Feb. 3, 1970 B. J. WATKINS 3,493,043

MONO GUIDE LINE APPARATUS AND METHOD

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FIG. 2.

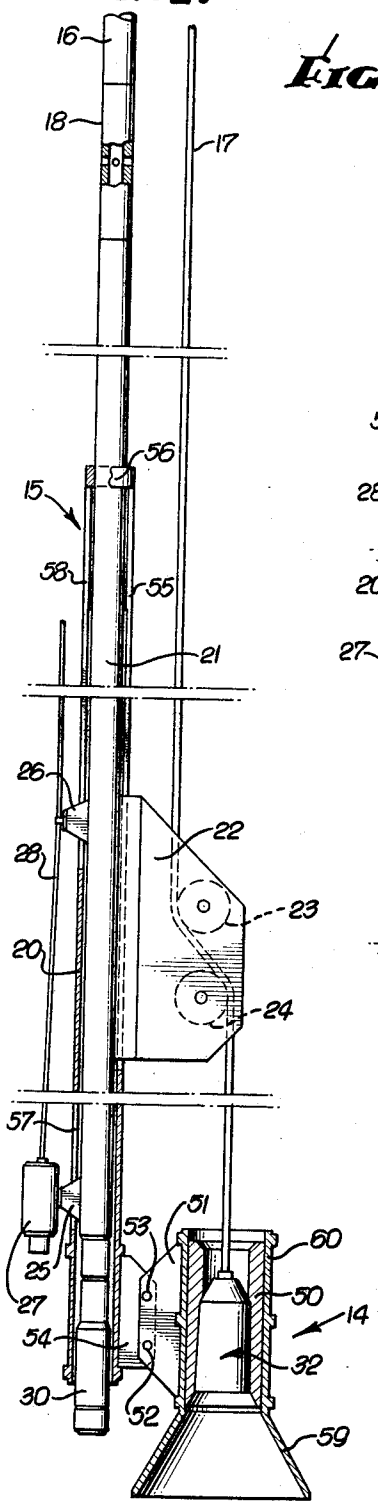


FIG. 3.

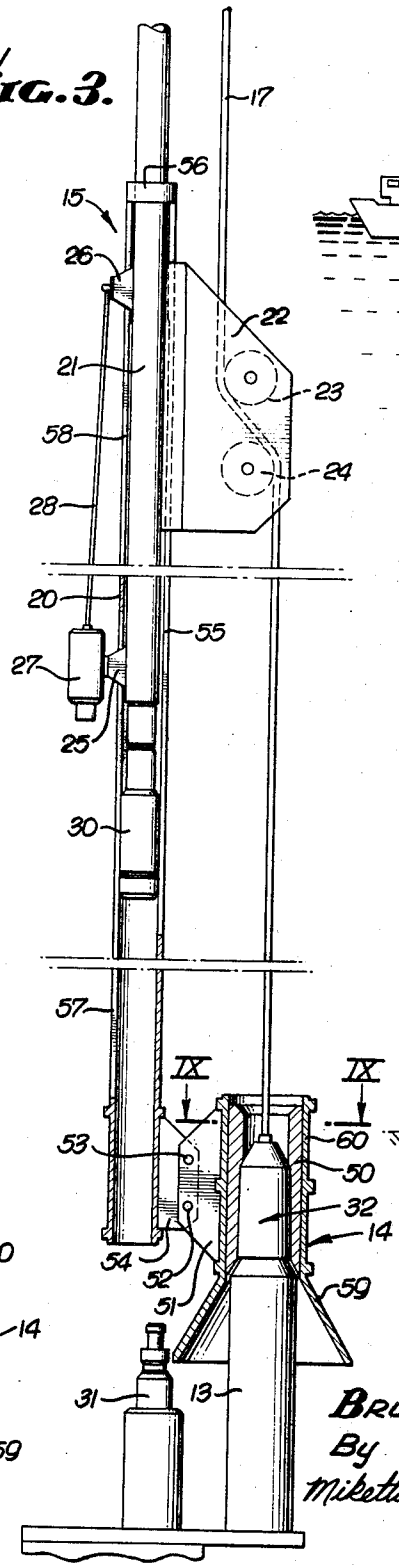
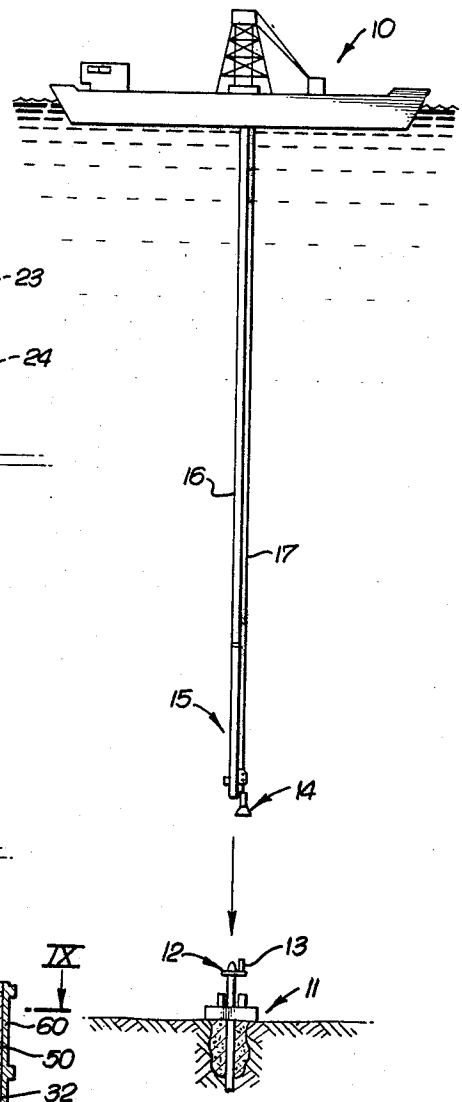


FIG. 1.



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FIG. 4.

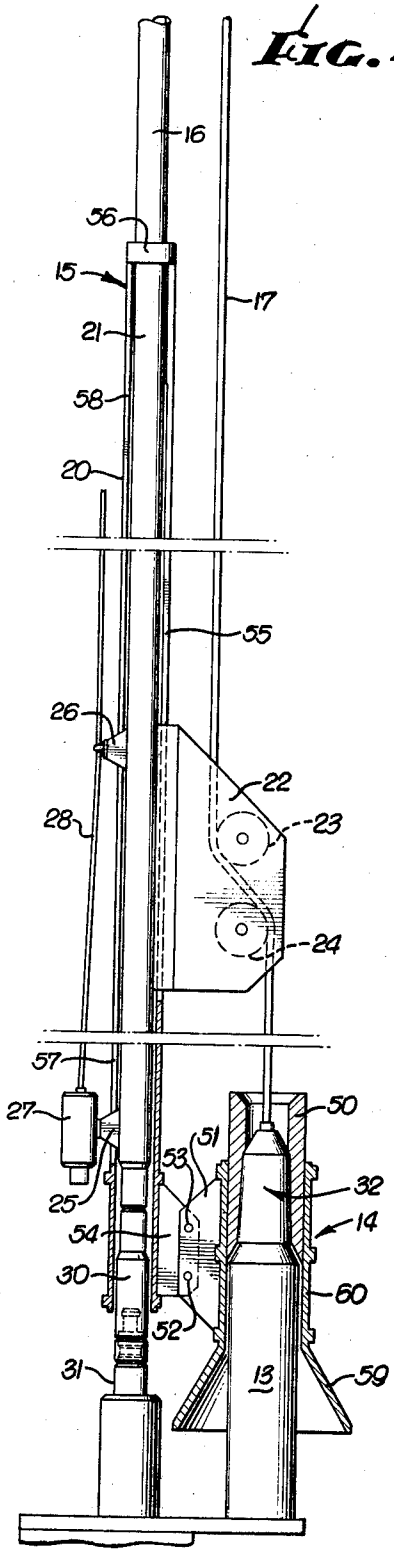
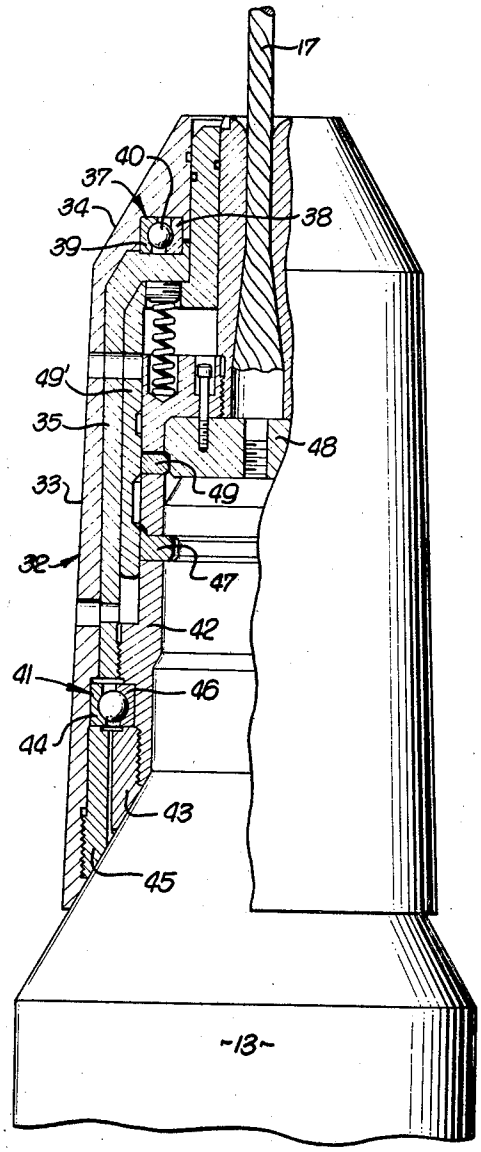


FIG. 5.



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FIG. 6.

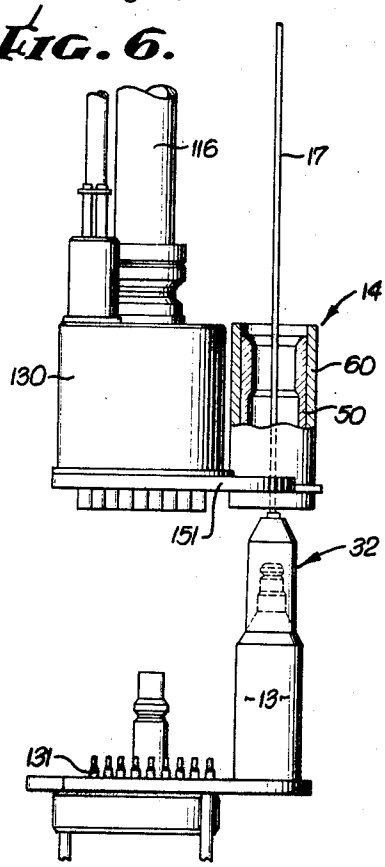


FIG. 8.

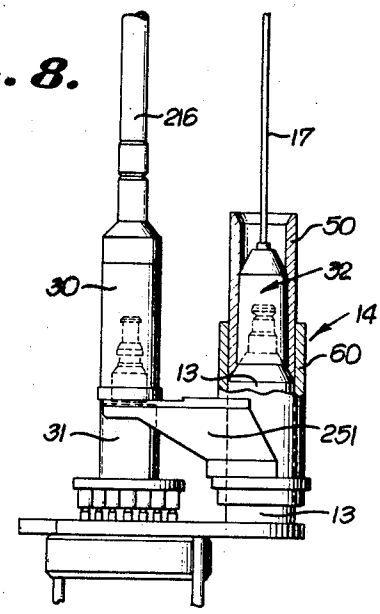


FIG. 7.

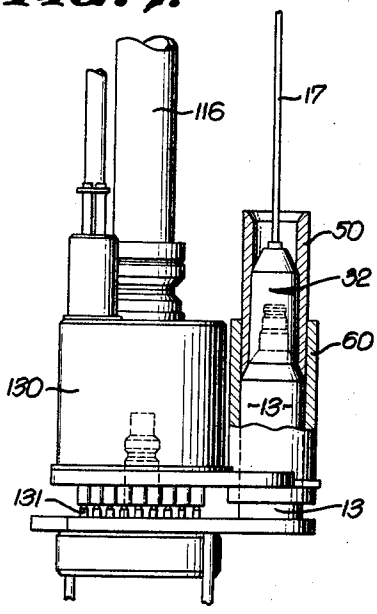
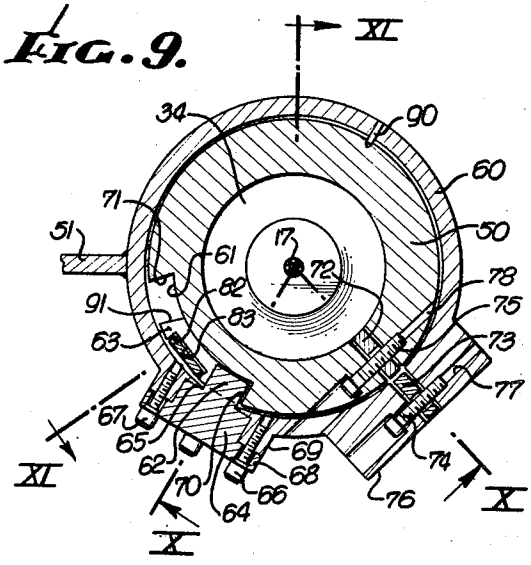


FIG. 9.



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FIG. 10.

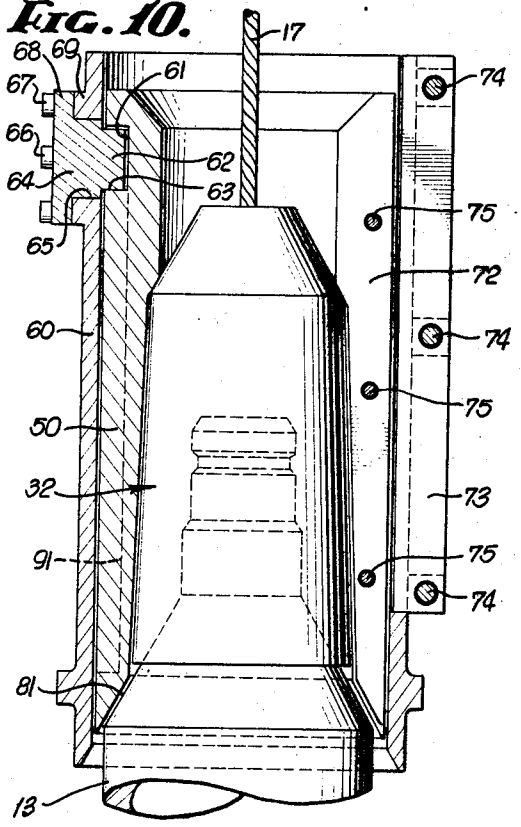


FIG. 11.

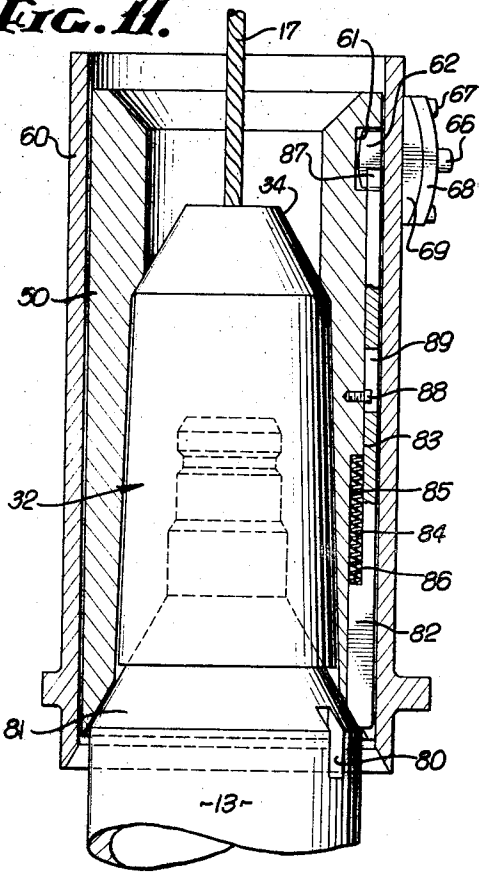


FIG. 13.

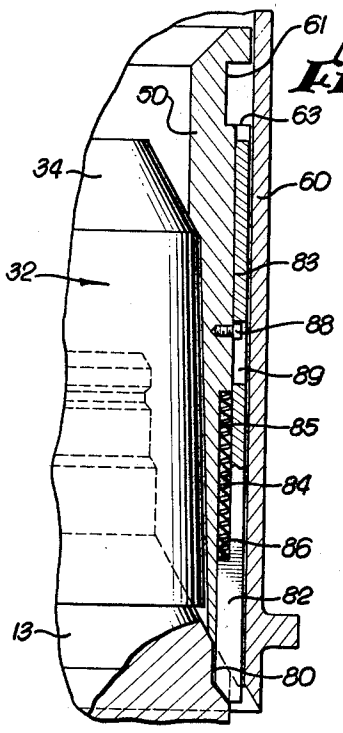
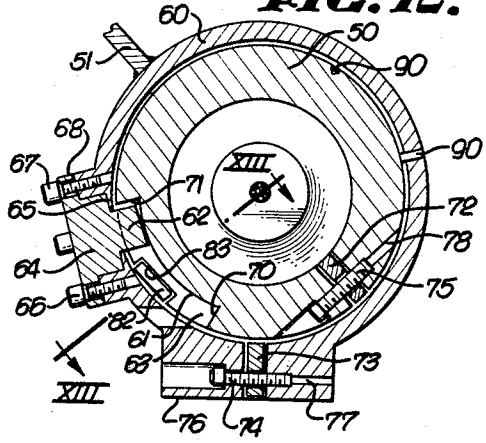


FIG. 12.



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MONO GUIDE LINE APPARATUS AND METHOD

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Filed Aug. 9, 1967, Ser. No. 659,497

Int. Cl. E21b *15/02*

U.S. Cl. 166—.5 20 Claims

ABSTRACT OF THE DISCLOSURE

A reentry frame associated with drill pipe for relative vertical movement therebetween and an associated orienting assembly seated upon a guide line latch means to be run to a well head from a floating vessel concurrently with the running of the drill pipe and latch means, the latch means being suspended by a single guide line which is operable from the floating vessel independently of the drill pipe for raising and lowering the reentry frame and associated orienting assembly relative to the drill pipe. An orienting slot on a single guide post at the well head for receiving a dog mounted to the orienting means to preorient the orienting means at the well head by such reference point on the guide post. Inner and outer members of the orienting assembly mounted to each other for relative rotation therebetween in a predetermined manner and extent when the associated dog is aligned to and dropped into the post orienting slot by rotation of the members on the guide post. Means associated with the inner and outer members for allowing downward movement of the outer member relative to the inner member into a well head oriented position when the limited allowed relative rotation between the inner and outer members is completed.

BACKGROUND OF THE INVENTION

After a subsea well has been drilled and production operations have been suspended, it frequently becomes necessary to reenter the well in order to resume production operations or to perform other conventional work-over operations at the well head beneath the sea. The amount of drill pipe or tubing necessary to run work-over tools to the subsea well head generally is very heavy and it becomes very difficult to land the work-over tool at the well head without doing considerable damage thereto. The landing of heavy tools and the accompanying drill string or tubing can be facilitated through the use of two or more guide lines where such guide lines are retained intact between the well head and a floating vessel or buoy or where it is possible to connect such guide lines through the use of divers or other means. In either event, the maintenance or problem of reconnecting such guide lines in operable relationship is expensive and burdensome. Prior efforts have been made to land and orient a tool at a subsea well head without the use of guide lines, but such efforts have resulted in damaging of fittings and other expensive and uneasily reached equipment at the well head.

It is therefore the primary object of this invention to disclose and provide an apparatus and method for running a tool by drill pipe or tubing from a floating vessel to a remote subsea well head without damaging equipment at the well head and without the need for maintaining or preconnecting guide lines between the floating vessel and the well head. It is another object within the present invention to run such tools to a subsea well head

from a floating vessel by drill pipe or tubing concurrently with the running of a single guide line to the well head which may thereafter be employed for subsequent operations in addition to that performed by the initially run tool.

It is another object of the present invention to disclose and provide an orienting assembly and method for orienting a drill string over a subsea well head prior to its landing thereon through the use of a single guide line only, such guide line being run with the drill string or prior thereto. It is another object within the present invention to disclose and provide a reentry frame for mounting about the lower end of the drill pipe or tubing for connecting the orienting assembly of the foregoing object to the drill string or tubing in a manner so that the concurrently run drill string or tubing may be held stationary above the well head while the associated orienting assembly is lightly landed upon the well head and is thereafter operated to align the drill string or tubing over a predetermined location at the well head, orienting the drill string or tubing prior to its landing on the well head.

SUMMARY OF THE INVENTION

Generally stated, the mono guide line apparatus and method of the present invention comprises the running of drill pipe or tubing mounting a tool at a lower end thereof from a floating vessel toward a remote subsea well head with an orienting assembly laterally constrained to the tubing and suspended for vertical movement relative thereto by a single guide line being run concurrently with the tubing from the floating vessel. The tool mounting drill string or tubing and its associated laterally constrained but vertically movable orienting assembly are guided over the well head and, with the drill string or tubing held in fixed vertical relationship to the well, the orienting assembly is lightly landed upon a guide post at the well head provided with a reference point means thereon for preorienting the orienting assembly thereon. The landed orienting assembly is then actuated into its preoriented assembly engagement with the reference point means on the guide post and thereafter into a fully oriented position by lateral movement of the drill string or tubing in an arcuate direction about the guide post to rotate portions of the orienting assembly about the guide post. The drill string and associated tool are thereafter landed on the well head while the orienting assembly laterally constrains the drill string or tubing in a fully oriented relationship over the well head.

More particularly, the apparatus for running a tool by drill pipe from a floating vessel to a remote subsea well head and orienting such tool into a predetermined location at the well head through the use of only a single guide line and an associated guide line latch means run with the apparatus to a single guide post at the well head comprises the provision of a reentry frame of preferably sleeve-like configuration mounted about a lower portion of the drill pipe or tubing for relative vertical movement therebetween. An orienting assembly is seated upon a guide line latch means to be run to the well head with the latch means being suspended by a single guide line. Means are provided for securing the orienting assembly to the reentry frame for selectably raising or lowering the reentry frame and orienting means relative to the drill pipe by the guide line, the orienting assembly being seated upon the latch means.

The orienting assembly, generally stated, includes inner nd outer tubular members and means for mounting the iembers to each other for relative rotation therebeween, the inner member being seated on the guide line atch means, the outer member being secured to the rentry frame and latching dog and means for mounting he dog to the tubular members for preventing their relaive rotation until the orienting assembly is placed in ts preoriented relation on the well head guide post with he latching dog engaging a reference point means on he guide post, which is preferably an orienting slot proided in a landing surface of the guide post. The comlete orienting of the drill string by the orienting asembly is accomplished through the provision of means ssociated with the tubular members of the assembly for llowing downward movement of the outer tubular mem)er relative to the inner tubular member into a well head)riented position when the latching dog has been re:eived in the orienting slot and the outer tubular mem)er is rotated relative to the inner tubular member a pretermined amount.

A complete understanding of the present invention as vell as the recognition of additional objects and advanages of the present invention can be obtained by those killed in the art from a consideration of the following letailed explanation of a preferred exemplary embodinent of the mono guide line apparatus and the method)f running a tool to a predetermined location at a renote subsea well head, according to the present invenion. In describing such preferred exemplary embodiment)f mono guide line apparatus and method, reference will)e made to the appended sheets of drawings in which:

FIG. 1 is an elevational view of an apparatus in iccordance with the present invention being run from an :xemplary floating vessel, dynamically positioned gen:rally above a remote subsea well, to the well head using)nly a single guide line in accordance with the method of he present invention;

FIG. 2 is a side elevation, partially in section, of the exemplary embodiment of apparatus of FIG. 1 for runiing a tool by drill pipe or tubing from a floating vessel oward a subsea well head in accordance with the method)f the present invention;

FIG. 3 is a side elevation of the exemplary embodiment of apparatus of FIGS. 1 and 2 showing the orienting assembly portion of the apparatus landed upon a guide post at the well head prior to orienting of the drill pipe or tubing and associated tool to the well head in accordance with the method of the present invention;

FIG. 4 is a side elevation of the exemplary embodiment of apparatus of FIGS. 1 through 3 showing the apparatus completely landed on and aligned to the well head in accordance with the method of the present invention with the tool associated with the drill pipe or tubing connected to a cap or fitting means at the well head;

FIG. 5 is a side elevation, partially in section, of an exemplary embodiment of guide line latch means which may be employed with the orienting assembly of the exemplary embodiment of apparatus of FIGS. 1 through 4 to connect the single guide line to the single guide post at the well head in accordance with the method of the present invention;

FIG. 6 is a side elevation of an alternative exemplary embodiment of a lubricator connector tool being run to the well head on the guide line of FIGS. 1 through 5 after the apparatus of FIGS. 1 through 5 has been removed from the well head, all in accordance with the apparatus and method of the present invention;

FIG. 7 is a side elevational view of the alternative exemplary embodiment of tool of FIG. 6 shown landed at the well head after it has been oriented thereon by the orienting assembly in accordance with the apparatus and method of the present invention;

FIG. 8 is an elevational view of a still further alternative exemplary embodiment of Christmas tree cap running tool showing the tool landed at the well head by means of the apparatus and method of the present invention;

FIG. 9 is a horizontal section view of the orienting assembly of the apparatus of FIGS. 1 through 8 taken along the plane IX—IX in FIG. 3 when the orienting assembly has been landed on the guide line post but prior to its engagement with a reference point means provided on the guide line post;

FIG. 10 is a vertical section view of the orienting assembly of FIG. 9 taken therein along the plane X—X;

FIG. 11 is a vertical section view of the orienting assembly of FIG. 9 taken therein along the plane XI—XI;

FIG. 12 is a horizontal section view of the orienting assembly of FIGS. 9 through 11 after it has been rotated on the guide post to engage the reference point means on the guide post and after an outer member of the orienting assembly has been rotated relative to an inner member of the orienting assembly just prior to the full orienting and landing of the apparatus as shown in FIG. 4; and

FIG. 13 is a vertical section view of the orienting assembly of FIG. 12 taken therein along the plane XIII—XIII.

Referring first to FIG. 1, a floating vessel, indicated generally at **10**, is shown dynamically positioned in the sea above a typical remote subsea well, indicated generally at **11**. An otherwise conventional subsea well head, indicated generally at **12**, is provided in accordance with the present invention with a single guide post **13** with reference point means thereon, as subsequently disclosed, to receive an orienting assembly, indicated generally at **14**. The orienting assembly is part of the apparatus in accordance with the present invention, indicated generally at **15**, being run by drill pipe or tubing string **16** and the single guide line **17** to the well from the floating vessel. The apparatus of the present invention, indicated generally at **15**, is connected to the lower end of tubing or drill pipe run or pumped down from the floating vessel toward the subsea well head with a movable frame portion of the apparatus mounting the orienting assembly being suspended about and movable with respect to the tubing **16** by the guide line **17** as hereinafter explained in detail. Any conventional subsea well tool may be mounted to the lower end of the portion of the apparatus fixed to the tubing or drill pipe string.

A preferred exemplary embodiment of the apparatus for running a tool by drill pipe or tubing from a floating vessel to a remote subsea well head is seen in FIGS. 2 through 4 during the various stages of the running and orienting of the tool to be landed at the well head by the apparatus and method of the present invention. As seen in FIG. 2, the orienting assembly, indicated generally at **14**, is laterally constrained at the lower end of the drill pipe or tubing string and mounted thereto for limited relative vertical movement by means of the associated sleeve-like frame **20** mounted about a mandrel for lower tubing section **21**. The mandrel or tubing section **21** is connected into the tubing string **16** below a jet means **18** of conventional construction employed for guiding the drill or tubing string laterally over the well head to align the orienting assembly, indicated generally at **14**, over the guide post **13** prior to landing of the orienting assembly on the guide post by lowering of guide line **17** as hereinafter more fully explained.

Mandrel or tubing section **21** is preferably provided with a laterally extending flange **22** with means, which in the exemplary embodiment include pulleys **23** and **24** rotatably mounted to flange **22**, for entraining guide line **17** to mandrel **21** while allowing relative vertical movement therebetween. Additional laterally extending flanges **25** and **26** may also be provided on mandrel **21** for mounting a television camera **27** and its associated cable **28** thereto. Television camera **27** may be employed for visually observing the guide post **13** during lateral jetting of the tubing string by means of the jet means **18** prepara-

tory to landing of the orienting assembly, indicated generally at **14**, on the guide post **13**.

A conventional subsea well tool, as retrieving tool **30**, is preferably mounted at the lower end of the mandrel or tubing string **21** to be run, oriented and landed upon the subsea well head. In the exemplary embodiment of FIGS. 1 through 4, retrieving tool **30** is intended to be used in removing the cap **31** provided at the well head during re-entry operations on the well concurrently with the landing and connecting of a guide line latch means **32** on post **13**. Subsequent work-over operations can thereafter be performed on the well head by guiding other tools to the well head by means of the guide line **17** after latch means **32** has been secured to post **13**. During such subsequent operations, as hereinafter explained, the orientating assembly, indicated generally at **14**, continues to perform its orienting function in orienting the associated re-entry guide frame **20** over the means at the well head to be operated on.

The orienting assembly, indicated generally at **14**, is positioned about and seated upon a guide line latch **32** suspended on guide line **17**. The orienting assembly, as shown in detail in FIGS. 9 through 13 and as more fully explained with reference to such figures hereinafter, generally includes an outer tubular member **60** and an inner tubular member **50**, the inner and outer members being mounted to each other for limited relative rotation and vertical movement therebetween during the orienting operation performed by the assembly. The outer tubular member **60** is provided with a laterally extending flange **51** which is mounted by conventional means, as by bolts **52** and **53** to a flange **54** secured to the re-entry frame or sleeve **20**. The orienting assembly is thus laterally constrained to the mandrel or lower tubing section **21** by means of the re-entry frame **20**.

Re-entry frame **20** is provided with a plurality of vertically extending narrow slot-like apertures to allow relative vertical movement between the frame **20** and the flanged mandrel or tubing section **21**. As seen in FIG. 2, the re-entry frame **20** is provided with a vertical aperture **55** extending from a point below flange **22** to the upper limits of the frame where an end collar **56** is secured. Collar **56** may be provided at the upper end of frame or sleeve **20** by a threaded connection or by welding. The overall length of aperture **55** may be chosen in view of the extent of relative vertical movement desired between the frame **20** and mandrel **21**. It has been found that a relative movement of from 14 to 20 feet is desirable during the landing operations as subsequently described. Aperture **55** should thus be at least approximately 15 feet longer than the height of flange **22** protruding through the aperture. Additional apertures or slots **57** and **58** are also provided in the frame or sleeve **20** to allow passage therethrough of the flanges **25** and **26** for the camera means **27** and for mounting an upper portion of cable **28**. The vertical extent of each of apertures **57** and **58** should be approximately equal to the amount aperture **55** extends in addition to the height of flange **22**.

As seen in FIG. 2, the orienting assembly, indicated generally at **14**, is seated upon guide line latch **32**, the inner tubular member **60** of the assembly seating upon an outer housing about latch **32**. When the drill pipe or tubing string with mandrel or lower tubing section **21** has been run down toward the well head within approximately 10 to 20 feet of the well head, the lowering or pumping of the drill string is preferably stopped. Using television camera **27** for visually observing guide post **13**, the drill string may be guided laterally over the well head by jet means **18** until the orienting assembly, indicated generally at **14**, can be landed by its guide flange **59** on post **13**. As shown in FIG. 3, the landing of the orienting assembly, indicated generally at **14**, on post **13** is accomplished by maintaining the tubing string **16** and mandrel **21** vertially stationary while lowering guide line **17** allowing re-entry frame **20** to extend downwardly about the mandrel **21** and associated tool **30** until the latch means **32** positioned within the orienting assembly is landed and connected onto post **13**. Over extending of the re-entry frame relative to mandrel **21** is prevented by means of the upper collar or cap **56** which will seat upon the upper end of flanges **22** and **26** preventing loss of frame **20** off of the mandrel or tubing section **21**. From the foregoing, it can be seen that the heavy drill or tubing string may be withheld from landing upon the well head and doing any appreciable damage thereto while the relatively lighter re-entry frame **20** and associated orienting means, indicated generally at **14**, is lightly landed by lowering of guide line **17** onto the guide post **13**. Generally, such landing will be accomplished with the re-entry frame **20** misaligned to the means at the well head, as cap **31**, to which the tool being run is to be aligned and landed upon. The operation of the orienting apparatus and the continued method of landing a tool at the well head in accordance with the present method will now be explained in detail after a short description of an exemplary latch means **32** is made.

While any conventional form of guide line latch means can be employed in association wtih the orienting assembly and apparatus of the present invention, in the preferred exemplary embodiment, the guide line latch of my co-pending application Ser. No. 491,247 filed Sept. 29, 1965, entitled "Guide Line Latch," now abandoned, is disclosed. However, whether the exemplary guide line latch means is employed, or some other form of latch means is employed, an additional housing **33** is preferably rotatably mounted about the guide line latch means to facilitate rotation of the orienting means about post **13** during the orienting operations as hereinafter explained. As seen in FIG. 5, housing **33** is provided with a landing conical surface **34** to receive inner member **60** of the orienting assembly thereon. Housing **33** is rotatably mounted to the latch housing **35** by means of circular race ball bearing means indicated generally at **37**. Such ball bearing means include an inner race **38** mounted to housing **35** with an outer race **39** mounted to outer or additional housing **33**. A plurality of ball bearing members, as member **40**, are provided between the circular inner tnd outer races **38** and **39**, respectively to rotatably mount the outer housing relative to inner or main latch housing **35**. An additionally similarly constructed circular race ball bearing means, indicated generally at **41**, may be provided at a lower portion of the housings to provide lower lateral support for the outer housing **33** relative to the inner latch housing **35** and the associated inner socket member **42** and the connected annular landing collar **43**. Outer bearing race **44** may be held to the outer housing **33** by means of the threaded collar **45** while the landing collar **43** is adapted to retain the inner bearing race **46** assembled within the latch housing **35** and socket member **42** .

The inner latch mechanism of the latch means illustrated in FIG. 5 is completely described and its operation explained in the co-pending Ser. No. 491,247, referred to hereinabove. However, for purposes of the present application, it should be understood that the exemplary latch means is self actuating upon landing post **13**. As seen in FIG. 5, a plurality of latch dogs **47** are slidably mounted in the inner socket member **42** for movement in a direction normal to the axis of the socket member into engagement with a peripheral groove provided in post **13**. On landing of the latch means upon post **13**, a trigger block **48** is pushed upwardly freeing dogs **49** which are slidably mounted in the side wall of inner socket member **42** for movement in an axial direction relative to the socket. Upon freeing of dogs **49** by upward movement of the trigger block **48**, an upwardly biased actuator **49'** moves upwardly camming dogs **47** into the peripheral groove provided in the upper end of post **13** and thereafter blocking withdrawal of dogs **47** and release of the latch means from post **13**. As more fully

escribed in the co-pending application Ser. No. 491,247, ıe latch means may be released by dropping a ring /eight downwardly about the guide line **17** to land about ıe upper open end of actuator **49'** to force it down-/ardly in FIG. 5 overcoming the upward spring bias pro-ided. Downward movement of actuator **49'** in FIG. 5 eleases the dogs **47** and allows release of the latch means rom post **13**.

Referring to FIGS. 9, 10 and 11, the preferred exem-lary embodiment of orienting assembly includes the pro-ision of inner tubular member **50** and outer tubular nember **60** and means for mounting the members to each ther for relative rotation therebetween. Such means for nounting members **50** and **60** to each other for relative otation therebetween, in the exemplary embodiment, in-ludes the provision of a horizontal arcuate recess **61** in he outer wall of inner tubular member **50** and a mating ug **62** provided on and extending inwardly of the outer ubular member **60** to ride within, and on the lower sur-ace **63** of, recess **61**. Lug **62**, as seen in FIGS. 9 and 10, s formed integrally with a body block **64** which is re-eived into a mating recess **65** provided in outer member 0 with conventional bolts **66** and **67** securing a flange 8 of block **64** to a boss **69** provided on outer member **60** nd in which recess **65** is formed. Relative rotation be-ween inner and outer members **50** and **60**, respectively, s limited by the vertical side walls **70** and **71** of recess **61** rovided in inner member **50**.

As shown particularly in FIG. 9, the inner and outer nembers **50** and **60**, respectively, of the orienting assem-ly are provided with removable line blocks **72** and **73**, espectively, to allow passing of the guide line **17** through he side walls of the orienting assembly on board the ves-el during initial setup of the apparatus or subsequent perations therewith without disconnecting the guide line **17** from between the vessel and post **13**. Such removable line blocks **72** and **73** are secured in place by the provision of bolt means, as bolts **74** and **75**, respectively, adapted to pass through the line blocks and screw into portions of the members **50** and **60**. As seen in FIG. 9, a split flange **76** is provided with a tapped and threaded bore **77** to receive bolt **74**, while the inner body **50** is provided with a tapped and threaded bore **78** to receive bolt **75** therein. Each of bores **77** and **78** are enlarged or reamed to receive the bolt heads as shown.

When the orienting assembly, indicated generally at **14**, and the associated latch means **32** is landed on post **13**, as seen in FIG. 3, the inner orienting tube **50** is seated on the conical landing surface **34** provided by outer additional housing **33** associated with the latch means. The apparatus, in accordance with the present invention, is provided with a latching dog and means for mounting such dog to the tubular members for preventing relative rotation therebetween when the members are first landed upon guide post **13** prior to a preorienting of the assembly relative to the well head by engagement between the assembly and a reference point means provided on post **13**. In the exemplary embodiment, such reference point means includes the provision of an upwardly opening slot **80** provided in post **13** with the upper end of slot **80** opening into the conical landing surface **81** in a portion thereof outwardly of the latch means **32**. As seen in FIG. 11, the latch means **32** seats upon the conical landing surface **81** of post **13** maintaining the inner tubular member **50** spaced upwardly of the post a slight distance to facilitate relative rotation therebetween via the outer housing **33** being rotatably mounted upon the inner latch means housing **35** as shown in FIG. 5. The exemplary latching dog for engaging the orienting slot **80** comprises the downwardly biased dog **82**. The means for mounting dog **82** to prevent relative rotation between members **50** and **60** prior to alignment and dropping of dog **82** into slot **80** includes the provision of a vertically extending recess **83** in inner member **50** with a downward bias on dog **82** effected by spring means, as spring **84**. The spring means may be mounted in a deeper recess portion **85** of recess **83** with a bottom end of the spring means seated on an inner ledge **86** provided by a recessed portion of dog **82** provided at its lower end. Such biased mounting of dog **82** forces it downwardly and outwardly of the orienting tubes **50** and **60** during the landing operation until the latch means **32** seats on post **13** bringing the inner tube member **50** down over and in close spaced relation to conical landing surface **81**.

Dog **82** is adapted, by its mounting means, to land on and abut surface **81** and be thereby forced upwardly relative to the orienting tube members **50** and **60** against the downward bias provided by spring means **84**. An upper end **87** of dog **82** is forced upwardly into recess **61** blocking relative rotational movement of lug **62** and the associated outer tubular member **60** by the landing of the inner tube member **50** about post **13** with the lower end of dog **82** resting upon post landing surface **81**.

Upon landing of the orienting assembly upon the guide post, the inner and outer orienting tube members are prevented from relative rotation therebetween by the blocking of the upper end **87** of dog **82** in recess **61** as clearly shown in FIG. 9. Upon lateral movement of the reentry frame by the drill string, in an arcuate movement about post **13** in the exemplary embodiment, the orienting assembly is rotated as a unit about post **13** until dog **82** is aligned to and dropped into orienting slot **80** as seen in FIG. 13.

A limit pin **88** in member **50** and a cooperating aperture **89** in dog **82** may be provided for limiting the vertical movement of dog **82** relative to member **50** under the urging of the spring bias of spring means **84**. In order to prevent premature relative rotation between the members **50** and **60**, a shear pin **90**, as seen in FIG. 9, may be provided between members **50** and **60** to prevent their rotation during the running of the orienting assembly from the vessel to the well head post **13** as seen in FIGS. 1 through 3.

Additional means are associated with the orienting assembly for allowing a limited predetermined arcuate movement of the associated reentry frame and inwardly constrained mandrel or lower tubing section **21** about post **13** after the assembly is preoriented on post **13** through engagement of dog **82** and orienting slot **80**. In the preferred exemplary embodiment, such additional means include means for allowing a downward movement of the outer tube member **60** from the position of FIG. 3 to the position of FIG. 4 when the outer tubular member is rotated (shearing pin **90**) relative to the inner tubular member **50** into a predetermined position over the well head. The exemplary means for allowing such downward movement of the outer tubular member **60** relative to the inner tubular member **50** includes the provision of a vertical recess **91** formed in an outer wall of the inner tubular member **50** and communicating at its upper end with the horizontal arcuate recess **61** provided in member **50**, as seen from its upper end in FIG. 9 and as seen in broken line in FIG. 10. After dog **82** is aligned to and dropped into slot **80**, it no longer serves to prevent relative rotation between outer tubular member **60** and inner tubular member **50**. Continued rotation of the outer tubular member **60**, while inner member **50** is held stationary through the engagement of dog **82** with post **13**, causes relative rotation therebetween with lug **62** progressing from the position of FIG. 9 to that of FIG. 12 just prior to the alignment of lug **62** over the vertical recess or slot **91** provided in outer member **50**. The vertical side wall **71** of recess **61** prevents over rotation of member **60** relative to the inner fixed member **50** at this stage in the orienting procedure.

Further relative rotation of member **60** to member **50** from the position of FIG. 12 causes lug **62** to drop downwardly in recess **91** allowing outer tube **60** to drop downwardly in a completely oriented position relative to the means at the well head to be oriented to as seen in FIG. 9.

If the drill string has not been lowered relative to the well head from the position of FIG. 2, there will only be a slight initial dropping of the reentry frame and orienting assembly relative thereto since collar **56** will land on flange **22**. Thereafter a lowering of the drill string will allow complete lowering of the reentry frame and associated orienting assembly to the position of FIG. 4 where the reentry frame or sleeve **20** guides landing of tool **30** by drill string **16** on the well head means, cap **31** in the exemplary embodiment. Even where the drill string is sufficiently close to the well head so that the reentry frame drops its full extent relative to inner member **50**, there will be no damage to the well head fittings since the reentry frame lowermost portion is positioned above the means at the well head being oriented to.

After landing of the tool **30** by drill string **16** in its completely oriented position relative to the well head effected by the apparatus and method of the present invention, the drill string and tool **30** (retrieving cap **31**) may be raised back up to the floating vessel raising re-entry frame **20** and the orienting assembly, indicated generally at **14**, therewith. Since collar **56** prevents the re-entry frame from dropping off the lower end of mandrel or lower tubing section **21**, a raising of the drill string **16** will cause an upward movement of the entire apparatus including the orienting assembly leaving latch means **32** and its associated outer housing fastened to the guide post, the assembly being withdrawn upwardly in easily controlled manner due to the engagement with the secured single guide line **17**. Thereafter, as particularly contemplated within the method of the present invention, additional work-over tools can be run to the well head by means of the previously secured guide line and the orienting assembly apparatus of the present invention.

Referring to FIG. 6, it can be seen that a conventional lubricator connector tool **130** may be connected to the lower end of a tubing string **116** with an orienting assembly, according to the present invention and as indicated at **14**, connected by a flange **151** to tool **130**. The tool **130** may be run down to the well head with the orienting means inner and outer tubular members **50** and **60** riding about the guide line **17** until inner tubular member **50** lands upon guide post **13**. Rotation of the drill string **116** about post **113** to cause actuation of the orienting assembly as hereinbefore described will place the alternative tool **130** directly over the means at the well head, connector **131**, for landing as shown in FIG. 7.

As seen in FIG. 8, after removal of the lubricator connector tool **130**, the Christmas tree cap may be replaced on the well head by rerunning Christmas tree cap running tool **30** on the lower end of a drill string **216** using the orienting assembly, indicated generally at **14**, as in the manner hereinbefore described. In this alternative exemplary embodiment, the orienting assembly may be mounted by a stepped flange **251** to allow clearance for the connector caps provided on the Christmas tree cap **31**.

From the foregoing description of an exemplary embodiment of apparatus for running a tool from a floating vessel to a predetermined location at a remote subsea well head, it can be seen that the foregoing objects of the invention have been attained. Generally summarized, the method according to the present invention includes the running of tubing **16** and **21** mounting a tool **30** at a lower end thereof from a floating vessel, indicated generally at **10**, toward a remote subsea well head, indicated generally at **12** in FIG. 1. The orienting assembly, indicated generally at **14**, is run laterally constrained to the tubing by re-entry frame **20** toward the well head concurrently with running of the tubing, the orienting assembly and its associated re-entry frame **20** being suspended by the single guide line **17**. The orienting assembly, re-entry frame and tubing are guided over the well head by means of the jet means **18** with the running of the tubing being stopped when the tool **30** is positioned approximately ten to twenty feet above the well head. The orienting assembly, indicated generally at **14**, is then landed on the well head by lowering of the guide line **17** independently of the running of tubing **16**. According to the present method, the orienting assembly is then actuated at the well head into a predetermined oriented position by moving the tube laterally of the well head to bring the dog **82** into engagement in slot **80** in a pre-oriented position. Further rotation of outer member **60** while the inner member **50** is held stationary to post **13** within a predetermined limited amount allows exact orienting of the reentry frame over the means, such as Christmas tree cap **31**, at the well head to be worked over by the tool being lowered to the well head. Such final orienting of the reentry frame by the orienting means is accomplished in the exemplary embodiment by a relative lowering of the orienting assembly outer tubular means and associated reentry frame relative to the preoriented stationary inner tubular member **50** on the guide post **13**. Also, as seen from the foregoing explanation of an exemplary apparatus in accordance with the present invention, a guide line latch means may be run with the orienting assembly and latched to the guide post at the well head on landing of the orienting assembly at the well head, the latch means being attached to the guide line and supporting the orienting assembly removably thereon. The initially run tool may be removed together with the re-entry frame and orienting assembly from the well by raising of the tubing and another tool rerun to the well using the orienting assembly and the previously secured guide line. It is therefore possible to obtain a running and orienting of a tool from a floating vessel to a predetermined location at a subsea well head concurrently with the running of a single guide line which is readily available for further rerunning of work-over tools thereafter.

Having thus described an exemplary embodiment of the apparatus and having explained the method of running a tool from a floating vessel to a remote subsea well head by means of a single guide line, it should be understood by those skilled in the art that the foregoing detailed descriptions were of an exemplary apparatus and method of operation thereof according to the present invention. Other modifications, adaptations and innovations upon the apparatus and method according to the present invention may be made within the scope of the present invention as defined and limited only by the following claims:

I claim:

1. A method of running a tool to a predetermined location at a remote subsea well head comprising the steps of:

running tubing mounting a tool at a lower end thereof from a floating vessel toward a remote subsea well head;

running an orienting assembly laterally constrained to said tubing toward said well head concurrently with said tubing with said orienting assembly being suspended by a single guide line being run concurrently with said tubing from said floating vessel;

guiding said tool and tubing to a location generally adjacent said well head and landing said orienting assembly on said well head by lowering of said guide line independently of said tubing;

actuating said orienting assembly at said well head into a predetermined oriented position by moving said tubing laterally of said well head; and

thereafter landing said tool onto said well head by lowering said tubing while said tubing is laterally constrained by said orienting assembly.

2. The method of claim **1** including the steps of:

running a guide line latch means with said orienting assembly and latching said latch means to a guide post at said well head on landing of said orienting assembly on said well head, said latch means being attached to said guide line and having the orienting assembly removably mounted thereon; and

removing said tool and orienting assembly from said

well head by raising of said tubing and leaving said guide line secured to said guide post by said latch means.

3. The method of claim 2 including the steps of:

rerunning a tool and said orienting assembly to said well head by said tubing with said orienting assembly being guided to said well head by said guide line secured to said well head guide post.

4. A method of running a tool by drill pipe from a floating vessel to a remote subsea well head and orienting said tool into a predetermined location at said well head through the use of a single guide line and an associated guide line latch means adapted to latch onto a guide post at said well head, said method comprising the steps of:

mounting an orienting assembly to a giude line latch means and mounting a frame means connected to said orienting assembly to a lower end of a drill pipe for limited relative vertical movement therebetween, said drill pipe being provided with a tool at its lower end;

running said tool by said drill pipe from said vessel toward said subsea well head and concurrently running said frame means and connected orienting assembly with said tool and drill pipe toward said subsea well head by said guide line associated with said guide line latch means to which said orienting assembly is mounted;

stopping the running of said drill pipe above said well head prior to said tool engaging any portion of said well head and independently running said latch means and associated orienting assembly and frame means to said well head by said guide line and landing said latch means on said guide post;

moving said drill pipe laterally of said guide post to rotate said frame means and connected orienting means on said post;

orienting said frame means over said well head at a predetermined location by said rotation of said orienting means on said guide post with respect to a predetermined reference point on said post; and

thereafter landing said tool at said well head.

5. The method of claim 4 including the step of laterally guiding said drill pipe and tool over said well head after said step of stopping the running of said drill pipe and prior to said step of independently running said latch means and associated orienting assembly and frame means to said well head.

6. An apparatus for running a tool by drill pipe from a floating vessel to a remote subsea well head comprising:

an orienting assembly laterally constrained at a lower end of said pipe to be run with said pipe to said well head;

a guide post at said well head with a reference point means thereon;

means associated with said orienting assembly for engaging said reference point means on said post for pre-orienting said assembly on said post; and

additional means associated with said orienting assembly for limiting the movement of the lower end of said pipe about said post in a predetermined manner after said assembly is pre-oriented on said post.

7. An apparatus for running a tool by drill pipe from a floating vessel to a remote subsea well head comprising:

an orienting assembly laterally constrained at a lower end of said pipe and including inner and outer members and means for mounting said members together for relative rotation therebetween;

a guide post at said well head with a reference point means thereon, said reference point means including a slot in an outer surface of said guide post;

means associated with said orienting assembly for engaging said reference point means on said post for pre-orienting said assembly on said post, said means associated with said orienting assembly including a latch dog and means for mounting said dog to said inner and outer members for preventing relative rotation therebetween when said dog is in a raised position and for preventing rotation of said inner member only relative to said post when said dog is aligned to and dropped into said post orienting slot on rotation of said members relative to said post; and

additional means associated with said orienting assembly for allowing a limited predetermined movement of the lower end of said pipe about said post after said assembly is pre-oriented on said post.

8. An apparatus as in claim 7 wherein:

said additional means associated with said orienting assembly includes means associated with said tubular members for allowing downward movement of said outer tubular member relative to said inner tubular member into a well head oriented position when said dog is in said slot and said outer tubular member is rotated relative to said inner tubular member by said movement of said pipe about said post.

9. An apparatus for running a tool by drill pipe from a floating vessel to a remote subsea well head and orienting said tool into a predetermined location at said well head through use of only a single guide line and associated guide line latch means run with said apparatus to a single guide post at said well head, said apparatus comprising:

a reentry frame associated with said drill pipe for relative vertical movement therebetween;

an orienting assembly seated upon said guide line latch means to be run to said well head with said latch means suspended by said single guide line;

means for securing said orienting assembly to said reentry frame for selectably raising and lowering of said reentry frame relative to said drill pipe by said guide line prior to latching said guide line latch means onto said well head guide post, said reentry frame being laterally constrained to said drill pipe; and

reference point means on said guide post for cooperating with said orienting assembly in orienting said reentry frame at said well head by rotation of said frame and assembly about said post on said latch means by lateral arcuate movement of said drill pipe about said post.

10. An apparatus as in claim 9 wherein:

said guide line latch means is provided with an outside housing and means for rotatably mounting said outside housing on said latch means to assist rotation of said orienting assembly about said guide post when said latch means is latched on said post.

11. An apparatus as in claim 9 wherein:

said reentry frame includes a sleeve body mounted about a lower end of said drill pipe, said sleeve body having a vertical aperture in a side wall thereof;

a laterally extending flange is provided on a lower portion of said drill pipe extending through said sleeve body aperture; and

guide line entraining means are mounted on said flange for laterally entraining said guide line to said lower portion of said drill pipe and for allowing relative vertical movement therebetween.

12. An apparatus as in claim 11 wherein:

said sleeve is provided with an additional vertical aperture in a side wall thereof, said drill pipe has an additional flange protruding through said additional aperture and a camera means is mounted to said additional flange.

13. An apparatus as is claim 9 wherein:

said reference point means on said guide post comprises the provision of an orienting slot in an outer surface of said post in a predetermined location; and

said orienting assembly comprises:

inner and outer tubular members and means for mounting said members to each other for relative rotation therebetween, said inner member seating on said guide line latch means, said outer member being se-

cured to said reentry frame by said means for securing;

a latching dog and means for mounting said dog to said tubular members for preventing relative rotation therebetween when said dog is in a raised position and for preventing rotation of said inner tubular member only relative to said post when said dog is aligned to and dropped into said post orienting slot on rotation of said members relative to said post; and

means associated with said tubular members for allowing downward movement of said outer tubular member relative to said inner tubular member into a well head oriented position when said dog is in said slot and said outer tubular member is rotated relative to said inner tubular member by said movement of said pipe about said post.

14. An apparatus as in claim **13** wherein:

said means for mounting said members to each other for relative rotation therebetween includes a horizontal arcuate recess provided in an outer wall of said inner tubular member and a lug provided on and extending inwardly of said outer tubular member to ride within said horizontal recess; and

said means associated with said tubular members for allowing downward movement of said outer tubular member relative to said inner tubular member includes a vertical recess formed in said outer wall of said inner tubular member communicating at its upper end with said horizontal arcuate recess to receive said lug upon said rotation of said outer member relative to said inner member.

15. An apparatus as in claim **13** wherein:

said means for mounting said members to each other for relative rotation therebetween includes a horizontal arcuate recess provided in an outer wall of said inner tubular member and a lug provided on and extending inwardly of said outer tubular member member to ride within said horizontal recess;

said means for mounting said dog to said tubular members including biasing means for biasing said dog downwardly of said members and mounts said dog to ride on a surface on said post in which said orienting slot is provided during rotation of said members about said post; and

said dog includes an upper end protruding into said horizontal recess formed in said inner member when said dog rides on said post surface to prevent movement of said outer member lug in said inner member horizontal recess until said dog is urged into said orienting slot by said biasing means.

16. An apparatus for orienting a tool run by tubing from a floating vessel to a subsea well head by means of a single guide line connected between the vessel and well head, said apparatus comprising:

a guide post at the well head including an orienting slot;

a housing including means for attaching the housing to a tool being run to said well;

an inner member mounted within said housing for relative rotation therebetween, said inner member receiving said guide line therethrough and seating on said post when in fully lowered position;

a horizontal arcuate recess formed in an outer wall of said inner member and a lug protruding inwardly of said housing to ride in said recess on relative rotation between said inner member and said housing;

a dog and means for mounting said dog to said inner member to place an upper portion of said dog in said horizontal recess blocking movement of said lug therein when said dog is in a raised position;

biasing means for biasing said dog out of said raised position into said slot when said inner member and housing are landed and rotated on said post to align said dog to said slot; and

vertically oriented recess means in said inner member outer wall connected into said horizontal recess to receive said housing lug upon rotation of said housing relative to said inner member by movement of said tool about said post when said dog is in said slot preventing further rotation of said inner member about said post.

17. A mono guide line orienting apparatus for orienting tools run on tubing lowered from a floating vessel to a subsea well head by use of only a single guide line between such vessel and a guide post at said well head wherein the improvement comprises:

the provision of an orienting slot in an outer surface of said post in a predetermined location relative to a means at said well head said tool is to be oriented to;

inner and outer tubular members and means for mounting said members to each other for relative rotation therebetween, said inner member being adapted to run about said guide line and to seat upon said post and said outer member having means connected thereto for laterally constraining said outer member to said tubing;

a latching dog and means for mounting said dog to said tubular members for preventing relative rotation therebetween when said dog is in a raised position and for preventing rotation of said inner tubular member only relative to said post when said dog is aligned to and dropped into said post orienting slot; and

means associated with said tubular members for allowing downward movement of said outer tubular member relative to said inner tubular member into a predetermined well head oriented position when said dog is in said slot and said outer tubular member is rotated relative to said inner tubular member by movement of said tubing about said post to position said associated tool to said means at said well head.

18. The improvement in mono guide line orienting apparatus of claim **17** wherein:

said means for mounting said members to each other for relative rotation therebetween includes a horizontal arcuate recess provided in an outer wall of said inner tubular member and a lug provided on and extending inwardly of said outer tubular member to ride within said horizontal recess.

19. The improvement in mono guide line orienting apparatus of claim **18** wherein:

said means associated with said tubular members for allowing downward movement of said outer tubular members relative to said inner tubular member includes a vertical recess formed in said outer wall of said inner tubular member communicating at its upper end with said horizontal arcuate recess to receive said lug upon said rotation of said outer member relative to said inner member.

20. The improvement in mono guide line orienting apparatus of claim **18** wherein:

said means for mounting said dog to said tubular members includes biasing means for biasing said dog downwardly of said members and mounts said dog to ride on a surface on said post in which said orienting slot is provided during rotation of said members about said post; and

said dog includes an upper end protruding into said horizontal recess formed in said inner member when said dog rides on said post surface to prevent movement of said outer member lug in said inner member horizontal recess until said dog is urged into said orienting slot by said biasing means.

(References on following page)

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References Cited

UNITED STATES PATENTS

2,981,347	4/1961	Bauer et al.	175—7
2,984,308	5/1961	Bauer et al.	175—7
3,012,610	12/1961	Bauer et al.	175—7 X
3,062,287	11/1962	Hayes	175—5
3,166,123	1/1965	Watkins	166—.6

16

3,191,695	6/1965	Bates et al.	175—5
3,302,709	2/1967	Postlewaite	175—7 X

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U.S. Cl. X.R.

175—7