July 15, 1969 C. D. POMEROY 3,455,395

METHOD OF POSITIONING RELATIVE TO A BOREHOLE OF A STRING OF TUBULAR MEMBERS FOR USE THEREIN

Filed Nov. 28, 1966 2 Sheets-Sheet 1

Fig. 1

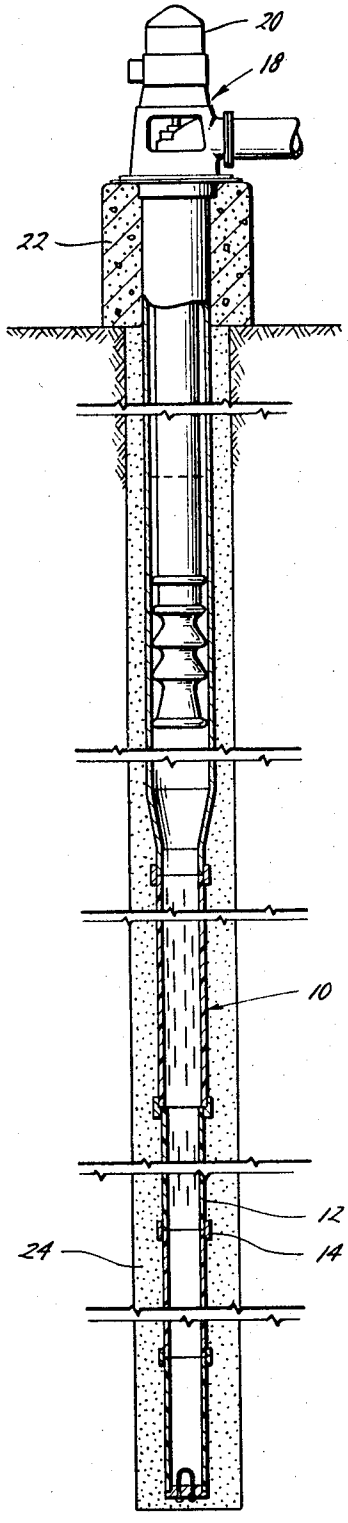
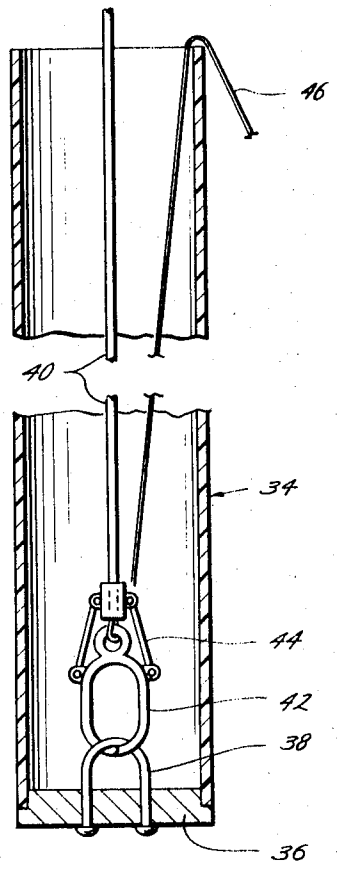


Fig. 5



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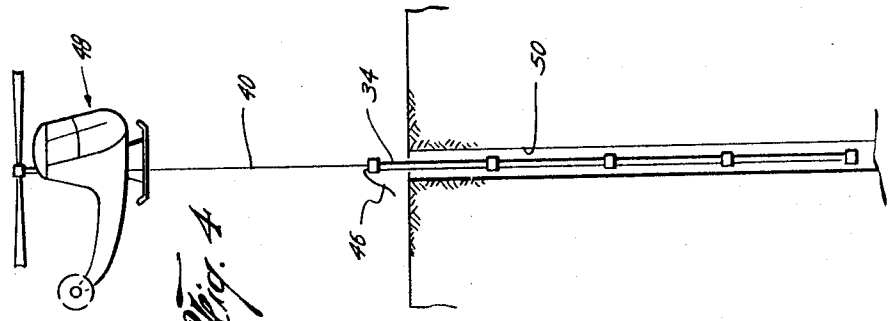


Fig. 4

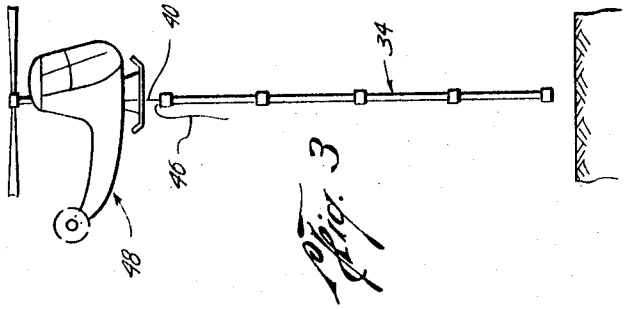


Fig. 3

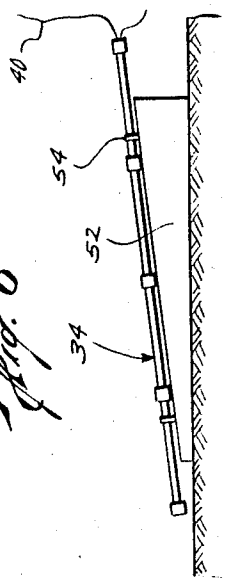


Fig. 6

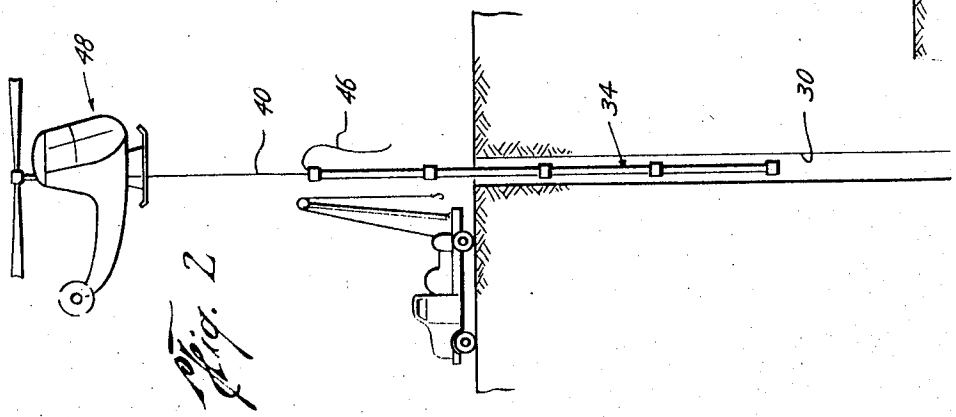


Fig. 2

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ABSTRACT OF THE DISCLOSURE

A method of positioning relative to a borehole of a tubular member such as a casing or the like for use therein in which the tubular member is made up of a series of sections forming a string of tubular members, the string of tubular members being made up either in horizontal position on the earth's surface or being lowered into an assembly pit or borehole during assembly, in which the string of tubular members is lifted by an airborne vehicle such as a helicopter which is capable of hovering or of vertical or lateral movement as desired, and the transfer of the tubular member string in substantially vertical position between the location of its assembly and the location of the borehole while it is so suspended with its lower end above the surface of the earth, and thereupon lowered into the borehole either by changing the altitude of the airborne vehicle or by lowering on the lifting line or other equipment employed for suspending the string from the airborne vehicle. The reverse operation, namely, the removal of a tubular member from a well, such as the removal of a drill string from the well or the removal of a deep well pump, can be accomplished in the same fashion. This makes possible the rapid installation or removal of tubular strings relative to wells by making possible the handling of much longer strings after they have been preassembled than is possible with normal supporting hoisting structures, and making possible far more extensive lateral movements of such string than would be possible with normally employed earth supported structures.

This invention relates to well completions, and more particularly to an improved method and apparatus for expeditiously completing a well by removing the drill string as a unit from the borehole, preassembling a permanent completion casing string, transporting the preassembled string to the wellsite and installing it in the borehole as a complete unit. It is particularly adapted but not limited to the preassembly and installation as a unit of a permanent completion casing string for water wells where completion string is formed at least in part of plastic pipe.

In some areas of the world, it is common practice to drill a multiplicity of large diameter water wells in a rather localized area. Large diameter water wells of moderate depth (100 to 800 feet) are most often drilled by the reverse circulation method of drilling, which provides a rapid means of drilling a large-diameter borehole without the necessity of filling the borehole with heavy drilling mud. While this method of drilling is of great advantage in preserving the integrity of the producing formation, it, unfortunately, leaves the wall of the borehole subject to caving, particularly if the formation is soft. It is, therefore, highly desirable that the drill pipe be removed and the casing installed as quickly as possible after the drilling operation is completed.

The invention is particularly advantageous when plastic pipe is used in the completion casing string. Plastic or fiber reinforced casing is often manufactured in 20-foot

lengths, and the individual joints are secured together by couplings. To assemble a string of plastic pipe, the end of each joint of pipe and the coupling is coated with a plastic cement and then assembled. It takes approximately 15 to 20 minutes for the cement to set. During the setting-up time of the cement, it is necessary to not place any strain on the assembly. Therefore, the assembling of a long string of plastic pipe by the conventional means used in well completion of adding joint by joint as a slow procedure. If the wall of the borehole is subject to caving, as is the case in larger wells drilled by the reverse circulation method, the long waiting period is particularly hazardous. While the drilling crews are particularly adept at disassembling and stacking drill pipe, nevertheless, the disassembly does take some time and if there is danger of caving any saving of time between the completion of the drilling operation and the installation of the permanent casing is also highly desirable.

It is an object of the present invention to provide a novel method for expeditiously completing a borehole after completion of drilling operations.

It is another object to provide a novel method of completing a wellbore in which the drill string is removed as an entire unit and preassembled permanent casing is delivered and installed as an entire unit.

It is a further object to provide a method whereby the entire string of completion casing can be assembled before the borehole is drilled, and for transporting the assembled casing quickly to the wellsite, and lowering it into the borehole as soon as the borehole is drilled and free of the drill pipe. The invention also provides for the entire drill pipe to be withdrawn as a unit without the expenditure of time required for its disassembly. This not only saves time and money in handling the pipe but also eliminates the hazard of leaving the borehole unprotected for a long period of time.

In order to accomplish the above objects and other objects which will be apparent from the detailed description which is about to follow, the invention comprises boring a large-diameter borehole, preassembling a string of permanent completion casing, attaching a lifting line to the assembled string, moving it to the wellsite and lowering it as a unit into the borehole immediately upon completion of the drilling operations. After the casing is properly installed the lifting line is disconnected. Likewise, a lifting line may be attached to the drill string immediatey upon cessation of drilling and the drill string lifted from the borehole and removed as a complete unit. The removed drill string may be moved to a location where it may be later disassembled.

In the preferred form of the invention the completion casing string may be assembled in an assembly pit located near the pipe storage yard. The casing string, particularly if formed at least in part of plastic pipe, can be assembled at such location under proper supervision. A plug having a bail is inserted in the bottom joint of casing and a line having a releasable catch is attached thereto. The line extends through the complete string and is attached to a lifting drum in a helicopter. Accordingly, while hovering, the helicopter reels in the line and lifts the pipe vertically until the bottom of the pipe is above the surface. The pipe is then laterially moved to the wellsite where, after centering it over the borehole, it is lowered into position and the lifting line disconnected.

Other objects, advantages and features of this invention will be apparent to one skilled in the art upon a consideration of the detailed description, the appended claims and the attached drawings, wherein:

FIG. 1 is a cross-sectional view of a typical water well using plastic pipe for its completion casing.

FIG. 2 is a diagrammatic illustration of an assembly

pit wherein a permanent string of completion casing has been preassembled; as can be seen, the string of casing is being withdrawn as a unit.

FIG. 3 is a diagrammatic illustration of the preassembled completion string being transported to the wellsite.

FIG. 4 is a diagrammatic illustration of the preassembled completion string being lowered into the newly-drilled borehole.

FIG. 5 is a cross-sectional view of the priorly assembled completion string illustrating the latching of lifting line attached thereto.

FIG. 6 is a diagrammatic illustration of an alternate form in which the casing string is assembled in a horizontal position.

In order to preserve the integrity of the producing formation it has been found particularly advantageous in drilling large-diameter water wells to utilize the reverse circulation method. Such method alleviates the necessity of a heavy drilling fluid; therefore, the walls of the potential producing formation remain relatively clean. However, particularly in the soft formations in which water is often found, the wall of the borehole has a tendency to cave in. Therefore, it is highly desirable that steps be taken to eliminate the possibility of the formation caving.

It has been found that plastic or fiber reinforced plastic pipe make an excellent permanent completion casing for water wells; however, the assembling of the plastic casing into a long string is a slow and laborious task. The plastic casing usually comes in 20-foot lengths. Individual lengths are secured together by couplings. Prior to installation of a coupling, each end of the joint and the coupling is coated with plastic cement and the two ends are then joined together in the coupling. It has been found necessary in order for the plastic cement to properly set to allow the coupled members to set for 20 minutes prior to placing any strain on the new connection. Accordingly, I propose that the completion string be assembled during or prior to the drilling operations so that immediately upon completion of the drilling operations the preassembled completion casing may be installed as a unit.

One means of accomplshing this is, particularly if a large project is involved, to drill a dummy well or assembly pit approximately the same depth as the various field wells thereby providing an assembly station. The string of completion casing may be assembled in the dummy well prior to or during the time that the well is being drilled. Upon completion of the drilling operation the drill string is removed from the borehole and the preassembled casing lifted from the assembly pit, transported to the wellsite and installed in the borehole as a unit.

FIG. 1 shows a typical water well installation utilizing a considerable amount of plastic casing. As can be seen, the completion casing **10** is formed of a plurality of lengths of fibre reinforced plastic pipe **12**, the individual lengths of plastic pipe being joined together by couplings **14**. The plastic pipe may be slotted in the areas of the potential completion zone. If desired, the upper portion of the completion string may be formed of steel casing. A pump **18** may be located in the upper portion of the casing **10**. A motor **20**, mounted on a base **22** surrounding the portion of the casing **10** extending above the surface drives the pump **18**. As a rule, a gravel pack **24** is located between the wall of the borehole and the completion casing **10** permitting good drainage between the potential producing formation and the slotted casing. As previously mentioned, the depth of water wells may range from 100 feet to 800 feet and, as can be seen, a considerable portion of the permanent completion casing string may consist of plastic pipe. Therefore, a large number of connections between individual lengths of plastic pipe secured together by couplings **14** may be involved. As mentioned, it takes considerable time to assemble a string of plastic pipe due to the setting time of the cement used in forming the connections.

Reference is now made to FIG. 2, where it can be seen that a dummy well **30** has been drilled to the approximate same depth as the field wells in the local area. The dummy well **30** is provided with a suitable metal or plastic-type casing **32**. The dummy well or assembly pit **30** may be located near the central storage yard. Prior to the drilling of the field well or sometime during the drilling operation, a completion string **34** is assembled in the assembly pit **30** under proper supervision.

Attached to the bottom joint of casing **34** is a plug **36** having a bail **38** attached thereto. A cable or lifting line **40** is attached to the bail **38** by a catch **42** which is provided with latch release mechanism **44** operable by latch line **46**. As can be seen, the catch **42** may be formed of two overlapping semicircular members which are so pivoted as to remain overlapping. Attached to each member is a pivot arm. The pair of pivot arms are attached to a latch line **46**. A pull on the latch line **46** moves the pivot arms sufficiently to spread the two members forming the ring catch **42**. The cable **40** and latch line **46** extend up through the casing string **10**, see FIG. 5. The end of the cable **40** is attached to a lifting drum in a helicopter **48**. The lifting of preassembled completion casing string **34** from the assembly pit **30** can be handled by the lifting drum of a helicopter with great facility, particularly if a considerable portion of the completion string **34** is formed of plastic pipe which is quite light. If desired, only the plastic portion of the completion string may be preassembled.

Immediately upon completion of the drilling operation, the drill string is immediately removed from the borehole. The drill string may be removed by the normal procedure of raising the drill string and removing the joints or, if desired, the drill string itself may be removed as a unit and then moved to the storage yard where it can be disassembled at leisure.

As soon as the drill string has been removed from the borehole, the lifting line **40** which extends through the preassembled completion casing string **34** is attached to the lifting drum of the helicopter **48**. The helicopter **48** hovers over the assembly pit **30** reeling in the lifting line **40** lifting the preassembled completion string **34** vertically until it clears the top of the assembly pit **30**.

Having removed the permanent completion string **34** from the assembly pit **30**, the helicopter **48** transports the preassembled completion string **34** from the site of the assembly pit **30** to the site of a field well having a newly drilled borehole **50**, see FIGS. 3 and 4. Arriving at the site of the field well, the helicopter **48** centers the preassembled completion string **34** over the newly drilled borehole **50** and then while hovering over the borehole **50** reels out the lifting line **40** lowering the preassembled completion string **34** into the bore hole **50**. Upon the proper positioning of the preassembled completion string **34** in the borehole **50**, the latch line **46** attached to the release mechanism **44** of the catch **42** is pulled to open the catch **42** and releases the catch **42** from engagement with the bail **38**. The lifting line **40** is then withdrawn from the completion string **34** and the remaining steps in completing the well are taken.

The helicopter **48** and lifting line **40** may also be used to move completely assembled pumps which are used to stimulate newly-cased wells into production from one well to another without disassembly. This is particularly advantageous when the pump assembly has a long string of short tubular members forming a pump column as is shown in FIG. 1. The assembly and disassembly of a long pump column is very time consuming. Moreover, it is most desirable that the stimulating pump be installed in the well as rapidly as possible so that the removal of the drilling fluids may be completed as quickly as possible. Such procedure aids in stabilizing the gravel

pack in a uniform manner around the wellbore and inlet area.

If the number of wells to be drilled is not sufficient to justify drilling a dummy assembling well **30**, a completion string, particularly the plastic pipe portion, may be assembled at a selected assembly station in a horizontal position on the surface of the earth in quite considerable lengths, perhaps even several hundred feet. The completed portion could be picked up at one end by a helicopter, transported to the wellsite and lowered into the borehole. Since the casing may not tolerate the bending moment that would be involved in such a procedure, the casing may be assembled on an inclined ramp **52** which would merely rest on the ground. The assembled casing may be strapped to the ramp **52** by straps **54** (see FIG. 6) and the entire assembly lifted. The inclined ramp **52** will act as a truss to support the assembled casing along its midsection during the lifting operation and thereby avoid objectionable bending forces. In such case, it may be preferable to make the transition from horizontal to vertical gradual and it would not be necessary to reel in the lifting line. Naturally, the vertical lifting capability of a helicopter may also be used to raise the lifting line and preassembled string from the assembly pit. The ramp would, of course, be removed before lowering the tubular member into a well.

As can be seen from the foregoing, by preassembling the permanent completion string, then moving it as a unit to the wellsite and then directly lowering it into the newly-drilled borehole, the completion process is greatly expedited and the possibility of cave-in of the borehole wall is considerably diminished. While the preferred embodiment is directed to installations utilizing plastic pipe which take considerable time to assemble due to the setting time of the plastic cement, the method may be also used for metal tubular members, particularly when light metal such as aluminum is used, which, although do not take the same time to assemble, do require sufficient assembly time which would justify preassembly when cave-in conditions are prevalent. While the entire string of casing may be preassembled, transported and installed as a unit, in some circumstances it may be desirable to only preassemble a portion thereof, such as the portion formed from plastic pipe which takes much longer to assemble. In such case, the preassembled portion would be installed as a unit and the remainder of the casing would be installed in the regular manner. In either case, the time during which the hole would be left unprotected would be greatly shortened.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matters herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. The method of servicing a plurality of earth boreholes with strings of tubular members from an assembly station remote from said boreholes, comprising providing for use in a selected one of said boreholes an assembled string of tubular members at said assembly station, in such manner that said string can be raised to a vertical position above the earth's surface after assembly without damage to the string; and transferring the assembled string between said station and said selected one of said boreholes by attaching a lifting line to said string in such fashion that the string suspended by the line will be positioned with the string's axis substantially vertical; lifting said line and string by an airborne vehicle until said string is suspended substantially vertically entirely from said vehicle with its lower end above the earth's surface; moving the vehicle laterally while maintaining it airborne and the lower end of the string above the surface of the earth and obstructions along its intended path of movement until the string is located above and in substantial alignment with the borehole in which it is to be used; and, while still maintaining the vehicle airborne and without lateral movement, lowering relative to the earth's surface the portion of the lifting line secured to the string until the string occupies the desired position in said last-mentioned borehole, and supporting the string therein other than by said airborne vehicle.

2. The method set forth in claim **1** in which the string is preassembled in a horizontal position and the initial raising of the preassembled string is preceded by the attachment to the string of an inclined ramp, and said ramp is maintained attached to the string to support the preassembled string during initial lifting of the string until said string occupies the suspended position with its lower end above the surface of the ground.

3. The method set forth in claim **1** in which the string prior to the raising operation is disposed in assembled form in a borehole in substantially vertical position and said raising operation includes raising the string in substantially vertical direction parallel to its axis until it is disengaged from its initial position in said borehole.

4. The method set forth in claim **1** in which the airborne vehicle is a helicopter, and while airborne said helicopter is raised to an altitude above the earth's surface greater than the length of the assembled string.

5. The method set forth in claim **1** in which the string is ultimately transferred from the one of said boreholes in which it is initially placed to another of said boreholes by the steps recited in claim **1** for transferring it from the assembly station to said selected one of said boreholes.

6. The method set forth in claim **1** in which the string is ultimately transferred from the selected one of said boreholes, in which it has been placed for use, back to said assembly station by a reversal of the steps recited in claim **1** for transferring it from said assembly station to said selected one of said boreholes.

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