary. The loosely threaded connecting member extension 34 and threads 32 will then become disengaged to free the connecting member 36 from the upper sub 24.

As the kelly and drill pipe 4 are subsequently raised, the upper sub 24 will be lifted off of the connecting member 36 and move the mandrel head 62 upwardly within the sleeve 54. The heavy wash-over pipe 18 will, of course, remain stationary and hold the sleeve 54 and connecting member 36 stationary. When the kelly has been raised sufficiently to insert another joint of drill pipe 4 in the wash-over string, the mandrel head 62 will have been moved into the upper end of the sleeve 54 to bring the lugs 66 and 68 into engagement. Therefore, the entire wash-over string may be rotated after the slip joint 22 is expanded, if desired. Rotative movement of the drill pipe 4 will be transmitted down through the upper sub 24, mandrel 58, mandrel head 62, lugs 66 and 68, connecting member 36 and sleeve 54 to the wash-over pipe 18 and reamer 20.

When the additional joint of drill pipe 4 is inserted in the wash-over string, the kelly is lowered through the rotary table to lower the drill pipe 4 and upper sub 24 until the lower end of the course threads 32 contact the upper end of the connecting member extension 34. The kelly and drill pipe 4 are then again rotated clockwise to thread the upper sub 24 onto the connecting member extension 34. It will be noted that the reamer 20 and wash-over pipe 18 will be held by the walls of the bore 2 to resist rotation of the sleeve 54 and connecting member 36. The threading action continues until the shoulders 42 and 46 of the connecting member 36 and upper sub 24 are in contacting relation, whereupon the clockwise rotation of the drill pipe 4 and upper sub 24 is again transmitted to the connecting member 36, sleeve 54, wash-over pipe 18 and reamer 20. The shoulders 42 and 46 are arranged to contact before the extension 34 is tightly engaged with the threads 32, thereby providing the loosest connection in the wash-over string to facilitate the subsequent addition of drill pipe 4.

It is to be noted that the reamer 20 is not moved upwardly when drill pipe 4 is added, therefore the footage previously reamed is retained and the usual cave-ins of the well bore 2 caused by a retracting movement of the reamer 20 are averted. In addition, only the drill pipe 4 and a portion of the slip joint 22 are raised by the drilling apparatus to add drill pipe 4 to the wash-over string. Also, the spear joint mechanism 70 (Fig. 12) remains in engagement with the upper drill collar 8 and is not affected by the addition of drill pipe 4. It will be apparent that any upward movement of the wash-over pipe 18 would cause an upward movement of the friction dogs 98 with a consequent actuation of the upper slips 90.

The reaming of the well bore 2 is continued, with a periodic addition of drill pipe 4, until the key seat 16 (see Fig. 4) is reamed out and the drill collars 8 and drill bit 10 are dislodged. When the drill collars 8 are freed, they will, of course, attempt to fall to the bottom of the well bore 2. The downward movement of the drill collars 8 is transmitted through the spear joint slips 138 (Fig. 12), spear 124, dogs 116, cage member 114, mandrel 72 and cap 76 to the slip shoe 80. Since the slips 90 will be retained in a fixed vertical position by the friction dogs 98 and wash-over pipe 18, the slip shoe 80 will move downwardly through the slips 90 and move the slips 90 outward into engagement with the wash-over pipe 18. Thus, the wash-over pipe 18 will be connected to the drill collars 8 to prevent further downward movement of the drill collars 8 and drill bit 10. The extent of downward movement of the drill collars 8 (upon being dislodged) necessary to actuate the joint spear mechanism 70 is small, therefore, the force imposed on the wash-over string by stopping the downward movement of the drill collars 8 and drill bit 10 is reduced to a minimum.

When the drill collars 8 and drill bit 10 are dislodged, the wash-over string is removed from the well bore 2 and the drill collars 8 will be simultaneously withdrawn to resume the normal drilling operations without having lost or damaged the drill collars 8 and drill bit 10. However, the well bore 2 may not have been reamed completely clean by the reamer 20 and upward movement of the drill collars 8 and drill bit 10 may again be resisted by the deformed well bore 2. Although lesser resistance may exist than was provided by the key seat 16, the wash-over pipe 18 and spear mechanism 70 is not adapted to pull the drill collars 8 upwardly against any appreciable resistance. Therefore, the wash-over string is lowered to bring the drill bit 10 gently to rest on the bottom of the well bore 2, whereupon the spear mechanism 70 is disjointed to permit removal of the wash-over string and subsequent use of stronger recovery tools.

The spear mechanism 70 (see Fig. 14) is disjointed by use of an elongated releasing plug 160 having its lower end 162 rounded and its upper end 164 reduced and threaded. A circumferential shoulder 166 is provided on the plug 160 immediately below the threaded end 164. In operation, the releasing plug 160 is inserted into the upper end of the wash-over string and allowed to drop downwardly through the drill pipe 4, slip joint 22 and wash-over pipe 18 into contact with the spear mechanism 70.

As the lower rounded end 162 of the plug 160 reaches the cap 76, it is giuded by the tapered wall aperture 78 into the mandrel 72. The plug 160 slides freely by gravity through the mandrel 72 until the lower end 162 contacts the inwardly projecting shoulders 119 of the holding dogs 116. The force imposed upon the shoulders 119 by the plug 160 expands the spring 118 and consequently expands the seat 120 formed by the dogs 116. The dogs 116 will then be disengaged from the head 122 of the spear 124. The plug 160 comes to rest when the shoulder 166 contacts the lower end of the tapered wall aperture 78 of the cap 76. In the rest position of the plug 160, it remains in contact with the shoulders 119 and retains the dogs 116 in a retracted position. The wash-over string may then be freely withdrawn from the well bore 2. The seat 120 and aperture 128 will move over the spear head 122 while the spear 124 remains in the well bore 2 connected to the drill collars 8.

A spear recovery tool (generally indicated at 170 and shown in detail in Fig. 15) is then secured in tandem relation on the lower end of the drill pipe 4 and run into the well bore 2 to recover the spear 124 and provide access to the drill collars 8 for a suitable overshot (not shown) of the usual type. The spear recovery tool 170 comprises an elongated member 172 having a longitudinal bore 173 therethrough and internal threads 174 in the upper end of the bore 173 to receive the pin 176 of the lowermost joint of drill pipe 4. Left hand threads 178 are provided in the lower portion of the bore 173 and the walls of the bore 173 are tapered outwardly from the threads 178 to the lower end 180 of the member 172.

The medial portion of the member 172 is provided with external threads 182 to receive the upper threaded end 184 of a sleeve 186. The sleeve 186 extends downwardly around the member 172 and below the lower end 180 thereof. A suitable reaming shoe 188 is threadedly secured on the lower end 190 of the sleeve 186.

As previously noted, the spear recovery tool 170 is run into the well bore 2 on the lower end of a string of the drill pipe 4. The reaming shoe 188 will ream out any cave-

ins or the like occurring after removal of the wash-over pipe 18 and will follow the bore previously formed by the reamer 20 and wash-over pipe 18. The tool 170 is rotated counter-clockwise as it is lowered in the well bore 2, and when it reaches the spear 124, the threads 178 are engaged with the left hand threaded spear head 122. The slips 138 were threaded into the box 150 of the uppermost drill collar 8 by action of the friction dogs 98 in the spear mechanism 70, whereas the drill pipe 4, recovery tool 170, and drill collars 8 were necessarily threaded together by suitable tools at the surface of the well. Thus, the slips 138 will be the loosest connection remaining in the drill collar string. Therefore, when the member 172 is tightly engaged with the spear head 122 by a counter-clockwise rotation, the slips 138 will be unthreaded from the box 150. The spear 124 and recovery tool 170 may then be freely removed from the well bore 2 and provide access to the uppermost drill collar 8 for subsequent use of a strong overshot (not shown) of any suitable type for removing the drill collars 8 and drill bit 10 from the well bore 2.

As previously noted, the drill collars 8 may be numerous and attain an overall length of as much as six hundred feet. Frequently, not enough wash-over pipe 18 is available to extend over all of the drill collars 8, or the operator is not permitted to use enough wash-over pipe to ream over all of the drill collars 8 in one operation. When either of these conditions exist, the wash-over pipe 18, with the spear mechanism 70 therein, is run over the top of the stuck drill collars 8 in the manner described above until only a portion of the drill collars 8 have been reamed out. The wash-over pipe 18 is then removed from the well bore 2, leaving the spear 124 secured in the uppermost drill collar 8. The spear recovery tool 170 may then be inserted in the well bore 2 to remove the spear 124 as described above; whereupon a reversing tool (not shown) is run into the well bore 2 and the drill collars 8 which have been reamed around may be disconnected from the remainder of the drill collars 8 and removed from the well. The entire operation of reaming and holding the drill collars 8 is repeated until all the drill collars 8 and drill bit 10 have been dislodged and removed from the well bore 2. It should also be noted that the wash-over string may be readily removed in the manner set forth above when it is necessary to replace a worn reamer 20.

It will be apparent that the fishing apparatus disposed in the wash pipe 18 will permit fluid circulation through the drilling string 4, 8 and the wash pipe 18 as is well known in the usual manner. The retrieving or fishing apparatus is provided with apertured mandrel or tubular portions 72 communicating with the bore 124*a* in the spear member 124 to maintain and assure fluid circulation through the fishing apparatus.

From the foregoing, it is apparent that the present invention provides a novel drill collar recovery mechanism wherein stuck or lodged drill collars and drill bits may be dislodged and prevented from falling to the bottom of the well bore. The drill collars are engaged at the beginning of the reaming operation and are held in position by the mechanism until the key seat or seats are removed to permit free removal of the drill collars from the well bore. Also, the entire mechanism may be efficiently disengaged from the drill collars to permit a removal of a portion of the drill collars in the event sufficient wash-over pipe is not available or cannot be used. In addition, drill pipe may be easily and efficiently added to the wash-over string without raising the wash-over pipe or disconnecting the recovery mechanism from the stuck drill collars.

Changes may be made in the combination and arrangement of parts as heretofore set forth in the specification and shown in the drawings, it being understood that any modification in the precise embodiment of the invention may be made within the scope of the following claims without departing from the spirit of the invention.

I claim:

1. An apparatus for retrieving drill collars lodged in a well bore, comprising a string of wash-over pipe of a size to be inserted in the well bore and telescoped over the drill collars, a tubular reamer on the lower end of the wash-over pipe of a size to ream around the drill collars, a string of drill pipe, and a slip joint unit interconnecting the drill pipe and wash-over pipe, said slip joint comprising an internally threaded upper tubular sub secured to the drill pipe, said slip joint having a lower sub portion secured to the wash-over pipe and having a threaded extension of a size to extend into the upper sub, and means to prevent complete separation of the slip joint.

2. An apparatus for retrieving lodged drill collars in a well bore, comprising a string of drill pipe, a string of wash-over pipe of a size to be inserted in the well bore and telescoped over the drill collars, a slip joint unit interconnecting the drill pipe and wash-over pipe providing for raising the drill pipe without raising the wash-over pipe, means in the wash-over pipe to engage the drill collars when the wash-over pipe is telescoped thereover, and a reamer on the lower end of the wash-over pipe to ream around and dislodge the drill collars.

3. An apparatus for retrieving drill collars lodged in a well bore, comprising a string of wash-over pipe of a size to be inserted in the well bore and telescoped over the drill collars, a fishing tool mechanism supported in the lower portion of the wash-over pipe, said fishing tool mechanism comprising an upper pipe gripping section and a lower spear section rotatably secured thereto, outwardly extending dogs on the upper pipe gripping section frictionally engaging the inner periphery of the wash-over pipe, slip means carried by the upper pipe gripping section and connected to said dogs for engaging the inner periphery of the wash-over pipe, and a threaded head on the lower end of the lower spear section of a size to threadedly engage the upper end of the uppermost drill collar.

4. An apparatus for retrieving drill collars lodged in a well bore, comprising a string of wash-over pipe of a size to be inserted in the well bore and telescoped over the drill collars, a tubular reamer on the lower end of the wash-over pipe of a size to ream around the drill collars, a fishing tool mechanism supported in the lower portion of the wash-over pipe, said fishing tool mechanism comprising an upper pipe gripping section and a lower spear section rotatably secured thereto, outwardly extending dogs on the upper pipe gripping section frictionally engaging the inner periphery of the wash-over pipe, slip means carried by the upper pipe gripping section and connected to said dogs for engaging the inner periphery of the wash-over pipe, and a threaded head on the lower end of the lower spear section of a size to threadedly engage the upper end of the uppermost drill collar.

5. An apparatus for retrieving drill collars lodged in a well bore, comprising a string of wash-over pipe of a size to be inserted in the well bore and telescoped over the drill collars, and a fishing tool mechanism in the lower portion of the wash-over pipe, said fishing tool mechanism comprising a tubular mandrel, friction blocks carried by the mandrel for frictionally engaging the inner periphery of the wash-over pipe, a slip shoe carried by the mandrel having downwardly and inwardly tapered sides, slips carried by the shoe on said tapered sides, links connecting the slips to the friction blocks whereby said slips will be moved outwardly to grip the wash-over pipe upon downward movement of the shoe in the wash-over pipe, and a downwardly extending spear rotatably carried by the mandrel and having means for providing a connection with the uppermost drill collar.

6. An apparatus for retrieving drill collars lodged in a well bore comprising a wash-over pipe of a size to be

inserted in the bore, a tubular reamer on the lower end of the wash-over pipe of a size to surround the drill collars, a fishing tool unit carried in the lower portion of the wash-over pipe, said fishing tool unit comprising make up means to provide a make up connection between the fishing tool unit and the drill collars, and pipe gripping means for engagement with the wash-over pipe and connected with the make up means, said gripping means including means operable responsive to downward movement of the wash-over pipe after the make up means have been connected to said lodged drill collars for maintaining the gripping means in position to permit continued downward movement of the wash-over pipe and reamer substantially below the make up connection, and means cooperating with the gripping means for moving said gripping means into gripping engagement with the wash-over pipe upon a downward movement of the loosened drill collars and fishing tool unit relative to the wash-over pipe.

7. An apparatus for retrieving drill collars lodged in a well bore comprising a wash-over pipe of a size to be inserted in the bore, a fishing tool unit carried in the lower portion of the wash-over pipe, said fishing tool unit comprising make up means to provide a make up connection between the fishing tool unit and the drill collars, and pipe gripping means for engagement with the pipe and connected with the make up means, said gripping means including means operable responsive to downward movement of the wash-over pipe after the make up means has been connected to the drill collars for maintaining the gripping means in position to permit continued downward movement of the wash-over pipe substantially below the make up connection, and means cooperating with the gripping means for moving said gripping means into gripping engagement with the wash-over pipe upon a downward movement of the loosened drill collars and fishing tool unit relative to the wash-over pipe.

8. An apparatus for retrieving drill collars lodged in a well bore, comprising a string of wash-over pipe of a size to be inserted in the well bore and telescoped over the drill collars, a tubular reamer on the lower end of the wash-over pipe of a size to ream around the drill collars, a fishing tool mechanism in the lower portion of the wash-over pipe, said fishing tool mechanism comprising a tubular mandrel, support means carried by the mandrel for engaging the wash-over pipe, a dog cage on the lower end of the mandrel having an aperture in the lower end thereof in alignment with the mandrel, a spear extending loosely through said aperture, means for connecting one end of the spear with the uppermost drill collar, a head on the upper end of said spear of a size to move through said aperture, a plurality of radially movable dogs in said cage, retractable spring means urging said dogs radially inward into engagement with said head to retain the head in said cage, each of said dogs having a projection extending inwardly above said head into alignment with the inner diameter of the mandrel, said projections responsive to engagement with a releasing plug whereby said dogs will move radially outwardly in said cage for releasing the spear head.

9. An apparatus for retrieving drill collars lodged in a well bore, comprising a string of wash-over pipe of a size to be inserted in the well bore and telescoped over the drill collars, a tubular reamer on the lower end of the wash-over pipe of a size to ream around the drill collars, a fishing tool mechanism in the lower portion of the wash-over pipe, said fishing tool mechanism comprising a tubular mandrel, a plurality of friction shoes carried by the mandrel engaging the inner periphery of the wash-over pipe, a plurality of slips carried by the mandrel and operable by the friction shoes for engaging the wash-over pipe upon downward movement of the mandrel relative to the wash-over pipe, a dog cage secured on the lower end of the mandrel, a spear extending loosely into the cage, means for connecting one end of the spear with the uppermost drill collar, a plurality of spring urged dogs in the cage engaging the spear, each of said spring urged dogs extending inwardly into alignment with the inner diameter of the mandrel, said dogs responsive to a releasing plug dropped through the mandrel for urging the dogs outwardly and providing disengagement with the spear.

10. An apparatus for retrieving drill collars lodged in a well bore comprising a wash-over pipe of a size to be inserted in the bore, a fishing tool unit carried in the lower portion of the wash-over pipe, said fishing tool unit comprising make up means to provide a make up connection between the fishing tool unit and the drill collars, and pipe gripping means for engagement with the pipe and connected with the make up means, said gripping means including means operable responsive to downward movement of the wash-over pipe after the make up means has been connected to the drill collars for maintaining the gripping means in position to permit continued downward movement of the wash-over pipe substantially below the make up connection, and also responsive to downward movement of the make up means and drill collars relative to the wash-over pipe for moving the gripping means into engagement with the wash-over pipe.

11. In an apparatus for retrieving stuck drill collars in a well bore comprising in combination a drill string having a wash-over pipe carried at the lower end thereof, a reamer shoe on the wash-over pipe and a fish retrieving mechanism carried in the wash-over pipe, said fish retrieving mechanism comprising slip means for providing engagement of the fish retrieving mechanism with the wash-over pipe during a lowering of the wash-over pipe into the well bore and a spear mechanism connected to said slip means adapted to be engaged with the stuck drill collars, means providing for disengagement of the slip means from the wash-over pipe during the reaming operation of the reaming shoe around the stuck drill collars operative responsive to movement of the drill collars upon loosening thereof to cause a substantially contemporaneous re-engagement of the slip means with the wash-over pipe with the loosening of the collars.

12. In an apparatus for retrieving stuck drill collars in a well bore comprising in combination a drill string having a wash-over pipe carried in the lower end thereof, a reamer shoe on the wash-over pipe and a fish retrieving mechanism carried in the wash-over pipe, said fish retrieving mechanism comprising slip means for providing engagement of the fish retrieving mechanism with the wash-over pipe during a lowering of the wash-over pipe into the well bore and a spear mechanism releasably connected to said slip means adapted to be engaged with the stuck drill collars, means providing for disengagement of the slip means from the wash-over pipe during the reaming operation of the reaming shoe around the stuck drill collars operative responsive to movement of the drill collars upon loosening thereof to cause a substantially contemporaneous re-engagement of the slip means with the wash-over pipe with the loosening of the collars, and means providing for disengagement of the spear mechanism of the fish retrieving mechanism from the remainder of the unit carried in the wash-over pipe.

13. An apparatus for retrieving drill collars lodged in the well bore comprising in combination a string of wash-over pipe adapted to be telescoped over the lodged drill collars, and a tubular reamer on the lower end of the wash-over pipe of a size to ream around drill collars, and a fishing tool mechanism carried in the lower portion of the wash-over pipe, said fishing tool mechanism comprising an upper pipe gripping means and a lower spear section connected thereto, means provided in the spear section for connecting the spear section with the uppermost drill collar, means to provide a swivel connection between the spear section and the upper pipe gripping means to permit continued downward movement of the wash-over pipe after connection of the fishing tool mechanism with

the drill collars, means provided in the upper pipe gripping means operable responsive to the downward movement of the wash-over pipe after connection of the spear section of the fishing tool mechanism with the drill collars to release the upper pipe gripping means supporting the fishing tool mechanism in the wash-over pipe, said releasing means provided in the upper pipe gripping means of the fishing tool mechanism also operable responsive to initial movement of the drill collars due to dislodgement thereof for instantaneously re-engaging the first mentioned means with the wash-over pipe.

14. An apparatus for retrieving drill collars lodged in the well bore comprising in combination a string of wash-over pipe adapted to be telescoped over the lodged drill collars, and a tubular reamer on the lower end of the wash-over pipe of a size to ream around drill collars, and a fishing tool mechanism carried in the lower portion of the wash-over pipe, said fishing tool mechanism comprising an upper pipe gripping section and a lower spear section releasably connected thereto, means provided in the pipe gripping section engageable with the wash-over pipe for supporting the fishing tool mechanism in the wash-over pipe during a lowering thereof into the well bore, means provided in the spear section for connecting the spear section with the uppermost drill collar, means

to provide a swivel connection between the spear section and the upper pipe gripping section to permit continued downward movement of the wash-over pipe after connection of the fishing tool mechanism with the drill collars, means provided in the pipe gripping section operable responsive to the downward movement of the wash-over pipe after connection of the spear section of the fishing tool mechanism with the drill collars to release the first mentioned means supporting the fishing tool mechanism in the wash-over pipe, and said releasing means provided in the upper pipe gripping section of the fishing tool mechanism also being responsible to initial movement of the drill collars due to dislodgement thereof for instantaneously re-engaging the first mentioned means with the wash-over pipe.

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