Jan. 31, 1967 S. H. SMITH 3,301,324

SWIVEL FOR SUPPORTING DRILL STRING IN SUBMERGED CASING HEAD

Filed June 12, 1964 2 Sheets-Sheet 1

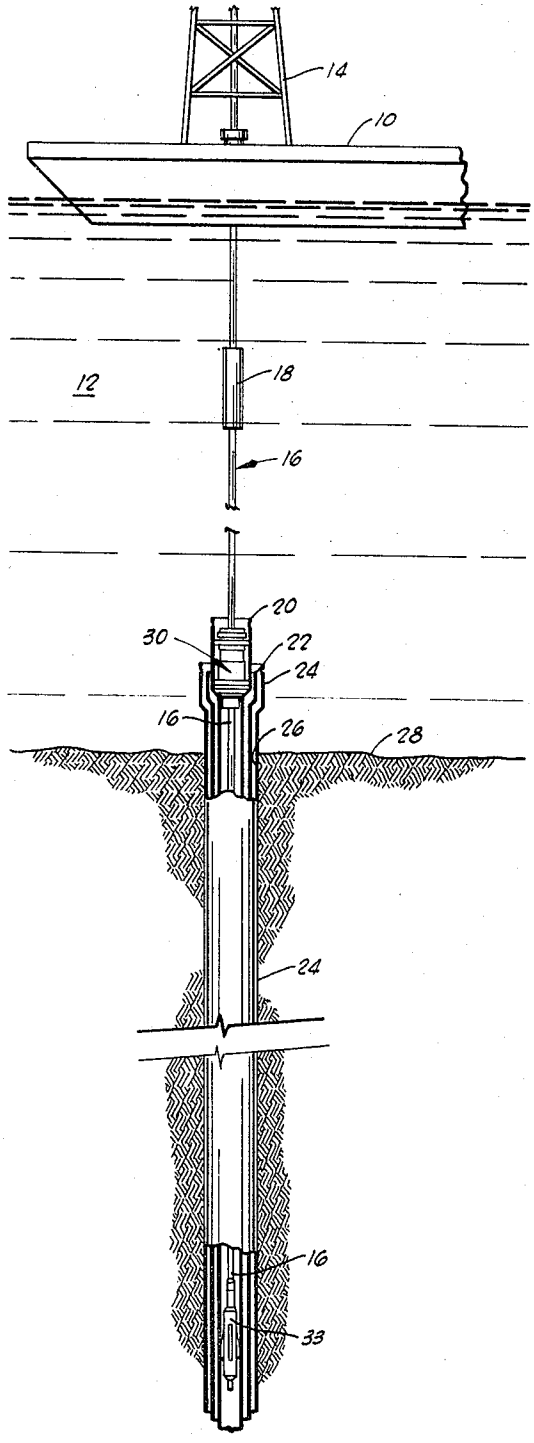


Fig. 1

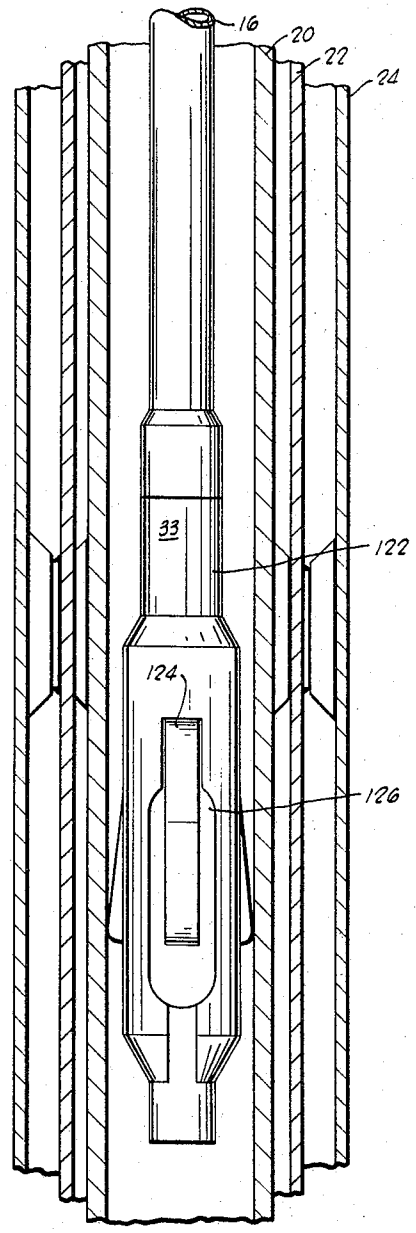


Fig. 3

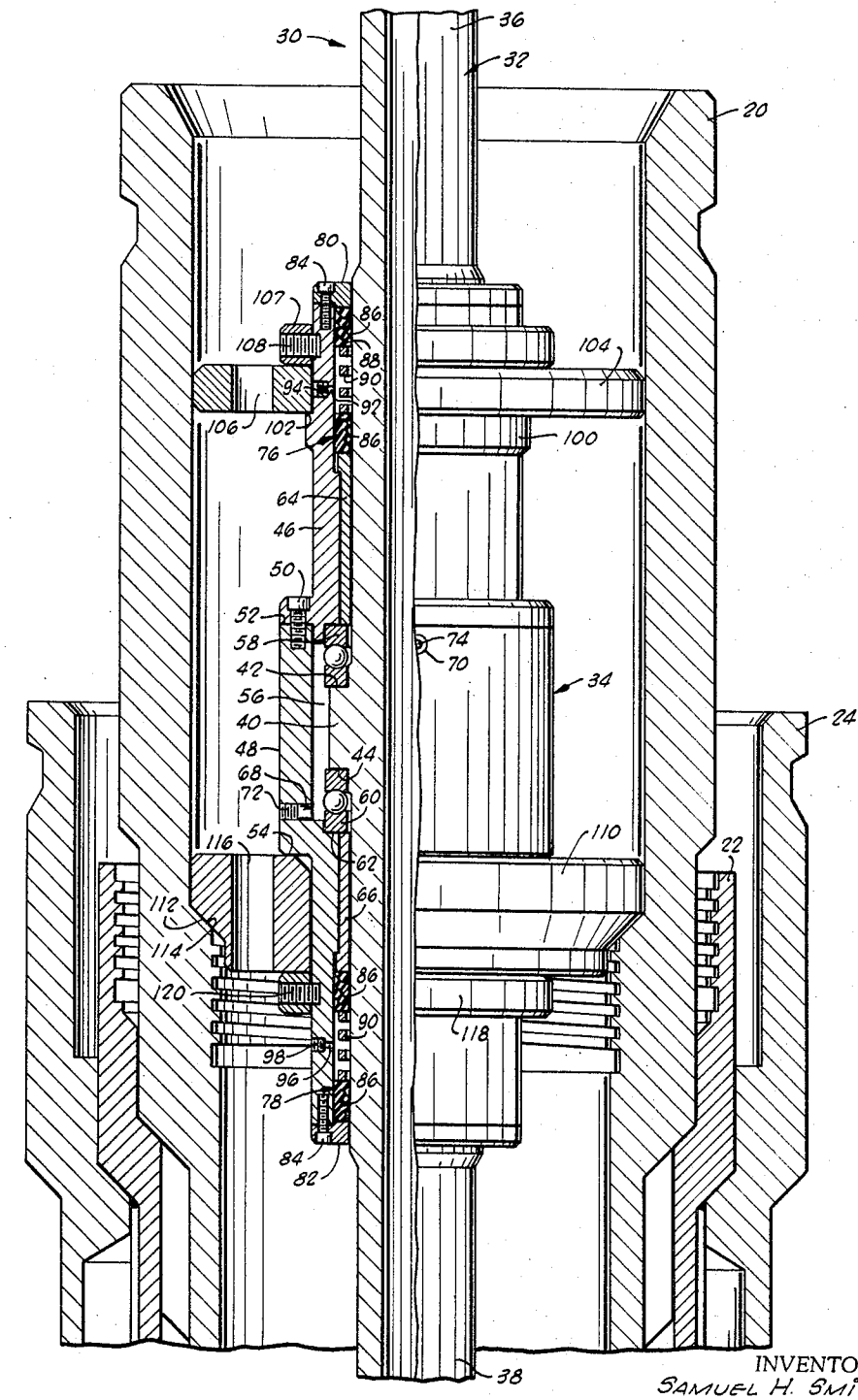
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SWIVEL FOR SUPPORTING DRILL STRING IN SUBMERGED CASING HEAD

Filed June 12, 1964 2 Sheets-Sheet 2



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Fig. 2

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3,301,324

SWIVEL FOR SUPPORTING DRILL STRING IN SUBMERGED CASING HEAD

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13 Claims. (Cl. 166—.5)

This invention relates generally to improved swivels useful in connection with well tools. More particularly, but not by way of limitation, this invention relates to an improved swivel useful in connection with operations performed in wells located beneath the surface of a body of water by apparatus extending from a floating drilling platform.

During relatively recent years, considerable drilling activity directed to locating new oil and gas production and reserves has been conducted in drilling wells located in the bottom of lakes or in the floor of the ocean lying offshore. Drilling activity occurring beneath the surface of bodies of water has introduced a variety of new problems in the technology of the oil industry. Initially, offshore wells and lake bottom wells were drilled from a platform that was supported by the lake bottom or ocean floor. Most of the new problems encountered in drilling from the fixed platforms resulted primarily from the separation between the drilling rig and the well head which was located on the lake bottom or ocean floor. Often, several hundred feet of water separated the rig from the well head.

More recently, it has been found more practical, particularly in extremely deep water, to drill such wells from floating barges or platforms. It has been found that the drilling barges can be successfully restrained in a position on the surface of the water over the well so that drilling operations can continue in all but the most severe weather. A great amount of difficulty has been encountered in attempting to compensate for the changes in depth of water due to strong wave action and tidal effects.

One method utilized to compensate for the depth changes is the provision of a slip or telescoping connection in the drilling string extending from the floating barges into the well. As the water depth decreases, the connection can telescope to reduce the overall length of the drilling string. As the water depth increases and the barge rises relative to the well head, the connection increases in length to provide a longer drilling string. It should be pointed out that the weight of the drilling string will retain that portion of the drilling string below the telescoping connection in position while the barge rises.

The use of telescoping connections has met with a degree of success when the drill bit is resting on the bottom of the well during actual drilling. When certain operations are to be performed in the well bore above the bottom of the well, the lower portion of the drilling string will move vertically in the well bore due to the depth changes of the water, unless restrained.

For various reasons, a metallic liner, known commonly as a well casing, is set in the well bore during the drilling of the well. Regulations have been promulgated requiring the removal of well casings to a specified depth below the ocean floor when a well has been determined to be a non-producer. Under normal circumstances, the well casing is generally removed by connecting a casing cutter or mill to the lower end of the drilling string and extending the drilling string and attached cutter into the well casing to the specified depth. Upon reaching the specified depth, the cutter members of the casing cutter are moved into engagement with the well casing and the drilling string and casing cutter rotated until the casing has been parted. A pulling tool is then latched onto the upper, separated portion of the well casing and an upward force exerted thereon, lifting the casing from the well bore. Difficulty has been encountered in attempting to cut the casing at the specified location when using floating platforms due to the water changing in depth and moving the floating platform vertically. Well casings are relatively hard and difficult to cut even with the cutter or mill engaging the casing along a single circumferential line of contact. It can be easily imagined how much more difficult such a cutting operation becomes when the cutter is constantly moving in the vertical plane during the attempt to part the well casing.

In very broad terms, this invention appertains to an improved swivel interposed in a drilling string extending from a floating platform wherein the swivel is cooperable with the well casing to prevent the drilling string from moving downwardly relative to the casing when performing operations such as cutting the well casing. The telescopic connection previously mentioned is placed in the drilling string to compensate for the vertical movement of the floating platform and the weight of the string is utilized to keep the swivel in position in the casing during upward movement of the floating platform.

This invention also contemplates an improved swivel including an inner tubular member adapted at each end for connection with the drilling string, a tubular housing encircling the inner tubular member which is rotatable relative to the housing, and an annular support member carried by the housing and engageable with the well casing to prevent downward movement of the swivel and drilling string relative to the well casing.

One object of this invention is to provide an improved apparatus useful in connection with operations performed in offshore wells from a floating drilling platform to prevent vertical movement of the drilling string in a well bore.

Another object of the invention is to provide an improved swivel adapted to be connected in a drilling string and arranged for cooperation with the well casing to prevent downward movement of the drilling string in the casing while permitting rotation of the drilling string relative to the casing.

A further object of the invention is to provide an improved swivel carrying an annular support member which is engaged with the swivel housing and with the well casing wherein the area of contact between the swivel housing and support member is less than the area of contact between the support member and casing, so that the swivel housing and drilling string will rotate relative to the support member in the event that the swivel bearings lock.

One other object of the invention is to provide an improved swivel of relatively simple construction yet arranged to permit relative rotation between the swivel and casing while preventing downward movement of the swivel in the casing.

A still further object of the invention is to provide an improved swivel for use underwater that incorporates means for preventing water from contacting the bearing means located therein.

One other object of the invention is to provide an improved swivel that can be easily and economically manufactured.

The foregoing and additional objects and advantages of the invention will become more apparent as the following description is read in conjunction with the accompanying drawings wherein like reference characters denote like parts in all views, and wherein:

FIG. 1 is a view, partly in elevation and partly in cross-section, of a portion of a floating drilling platform and a

drilling string incorporating a telescopic connection extending from the platform to a swivel and cutter positioned in a well located in the ocean floor;

FIG. 2 is an enlarged cross-sectional view of the well casing with one embodiment of a swivel constructed in accordance with the invention located therein; and,

FIG. 3 is a view, partly in cross-section and partly in elevation, showing a cutter or mill in the well casing.

Referring to the drawings in detail, and to FIG. 1 in particular, shown therein is a portion of a drilling barge or platform **10** floating on the surface of a body of water **12**. Mounted on the upper surface of the drilling barge or floating platform **10** is a drilling rig **14**. Extending downwardly from the drilling rig **14** through the floating platform **10** is a drilling string **16** which includes a telescoping or slip connection **18** for purposes which will be described more fully hereinafter. The drilling string **16** extends downwardly into an inner casing **20** which is disposed in axially aligned intermediate casing **22** and exterior casing **24**. The exterior casing **24** is positioned in a bore hole **26** extending into the bottom **28** of the body of water **12**. The drilling string **16** is shown connected with a swivel assembly **30** which will be described in more detail hereinafter. One or more sections of the drilling string **16** extend downwardly from the swivel assembly **30** and are connected at their lower end with a casing mill or cutter assembly **33**.

FIG. 2 illustrates, in a greatly enlarged sectional view, the details of construction of the swivel assembly **30**. As shown therein, the swivel assembly **30** is positioned in the inner casing **20**. The swivel assembly **30** includes an inner tubular member **32** which extends axially through a tubular housing **34**. The inner tubular member **32** includes an upper end **36** and a lower end **38**, each of which is suitably arranged for connection with the drilling string **16**. A radially extending exterior flange **40** encircles the medial portion of the inner tubular member **32**, providing an upwardly facing shoulder **42** and a downwardly facing shoulder **44** thereon. The tubular housing **34**, which encircles the inner tubular member **32**, comprises an upper portion **46** and a lower portion **48** which are secured together by means of a plurality of screws **50** extending through a circumferential flange **52** on the lower end of the upper portion **46** and into the upper end of the lower portion **48** of the tubular housing **34**. The upper end of the lower portion **48** is enlarged in diameter to provide a downwardly facing shoulder **54** and an enlarged bore **56** surrounding the exterior flange **40** of the inner tubular member **32**.

An upper thrust bearing assembly **58** is disposed between the lower end of the upper portion **46** of the tubular housing **34** and the upwardly facing shoulder **42** provided by the flange **40** on the inner tubular member **32**. Similarly, a lower thrust bearing assembly **60** is located between an upwardly facing shoulder **62** formed by the bore **56** in the lower portion **48** of the tubular housing **34** and the downwardly facing shoulder **44** provided by the flange **40** located on the inner tubular member **32**. The arrangement of the thrust bearing assemblies **58** and **60**, in cooperation with the flange **40** and the tubular housing **34**, is such that the inner tubular member **32** is prevented from moving vertically with respect to the tubular housing **34**.

Upper and lower annular sleeve bearings **64** and **66**, respectively, are disposed between the inner tubular member **32** and the tubular housing **34**, to permit relative rotation therebetween. The upper sleeve bearing **64** is disposed within the upper portion **46** of the tubular housing **34** and the lower sleeve bearing **66** is disposed within the lower portion **48** of the tubular housing **34**.

A pair of threaded openings **68** and **70** extend through the enlarged portion of the tubular housing **34** to provide communication with the bore **56**. The openings **68** and **70** are utilized to introduce a lubricant into the enlarged bore **56** for the purpose of reducing the friction in the various bearing members. After the lubricant is introduced into the bore **56**, the openings **68** and **70** are closed by threaded plugs **72** and **74**, respectively.

An upper packing assembly **76** encircles the inner tubular member **32** and is disposed with the upper portion **46** of the tubular housing **34**, adjacent the upper end of the upper sleeve bearing **64**. A lower packing assembly **78**, which is identical to the packing assembly **76**, encircles the inner tubular member **32** within the lower portion **48** of the tubular housing **34**, adjacent the lower end of the lower sleeve bearing **66**. The packing assemblies **76** and **78** are retained within the tubular housing **34** by upper and lower end caps **80** and **82**, respectively, which closely encircle the inner tubular member **32** and are attached to the ends of the tubular housing **34** by means of a plurality of screws **84**.

Each of the packing assemblies **76** and **78** includes a pair of identical, though inverted, packing members **86**, each of which is comprised of a plurality of chevron-type packing elements **8**. The packing members **86** in each of the packing assemblies **76** and **78** are spaced apart by means of a coil spring **90** which encircles the inner tubular member **32** and exerts a force tending to compress the packing members **86**. A passageway **92**, which extends through the upper portion **46** of the tubular housing **34** into the space containing the upper packing assembly **76**, is provided for the purpose of injecting a quantity of lubricating material, such as a heavy grease, therein. The lubricant injected into the space between the packing members **86** serves to enhance the sealing qualities of the packing assembly **76**, as well as providing additional lubricant for the rotating parts of the swivel assembly **30**. A plug **94** is illustrated as being inserted in the passageway **92** after the lubricant has been injected therein. A passageway **96** extends through the lower portion **48** of the tubular housing **34** into the space between the packing members **86** of the lower packing assembly **78** for the identical purpose that the passageway **92** serves in connection with the upper packing assembly **76**. A plug **98** is utilized to close the passageway **96** after lubricant has been injected therein.

The upper portion **46** of the tubular housing **34** is provided with a circumferential flange **100** which provides an upwardly facing shoulder **102**. An annular guide member **104**, having a plurality of vertically extending ports **106** therein, encircles the upper portion **46** of the tubular housing **34** above the upwardly facing shoulder **102**. The annular guide member **104** is retained on the tubular housing **34** by means of a retaining ring **107** which is attached to the upper portion **46** by means of set screws **108**. The annular guide member **104** has an outer diameter sized to fit within the interior of the inner casing for purposes which will become more apparent hereinafter.

A support member **110** encircles the lower portion **48** of the tubular housing **34** and has an upper surface thereon engageable with the downwardly facing shoulder **54** of the tubular housing **34**. The support member **110** has a beveled lower surface **112** that engages an upwardly facing shoulder **114** formed in the inner casing **20**. A plurality of vertical passageways **116** extend through the support member **110**. The support member **110** is retained on the tubular housing **34** by a ring **118** which encircles the lower portion **48** of the tubular housing **34** below the support member **110**. The ring **118** is fixed to the tubular housing **34** by means of set screws **120** which extend through the ring **118** into the tubular housing **34**. It should be pointed out that the area of contact between the downwardly facing shoulder **54** on the tubular housing **34** and the upper surface of the support member **110** is less than the area of contact between the beveled surface **112** of the support member **110** and the upwardly facing shoulder **114** in the inner casing **20**, for purposes which will be explained in connection with the operation of the swivel assembly **30**.

As illustrated in FIG. 1, a cutter assembly **33** is connected with the swivel assembly **30** by one or more sections of the drilling string **16**. FIG. 3 illustrates the cutter assembly **33** in more detail. As shown therein, the cutter assembly **33** includes a body portion **122** which carries a plurality of extensible cutter members **124** in recesses **126** located therein. The cutter members **124** are extended into engagement with the inner casing **20** by hydraulic or mechanical forces acting on the cutter members **124** so that the casing **20** will be cut at the desired point upon rotation of the cutter assembly **33**. The construction and operation of suitable cutter assemblies is well known to the skilled in the oil industry. Several suitable types are commercially available.

In using the apparatus constructed in accordance with the invention, the casing cutter assembly **33** is attached to the lower end of the drilling string **16** and the casing cutter and drilling string are then lowered from the drilling rig **14** and floating platform **10** until the proper number of sections of the drilling string **16** are assembled to provide the proper spacing between the cutter assembly **33** and the swivel assembly **30**. The swivel assembly **30** is then connected in the drilling string **16** and lowered therewith into the inner casing **20**. The telescoping connection **18** is inserted in the drilling string **16** in any suitable position between the swivel assembly **30** and the floating platform **10**, so that the telescoping connection **18** can compensate for changes in depth of the water **12**, as previously described.

When the beveled lower surface **112** of the support member **110** on the swivel assembly **30** engages the upwardly facing shoulder **114** in the inner casing **20**, the cutter assembly **33** is in the desired position to cut the inner casing **20**. At this time the guide member **104** has also entered the inner casing **20** and fits sufficiently closely therein to maintain the axial alignment of the drilling string **16** with the inner casing **20**. Upon reaching this position, the cutter assembly **33** is actuated to extend the cutter members **124** into engagement with the wall of the inner casing **20**. The drilling string **16** is then rotated, causing the inner tubular member **32** of the swivel assembly **30** to rotate, which in turn rotates the sections of drilling string **16** between the cutter assembly **33** and the swivel assembly **30** and, at the same time, rotating the cutter assembly **33**. During this stage of the operation of the swivel assembly **30**, the inner tubular member **32** is rotating relative to the tubular housing **34** with little or no frictional resistance, due to the provision of the lubricated thrust bearing assemblies **58** and **60** and the annular sleeve bearings **64** and **66**.

Should any of the bearings become locked, causing the tubular housing **34** to rotate with the inner tubular member **32**, the tubular housing **34** will rotate relative to the support member **110**. As previously mentioned, the relative rotation between the tubular housing **34** and the support member **110** occurs due to the area of contact between the tubular housing **34** and the support member **110** being less than the surface area of contact between the support member **110** and the upwardly facing shoulder **114** of the inner casing **20**. Thus, it can be seen that even though a malfunction should occur in the bearings of the swivel assembly **30**, provision is made for the continued rotation of the drilling string **16** relative to the inner casing **20**, thereby permitting the completion of the cutting operation without the necessity of withdrawing the entire apparatus for replacement of the locked swivel assembly **30**.

It can be seen that during the cutting operation the weight of the drilling string **16** will retain the beveled lower surface **112** of the support member **110** in engagement with the upwardly facing shoulder **114** due to the action of the telescoping connection **18**, even though the floating platform **10** may be moving upwardly with respect to the inner casing **20**. Downward movement of the floating platform **10** will not affect the position of the cutter assembly **33** in the inner casing **20** due to the thrust bearing arrangement between the inner tubular member **32** and the tubular housing **34**, which transfers any downward force exerted thereon to the support member **110** which is in engagement with the inner casing **20**. It can be seen, then, that regardless of the vertical movement of the floating platform **10**, the cutter assembly **33** will be retained in a fixed vertical position relative to the inner casing **20**.

It can be appreciated from the foregoing description that even though the swivel assembly **30** is to be used under water, the bearing assemblies located therein are effectively sealed from the effects of the water by the upper and lower packing assemblies **76** and **78**, respectively. Furthermore, it can be appreciated that the swivel assembly **30**, constructed in accordance with the invention, can be relatively easily and economically manufactured.

It should also be understood that the single embodiment of the invention shown and described herein is by way of example only and that many changes and modifications can be made thereto without departing from the spirit of the invention or from the scope of the annexed claims.

What I claim is:

1. A swivel adapted for connection in a drilling string for supporting a well tool in a well casing, comprising:

an inner tubular member having upper and lower open end portions arranged for connection with the drilling string, said inner tubular member having a circumferential flange extending radially from the medial portion thereof;

a tubular housing encircling the medial portion of said inner tubular member, said housing having an enlarged central portion forming a downwarly facing exterior shoulder;

thrust bearing means disposed between said circumferential flange and said housing for preventing relative up or down movement between said inner tubular member and housing;

annular bearing means disposed above and below said thrust bearing means for permitting relative rotational movement between said inner tubular member and housing; and,

an annular support member encircling and supported on said housing below said exterior shoulder in sliding engagement with said exterior shoulder and engageable with a well casing to prevent downward movement of said swivel relative to the casing.

2. The swivel of claim **1** wherein said tubular housing also has:

an enlarged bore forming an annular chamber in the central portion thereof adjacent said thrust bearing; and,

upper and lower openings extending through said housing into said chamber, whereby a lubricant is introduced into and substantially fills said annular chamber.

3. The swivel of claim **1** and also including:

upper and lower end caps attached to said tubular housing and closely encircling said inner tubular member;

packing means disposed within said housing between said end caps and annular bearing means; and,

annular guide means encircling said housing spaced from said support member and sized to fit within the well casing to maintain a substantial axial alignment between said swivel and casing.

4. The swivel of claim **1** wherein said annular support member is rotatable on said housing; and, wherein the area of contact between said support member and downwardly facing shoulder is less than the area of contact between the support member and casing, whereby said inner tubular member and housing can rotate relative to

said support member should said inner tubular member and housing become locked together.

5. Apparatus useful in the drilling of wells located below the surface of a body of water wherein a floating drilling platform is utilized, the improvement comprising:

a drilling string extending from the drilling platform into the well;

a telescoping joint interposed in the drilling string whereby the relative length of the drilling string can change in response to changes in the water level;

a well casing disposed in the well and having an upwardly facing shoulder formed in the interior thereof; and,

a swivel interposed in the drilling string and disposed within said casing, said swivel including:

an inner tubular member having upper and lower end portions connected with said drilling string,

a tubular housing encircling the medial portion of said inner tubular member and rotatable relative thereto, and

an annular support member carried by said housing and engageable with the upwardly facing shoulder in said casing to prevent relative downward movement of said swivel and drilling string in said casing.

6. Apparatus useful in connection with wells located below the surface of a body of water wherein a floating drilling platform is utilized, the improvement comprising:

a drilling string extending from the drilling platform into the well;

a telescoping joint interposed in the drilling string whereby the relative length of the drilling string can change in response to changes in the water level;

a well casing disposed in the well and having an upwardly facing shoulder formed in the interior thereof; and,

a swivel interposed in the drilling string and disposed within said casing, said swivel including:

an inner tubular member having upper and lower end portions arranged for connection with the drilling string, said inner tubular member having a circumferential flange extending radially from the medial portion thereof;

a tubular housing encircling the medial portion of said inner tubular member;

thrust bearing means disposed between said circumferential flange and said housing for preventing relative up or down movement between said inner tubular member and housing,

annular bearing means disposed above and below said thrust bearing means for permitting relative rotational movement between said inner tubular member and housing, and

an annular support member encircling said housing in engagement with said housing and engageable with the upwardly facing shoulder of said well casing to prevent downward movement of said swivel and drilling string relative to the casing.

7. Apparatus useful in connection with wells located below the surface of a body of water wherein a floating drilling platform is utilized, the improvement comprising:

a drilling string extending from the drilling platform into the well;

a telescoping joint interposed in the drilling string whereby the relative length of the drilling string can change in response to changes in the water level;

a well casing disposed in the well and having an upwardly facing shoulder formed in the interior thereof; and,

a swivel interposed in the drilling string and disposed within said casing, said swivel including:

an inner tubular member having upper and lower end portions arranged for connection with the drilling string, said inner tubular member having a circumferential flange extending radially from the medial portion thereof,

a tubular housing encircling the medial portion of said inner tubular member, said housing having an enlarged central portion providing a downwardly facing exterior shoulder and having an enlarged bore therein forming an annular chamber adjacent said circumferential flange and providing upwardly and downwardly facing interior shoulders,

upper and lower thrust bearings encircling said inner tubular member and disposed between said circumferential flange and downwardly and upwardly facing shoulders, respectively,

upper and lower annular bearing members disposed between said inner tubular member and housing above and below said upper and lower thrust bearings, respectively,

an annular support member encircling said housing in engagement with said downwardly facing exterior shoulder and engageable with the upwardly facing shoulder of the well casing to prevent downward movement of said swivel and drilling string relative to the casing, and

annular guide means encircling said housing spaced from said support member and sized to fit within the well casing to maintain a substantial axial alignment between said swivel and casing.

8. The apparatus of claim 7 wherein said annular support member is rotatable on said housing; and, wherein the area of contact between said support member and downwardly facing shoulder is less than the area of contact between the support member and the upwardly facing shoulder of said casing, whereby said inner tubular member and housing can rotate relative to said support member should said inner tubular member and housing become locked together.

9. A swivel adapted for connection in a drilling string for supporting a well tool in a well casing, comprising:

an inner tubular member having upper and lower end portions arranged for connection with the drilling string, said inner tubular member having a circumferential flange extending radially from the medial portion thereof;

a tubular housing encircling the medial portion of said inner tubular member, said housing having an enlarged central portion forming a downwardly facing exterior shoulder;

thrust bearing means disposed between said circumferential flange and said housing for preventing relative up or down movement between said inner tubular member and housing;

annular bearing means disposed above and below said thrust bearing means for permitting relative rotational movement between said inner tubular member and housing;

upper and lower end caps attached to said tubular housing and closely encircling said inner tubular member:

packing means disposed within said housing between said end caps and annular bearing means; and

an annular support member encircling said housing below said exterior shoulder in engagement with said exterior shoulder and engageable with a well casing to prevent downward movement of said swivel relative to the casing.

10. In apparatus useful in the drilling of wells located below the surface of a body of water wherein a floating drilling platform is utilized, the improvement comprising:

a drilling string extending from the drilling platform into the well;

an extensible slip joint interposed in the drilling string whereby the relative length of the drilling string can change in response to changes in the water level;

a well casing disposed in the well and having an upwardly facing shoulder formed thereon; and

a swivel interposed in the drilling string and disposed at least partially within said casing, said swivel including:

an inner tubular member having upper and lower end portions connected with said drilling string,

a tubular housing encircling the medial portion of said inner tubular member and rotatable relative thereto, and

an annular support member on said housing and positioned for engagement with the upwardly facing shoulder of said casing to prevent relative downward movement of said swivel and drilling string in said casing.

11. A swivel adapted for connection in a drilling string for supporting a well tool in a well casing comprising:

an inner tubular member having upper and lower end portions arranged for connection with the drilling string, said inner tubular member having a circumferential flange extending radially from the medial portion thereof;

a tubular housing encircling the medial portion of said inner tubular member, said housing having an enlarged central portion forming a downwardly facing exterior shoulder;

thrust bearing means disposed betwen said circumferential flange and said housing for preventing relative up or down movement between said inner tubular member and housing;

annular bearing means disposed above and below said thrust bearing means for permititng relative rotational movement between said inner tubular member and housing;

an annular support member encircling said housing below said exterior shoulder and engageable with a well casing to prevent downward movement of said swivel relative to the casing;

upper and lower end caps attached to said tubular housing and closely encircling said inner tubular member;

packing means disposed within said housing between said end caps and annular bearing means; and

annular guide means encircling said housing spaced from said support member and sized to fit within the well casing to maintain a substantial axial alignment between said swivel and casing.

12. A swivel adapted for connection in a drilling string for supportintg a well tool in a well casing comprising:

an inner tubular member having upper and lower end portions arranged for connection with the drilling string, said inner tubular member having a circumferential flange extending radially from the medial portion thereof;

a tubular housing encircling the medial portion of said inner tubular member, said housing having an enlarged central portion forming a downwardly facing exterior shoulder;

thrust bearing means disposed between said circumferential flange and said housing for preventing relative up or down movement between said inner tubular member and housing;

annular bearing means disposed above and below said thrust bearing means for permitting relative rotational movement between said inner tubular member and housing; and

an annular support member rotatably supported on and encircling said housing below said exterior shoulder and having a first surface in contact with a part of said shoulder and a surface of larger area than said first surface positioned thereon for engagement with a well casing to prevent downward movement of the swivel relative to the casing, the relative areas of said surfaces being such that said inner tubular member and housing can both rotate relative to said support member when said second mentioned surface is in engagement with a well casing and said inner tubular member and housing become locked together.

13. A swivel adapted for connection in a drilling string for supporting a well tool in a casing comprising:

an inner tubular member having upper and lower ends arranged for connection with the drilling string, said inner tubular member having a circumferential flange extending radially from the medial portion thereof;

a tubular housing encircling the medial portion of said inner tubular member, said housing having an enlarged central portion providing a downwardly facing exterior shoulder and having an enlarged bore therein forming an annular chamber adjacent said circumferential flange and providing upwardly and downwardly facing interior shoulders;

upper and lower thrust bearings encircling said inner tubular member and disposed between said circumferential flange and downwardly and upwardly facing shoulders, respectively;

an annular support member encircling said housing in engagement with said downwardly facing exterior shoulder and engageable with the well casing to prevent downward movement of said swivel relative to the casing, said annular support member being rotatably mounted on said casing, and the dimensions of said annular support member and housing being such that the area of contact between said support member and the downwardly facing shoulder of the housing is less than the area of contact between the support member and casing, whereby said inner tubular member and housing can rotate relative to said support member should said inner tubular member and housing become locked together; and,

annular guide means encircling said housing spaced from said support member and sized to fit within the well casing to maintain a substantial axial alignment between said swivel and casing.

References Cited by the Examiner

UNITED STATES PATENTS

1,398,551	11/1921	Hanson	175—171 X
2,929,610	3/1960	Stratton	175—171 X
3,115,755	12/1963	Siebenhausen	175—171 X
3,252,528	5/1966	Nicolson	175.7

ERNEST R. PURSER, *Primary Examiner*.