

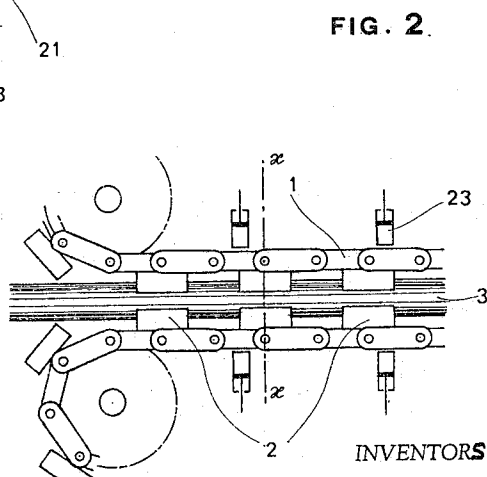
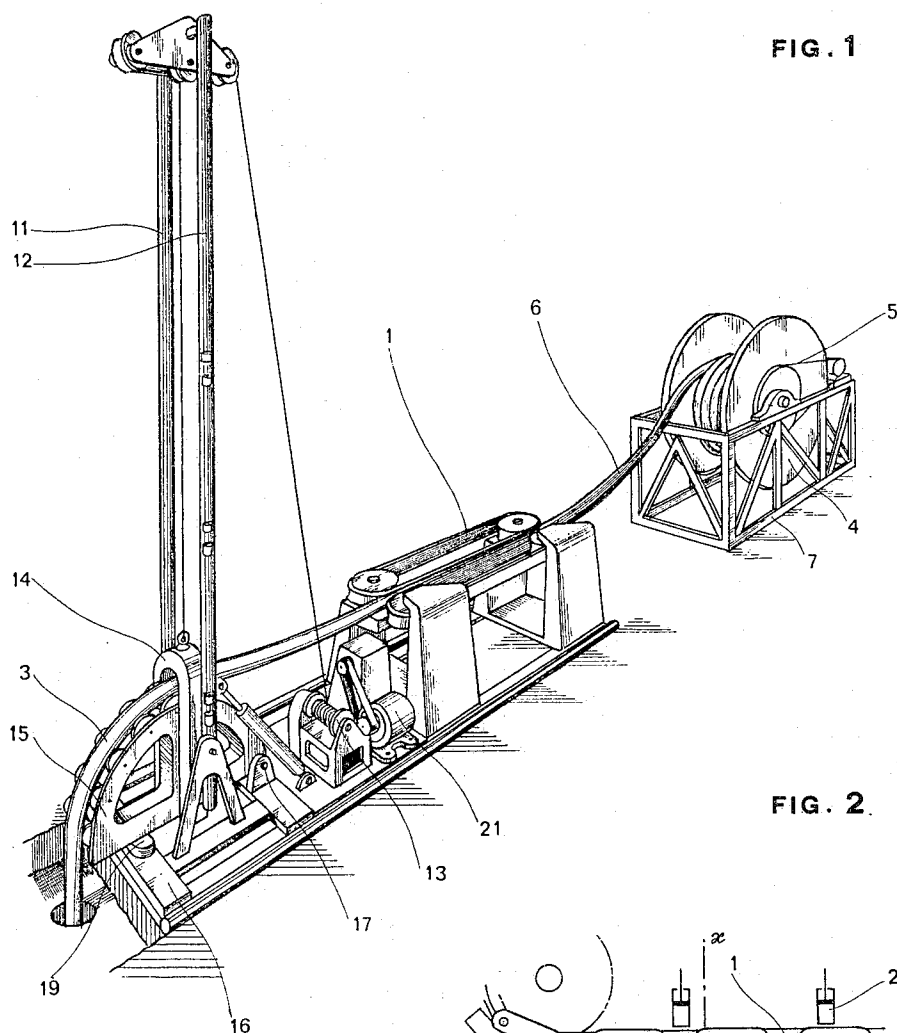
Sept. 27, 1966

J. DELACOUR ETAL
WELL DRILLING APPARATUS

3,275,300

Filed June 1, 1964

5 Sheets-Sheet 1



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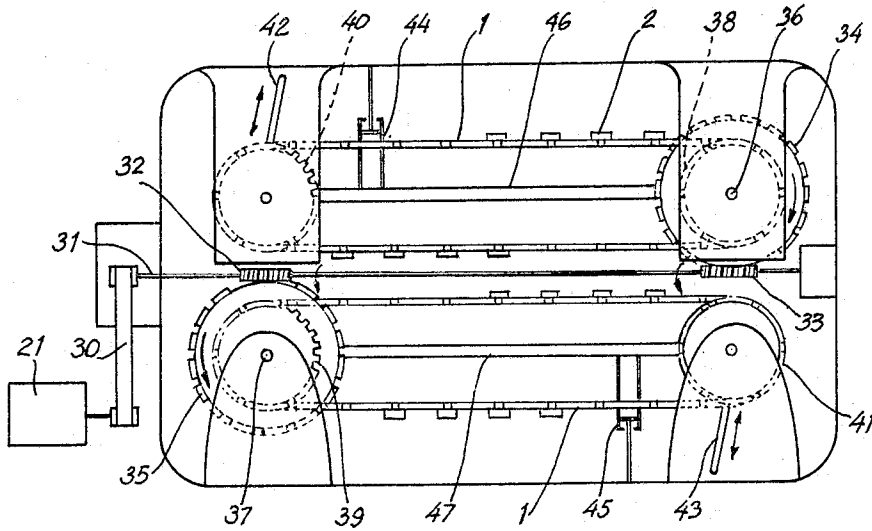


Fig. 7a

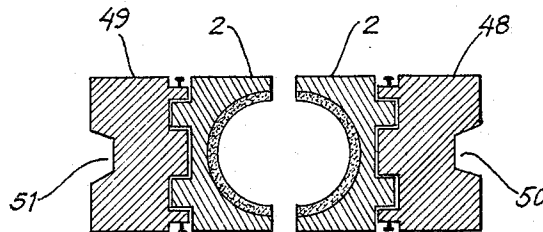


Fig. 2a

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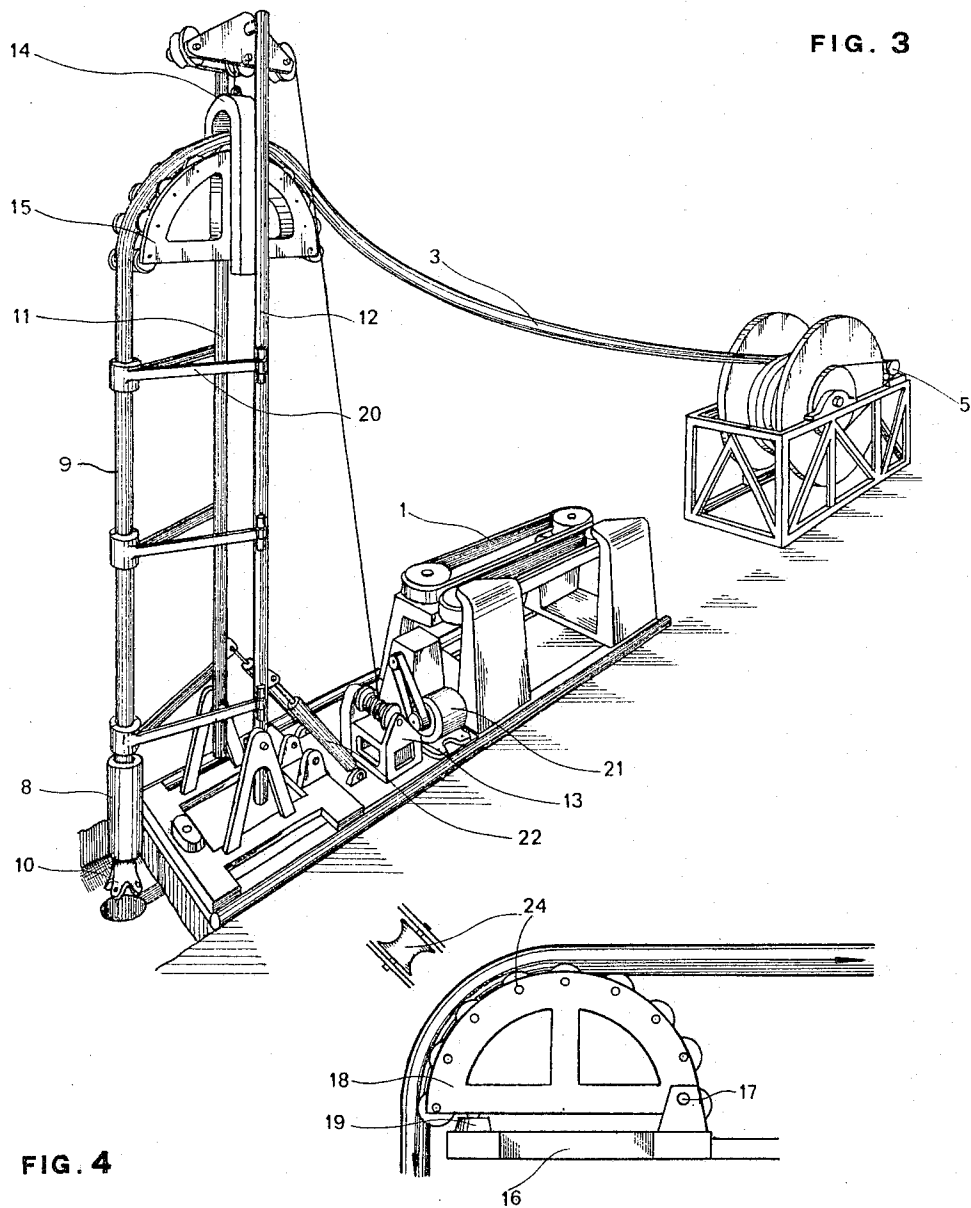


FIG. 4

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FIG. 5

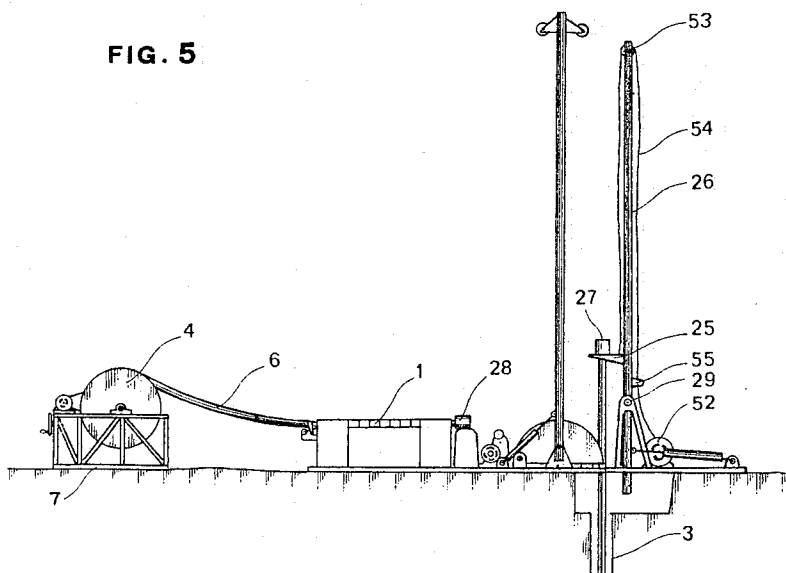
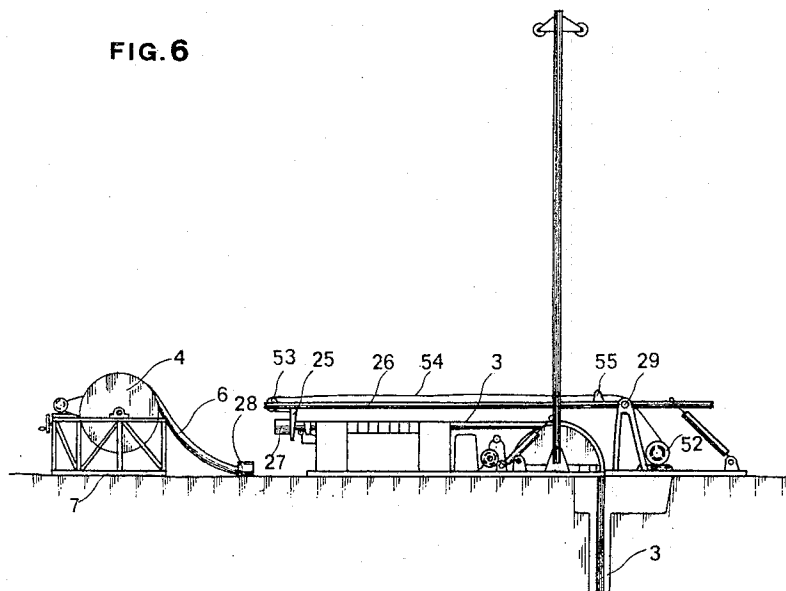


FIG. 6



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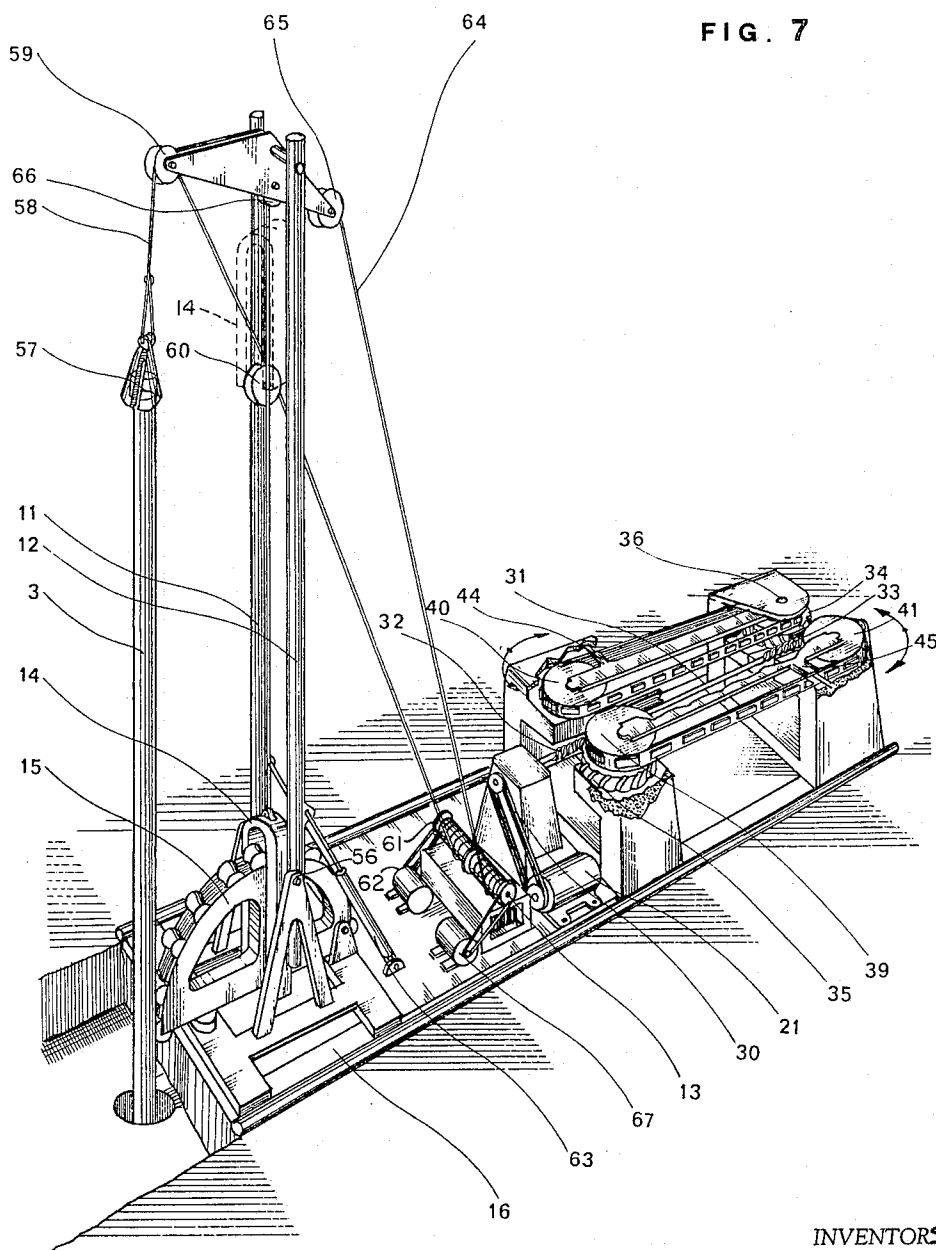
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FIG. 7



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WELL DRILLING APPARATUS

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Claims priority, application France, July 29, 1960, 834,590

8 Claims. (Cl. 254—175.7)

This invention is a continuation-in-part of application Serial No. 125,263, filed July 19, 1961, now abandoned, which in turn claimed priority of French patent application 834,590, filed July 29, 1960, and French patent application 851,029, filed January 26, 1961.

On certain drilling operations the drill bit is actuated by means of a bottom boring machine, such as an electromotor or a hydraulic turbine, which is suspended to the end of a flexible tubing. The drilling liquid passes through the tubing which may be provided with electrical conductors to feed the bottom boring machine with electrical current.

In such a case the surface apparatus used for operating the drill string, i.e., for winding and unwinding the flexible tubing or hose supporting the bottom boring machine and the drilling bit, generally comprises a motor winch of a conventional type.

The drum of this winch is actuated by a motor of suitable power through a transmission system which simultaneously provides:

Either for the traction and the winding of the flexible hose during the withdrawal of the drill string, Or for the unwinding of the flexible hose and control thereof during the lowering of the drill string into the well.

Such a motor winch may be used with a lifting device of the conventional type such as, a derrick or a tower provided with upper and lower pulleys (e.g., crown block and travelling block) on which must pass the flexible hose. Such pulleys have a diameter which cannot be selected at will but must be in accordance with the structural characteristics of the derrick or the tower.

However, such methods suffer from the drawbacks of subjecting the flexible hose to simultaneous pulling, bending-torsional and compression stresses which are detrimental on one hand to a normal circulation of both the drilling liquid and electrical current and on the other hand to the mechanical strength of the flexible tube over a long period of time.

It is therefore an object of the present invention to avoid these drawbacks by using an apparatus for handling the hose by means of which the traction part is separated from the winding part.

It is another object of this invention to provide means for handling the hose so as to substantially avoid the tendency of the hose to bending-torsion and crushing on the winding drum.

It is still another object of this invention to provide a lifting device of reduced bulkiness for handling, and particularly for lowering and raising, flexible tubings into and out of a well.

It is a further object of this invention to provide a lifting device adapted to maintain the flexible tubing in substantially rigid alignment during the drilling operation and to raise and lower the rigid terminal part of the drill string, consisting essentially of the bottom motor, a few drill collars and the drilling bit.

These and other objects and advantages are achieved by use of the surface apparatus according to this invention comprising a pair of endless chains for applying

traction to the tube, in combination with a lifting device provided with a frame having an arcuate periphery and a plurality of grooved rollers mounted on said arcuate periphery, said frame being slidably mounted between two vertical masts and on which passes the flexible tube.

However, when using such a surface apparatus it may be difficult to pass the coupling sleeves of the tubing on the arcuate roller-carrying frame in view of their rigidity over a certain length and in the path between the endless chains in view of their diameter which is larger than that of the tube itself.

It is therefore a still further object of this invention to avoid these drawbacks by providing means, in association with the endless chains means, for facilitating the operations of coupling and uncoupling of successive tubing lengths, by avoiding the passage of the coupling sleeves on the pulley and in the path between the endless chains.

Still other objects and advantages of this invention will be appreciated upon consideration of the following specification and the accompanying drawings, which constitute a part of said specification and wherein:

FIGURE 1 is a somewhat schematic perspective view of the general assembly of the surface apparatus according to this invention,

FIGURE 2 is an enlarged view of the two endless chains having a portion of tube therebetween,

FIGURE 2a is a transverse section through the clamps taken along the line $x-x'$ in FIG. 2.

FIGURE 3 is a view similar to that of FIG. 1 and illustrating the rigid part of the drill string in upper position,

FIGURE 4 is a detailed elevational view of the arcuate roller-carrying frame and the guide rollers provided thereon,

FIGURES 5 and 6 are side elevational views of the surface apparatus shown in FIG. 1, and illustrating the use of a complementary device providing means for avoiding the passage of the tube couplings on the arcuate roller-carrying frame and between the endless chains,

FIGURE 7 is a perspective view showing more details the structure of the endless chain means and illustrating the use of two articulated masts, and

FIGURE 7a is a view from above of the endless chain means shown in FIG. 7.

In the different drawings the same parts are designated by the same reference numbers.

Referring first to FIGURE 1, it may be seen from the general assembly of the surface apparatus shown therein that the traction of the tube is entirely effected by the endless chains with the advantage of a good distribution of the longitudinal strains on its whole external surface, whereas, during the winding, the tube is only subjected to the minor strains resulting from its own weight of the unwound part thereof 6 between the endless chain 1 and the reel 4. The pair of endless chains used according to this invention is of a conventional type already used in cable manufacturing for the traction of cables or tubes during the manufacturing steps thereof, between the various store-reels receptacles on one hand and the slubbing or the extruding machines on the other hand. The drill sustaining mechanism of this invention consists of two endless chains driven from a motor 21.

As shown in FIGURE 7a the motor 21 by means of the belt 30 imparts rotation to the shaft 31 journaled in the frame and carrying two worms 32, 33 of the same pitch. When this shaft is rotated in the direction of the arrow, these worms drive the gears 34, 35 in the directions indicated by the arrows about the vertical axes 36, 37.

The gears 34, 35 are integral with co-axial sprocket wheels 38, 39 which drive the endless chains constituting

the caterpillars 1, only a few of their clamps 2 being shown. The endless chains then pass over the idler sprockets 40, 41 whose vertical axes can be moved in guideways 42, 43 provided in the supporting frame to permit the conduit to be grasped by the clamping jaws on the endless chains when the two jacks 44, 45 bearing against the main-frame are actuated to press against the pieces 46, 47 on which the pairs of sprocket wheels 40, 41 are mounted.

This clamping mechanism is exactly the equivalent of that shown in FIGURE 2 where the jacks 23 act directly on the endless chains.

Endless chains of this type have also been used for sustained drill cables in drilling apparatus of the impact type or inserting a cable, for measuring purposes, into a high-pressure well.

FIGURE 2 illustrates the operation of the endless chains system. A flexible hose 3 is engaged in the path between two chain belts composed of a number of articulated links, which rotate simultaneously in opposite directions so that oppositely facing links thereof move in the same direction at the same time.

Clamps 2 which are carried by the links of the chains hold the tubing from slipping. These clamps are adapted to grip the hose or tubing by frictional strength resulting from a compressive force applied to said links and clamps by means of an appropriate hydraulic, pneumatic or oil and air-compressing device 23. The surfaces of the clamps which contact the external surface of the tube are preferably substantially semicircular in shape so as to apply a uniform compression on the tube and thereby secure a good distribution of the longitudinal stress and strains to which the tubing is subjected, on its entire external surface.

FIGURE 2a represents a transverse section through FIGURE 2 showing the clamps 2 (in slightly separated positions) for grasping the conduit, the clamping jaws being articulated on two shackles 48, 49 carried respectively by the two endless chains. These shackles have recesses 50, 51 to be engaged by the teeth of the sprocket wheels.

The clamps are lined with an elastic material (such as rubber) or plastic on their contact surfaces.

The two chain belts may be moved simultaneously by means of a motor which actuates sprockets in operable engagement with the chain belts, at a speed which is adapted to the desired linear speed of the tubing.

The characteristics of the pair of endless chain systems may be adapted to any required traction strength by selecting

The shape of the clamps and the type of material of which they are made,

The length of the path formed between the two endless chains, and

The gripping pressure applied to the clamps of the chains, so as to uniformly distribute the traction strain substantially on the entire external surface of the tube section engaged between the clamps, the resulting pressure per surface unit on the tube being substantially lower than the maximum pressure sustainable by the tube or its constituent materials.

Accordingly, this avoids subjecting the tube to any excessive torsion or crushing.

After its passage through the endless chains system 1, the tube is wound on the reel 4 actuated, for instance, by means of a driving motor 5 preferably adapted for operation at constant torque and having a running speed automatically adjusted to the travelling speed of the tube through the endless chains system. As a result, no traction strain is applied to the tube except that negligible one resulting from the own weight of the portion 6 of the tube between the endless chain system and the reel.

The automatic adjustment of the speed of rotation of the electric motor 5 with respect to the speed of move-

ment of the chain is readily accomplished by the use of a constant torque motor of a well known type and does not require any special connections between the motor and the chain. Constant torque motors are well known and are described in the "Electric Motor Book," published by "Machine Design" Ed. Fenton, Cleveland, 1961, chapter 17, "Torque Motors," pages 129-132.

Both the reel 4, mounted for rotation on some form of support 7, and its driving motor may accordingly be chosen of very simple and light types which makes easier the coupling of successive lengths of tubing and the storage of the same on one or more reels of convenient size.

Although the drill-string consists essentially of the flexible tubing supporting the drill bit and the boring machine, it necessarily comprises a rigid part corresponding to the bottom boring machine 8 and the few drill collars 9 surmounting the same which are used for applying to the drill bit 10 a sufficient weight to assure a vertical positioning of the bore hole (see FIG. 3).

For raising and lowering this rigid part of the drill string a lifting device of an appropriate height is required. It is just an object of this invention to provide such a lifting device conceived for cooperation with the endless chains system so as to avoid any detrimental effect on the mechanical strength of the tube or its components.

The lifting device according to this invention as illustrated by FIGURES 1 and 3, essentially comprises two vertical masts 11 and 12 having slidable therebetween an elevating member 14 actuated by a winch 13 and consisting essentially of a large diametered arcuate roller-carrying frame 15 on which passes the flexible tubing 3.

The lowering and raising of this rigid part of the drill string into and out of the well is effected by operation of the elevating member 14, the reel 4 being blocked and the flexible tube passing directly from the reel to the elevating member instead of passing intermediately through the endless chain system, the chains of the latter being first spaced from each other (operating position shown in FIG. 3) so as to release the tube.

In the lower position shown in FIGURE 1, the elevating member 14 rests on a common platform 16 which supports both the endless chains system and the lifting device.

The radius of the arcuate roller-carrying frame 15 is preferably chosen equal to the height of the plane of the endless chains above the platform. The flexible tube is thus exactly engaged in the path between the endless chains which are then pushed nearer to each other so as to restore the working conditions as set forth above.

Such an arrangement of apparatus thus provides means for reducing the number of direction changes of the tubing to one, which is of 90°. This direction change is effected by means of the large diametered arcuate roller-carrying frame so that the strains to which the tube is subjected are amply compatible with its mechanical strength and that of its components.

Moreover, the strains to which the tube is subjected when passing on the arcuate roller-carrying frame may be substantially reduced by providing the latter with a number of guide rollers 24, the cross-sections of which closely conform to that of the tube. The arcuate roller-carrying frame may be formed by assembling said guide rollers between two joint plates.

The arcuate roller-carrying frame is advantageously articulated to the platform when in lower position (see FIGS 3 and 4) by means of pivot 17 provided at that end of its diameter which is the most remote from the bore hole. The other end 18 is free. Provision is made for inserting a compressiometer 19 between the platform 16 and the lower part of the arcuate roller-carrying frame.

The distance at which this compressiometer, measuring the weight of the suspended drill string, is placed from the articulation axis is so selected as to obtain the desired sensitivity of the measuring.

When starting the drilling operation, the elevating mem-

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ber is placed at its upper position, the reel is blocked and the tube passes directly from the reel to the elevating member (see FIG. 3).

The rigid part of the drill string (8 and 9) is maintained vertical, i.e., parallel to the two masts, by means of a number of guides 20 detachably mounted on said masts and preferably regularly spaced from one another over the entire height of the masts.

The drilling operation is carried out by progressively lowering the elevating member 14 in proportion to the depth drilled, the guides being progressively withdrawn as the drilling proceeds.

As soon as the elevating member attains its lower position, which corresponds to a drilled depth equal to the length of the rigid part of the drill string, the flexible tubing is engaged between the endless chains and the drilling continues in the manner stated above, the drill string being then supported by the endless chains system.

As the drilling further continues, it may be necessary to connect a plurality of tube lengths to each other. Similarly during the withdrawal of the drill string these tube lengths would have to be detached from one another.

The coupling and uncoupling of the tube lengths may be carried out when the coupling sleeves have a position intermediate between the reel and the endless chains system, after blocking of the tubing between the two chains of the latter.

However, in this case, the coupling sleeves must pass on the arcuate roller-carrying frame and through the endless chains system, which requires the use of a particular hydraulic, pneumatic or oil and air-compressing device for applying the clamps of the endless chains against the tube. This device is adapted for gripping between the endless chains the coupling sleeves of larger diameter than the tube when the latter is conveyed through the endless chains system.

This drawback as well as the difficulties of passing the coupling sleeve elements 27 and 28 on the arcuate roller-carrying frame in view of their rigidity, may be avoided by use of an appropriate device as shown in FIGS. 5 and 6 which provides means for avoiding the passage of the coupling sleeves both on the arcuate roller-carrying frame and through the endless chains system. Accordingly, a plurality of tubing lengths may easily be either coupled to each other as the drilling proceeds or uncoupled during the withdrawal of the drill string with each tubing length being wound on a corresponding reel of convenient size.

The particular device for handling the coupling sleeves apart from the arcuate roller-carrying frame and the endless chains system is an articulated mast consisting of one or two vertical bar members rigidly connected to each other and supporting a vertical guide for a slidable carrying sling for holding the coupling sleeve. This sling supports the flexible tube which may be vertically displaced by actuation of the sling.

FIGURES 5 and 6 illustrate by way of example and in the case of use of a special articulated mast, the operating manner for the withdrawal of the tubing and the storage of the successive lengths of the same on the corresponding reels, or inversely, for adding new tube lengths as the drilling proceeds.

In the case where the tubing is withdrawn, at the moment where the coupling sleeve appears at the earth surface, the carrying sling 25 associated to the articulated mast 26 is placed just under the coupling sleeve so as to support the tubing 3.

The two sleeve elements 27 and 28 of the coupling are then detached from one another. The tube length 6 provided with the sleeve element 28 is released from the endless chains system and thereafter wound on the reel 4 rotatably mounted on the support 7. A new empty reel takes its place for furthering the operation. The carrying sling 25 supporting the tubing 3 is then caused to slide

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upward along the mast 26 up to a height above the articulation axis 29 of the latter which is at least equal to the distance between said articulation axis and the most remote end of the endless chains. The articulated mast is then lowered to a substantially horizontal position so as to engage the tubing 3 into the path between the two endless chains which are then pushed nearer to each other so as to grip the tube between the clamps (position illustrated by FIG. 6). The tube, being then held by the endless chains system, the mast 26 is raised back to a vertical position. The withdrawal of the tubing is then performed by operating the endless chains system and winding the tubing length on the new reel provided therefor. The sling 25 is operated by means of a motor 52, pulley 53 and cable 54 passing along the mast 26 through a guide 55 and over the pulley 53.

Concerning the passage of the articulated mast 26 between the masts 11 and 12 (FIGURE 6), in the case where the articulated mast 26 is separate from the masts 11 and 12, it can be seen that while for the purpose of simplification the lifting means for elevating member 14 has been represented as a simple cable, it is obvious from FIGURE 7 that two pulleys at the top of masts 11 and 12 could be employed for supporting the elevating member 14 separated from arcuate roller carrying frame 15 by leaving between the masts 11 and 12 and the prongs of 14 a space for the passage of mast 26.

It must be observed that the uncoupling of the two sleeve elements may be effected when the coupling sleeve has a position intermediate between the reel and the endless chains and, for instance, close to the outlet end of the latter.

In such a case the surface apparatus is operated as follows:

The articulated mast being vertical, the carrying sling is placed just under the lower end of the coupling sleeve and the endless chains system is released. The raising of the carrying sling on the mast completely disengages the tube from the path between the endless chains. The whole coupling sleeve as well as the adjacent parts 3 and 6 of the tube are then tilted back to a substantially horizontal position so that the tube portion 3 is engaged in the path between the endless chains 1 which are then pushed nearer to each other, thereby gripping the tube within the clamps. The two sleeve elements 27 and 28 of the coupling are thereafter disconnected (see FIG. 6), and the end part of the tube length 6 is wound on the reel 4, another reel being thereafter used for the storage of the next tubing length 3.

The lowering of the tubing into the bore hole is effected similarly but in reverse order.

When the end of the tube length 3 arrives in front of the endless chains (FIG. 6), the articulated mast 26 having its slidable sling in upper position, is tilted back so as to place the sling just behind the terminal sleeve element 27 of said tube length, i.e. just against the shoulder formed by said element so that the latter is held by the sling. After releasing of the endless chains the tube is raised to a vertical position by means of the mast 26 and lowered into the bore-hole by sliding down the carrying sling. Another tubing length is then unwound from another reel and engaged into the path between the endless chains to such an extent that the terminal sleeve element of said tubing length is outside the endless chains system (see FIG. 5). Said sleeve element is then coupled with that of the end of the tubing length 3 and the drilling is thereafter continued normally.

Obviously it will be also possible in this latter case to connect the two tubing lengths when the position of the coupling sleeve is intermediate between the reel and the endless chains, the mast 26 bringing back to a vertical position the whole coupling sleeve with the adjacent parts of tube.

In this latter case and when the lifting device comprises

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two parallel bar members, the space therebetween must be sufficient for providing a passage to the endless chains system when they are in a substantially horizontal position.

It is not however necessary to make use of special masts for performing the above described operations, since the masts 11 and 12 of the lifting device adapted for lowering or raising the arcuate roller-carrying frame 15 may also be used for that purpose, as hereinafter described with reference to FIGURE 7.

In this surface apparatus the masts 11 and 12 are rotatably mounted around an horizontal axis 56 supported by the platform 16. Movable jaws 57 for holding the coupling sleeves can be raised or lowered vertically by means of a cable 58 passing over the pulley 59 and the guide pulley 60 and wound on the winch 61 operated by the motor 62. The lowering or raising of the masts 11 and 12 is effected by means of jacks 63.

Obviously the space between the masts 11 and 12 must be sufficient to provide a passage to the endless chains, when these masts are in a substantially horizontal position. However on FIGURE 7, the endless chains system has been shown wider than said space between the masts, in order to represent the same with more details. In this surface apparatus the elevating member 14 is actuated by the cable 64 passing over pulleys 65 and 66 and wound on the winch 13 operated by the motor 67.

By way of example, here is now described a manner of operating the apparatus according to FIGURE 7. When a coupling sleeve appears at the earth surface during the withdrawal of the tubing (the elevating member 14 being in its lowermost position), the jaws 57 grasp the lower element of the coupling sleeve and then the two sleeve elements are detached from each other.

The tube element ending with the upper sleeve element (not shown on FIGURE 7) is released from the endless chains system and thereafter wound upon the storing reel.

The jaws 57 are then raised by operating the motor 62, up to an height above the articulation axis 56 of the masts which is at least equal to the distance between said articulation axis and that end of the endless chains which is the most remote therefrom.

The articulated masts are then lowered to a substantially horizontal position so as to engage the tubing 3 into the path between the two endless chains which are then pushed nearer to each other so as to grip the tube therebetween.

The operation then proceeds in the same way as hereinabove described with reference to FIGURES 5 and 6, in the case of the use of one or two special separate masts.

It will be understood that while there have been given herein certain specific examples of the practice of this invention it is not intended thereby to have this invention limited to or circumscribed by the specific details of materials, size or conditions herein specified for illustrative purposes, in view of the fact that the invention may be modified according to individual preference or conditions without necessarily departing from the spirit of this disclosure and the scope of the appended claims.

What is claimed is:

1. A surface apparatus for handling a drill string in drilling bore holes by means of a well boring machine suspended on a flexible tubing, and comprising in combination substantially vertical mast means positioned at substantially the head of a bore hole, an arcuate roller-carrying frame provided with grooved rollers, said frame being slidably mounted between said substantially vertical mast means for movement from an upper position to a lower position, means for so moving said frame, said flexible tubing extending over said frame and grooved rollers and carried thereby, means supporting said frame in said lower position to receive the flexible tubing vertically and tangentially from said bore hole and for delivering it horizontally and tangentially to a horizontal support, means on said support for laterally gripping said tubing

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on said support and moving it horizontally, said last named means comprising opposed horizontally operating endless chain means having a path therebetween for said tubing, means for driving said endless chain means and reel means to receive the tubing moved horizontally by said chain gripping and moving means.

2. A surface apparatus for handling a drill string in drilling bore holes by means of a well boring machine suspended on a flexible tubing, and comprising in combination a pair of vertical masts positioned at substantially the head of a bore hole, an arcuate roller-carrying frame slidably mounted between said two vertical masts to form a lifting device therewith for said drill string, said frame having a plurality of guide rollers thereon for the passage of a tubing thereon and imparting to the tubing a substantially horizontal position after the tubing passes from the bore hole over the frame when the frame is in its lowermost position, substantially horizontal endless chain means forming a passage for the horizontally positioned tubing after passage of the tubing over said frame, said two endless chain means gripping the tubing therebetween so as to neutralize the traction, bending-torsional and crushing strains to which the tube is subjected, and reel means receiving flexible tubing after passage of the same through said endless chain means to store the tubing thereon.

3. A surface apparatus as claimed in claim 1, and further comprising a lifting mast pivoted for movement around a pivot axis and positioned substantially at the head of a bore hole and in alignment with said roller-carrying frame and said endless chain means, a carrying sling slidably mounted on said lifting mast in alignment with the bore hole and adapted to support a drill string by holding a coupling sleeve element thereof, means for moving said sling to the top of the mast, the flexible tubing of said drill string comprising a plurality of tube lengths detachably connected to each other by coupling sleeves, the height of said lifting mast above its pivot axis being at least equal to the distance between said axis and the farthest end therefrom of said endless chain means, said pivot axis being perpendicular to the direction of alignment of said mast with said frame and said endless chain means.

4. A surface apparatus according to claim 1 wherein said reel means comprise a reel for the storage of the tubing and a motor driving said reel and operated at constant torque, the running speed of said motor being thus automatically adapted to the travelling speed of the tubing through said endless chain means.

5. A surface apparatus according to claim 1 wherein said frame is mounted on an elevating member slidably mounted between said mast means.

6. A surface apparatus according to claim 1 wherein said frame when in said lower position is articulated to a common platform for said endless chains means and said lifting device, through articulating means provided at that end of its diameter which is the most remote from the bore hole, and a compressiometer is inserted between said platform and the lower part of the frame adjacent the borehole.

7. A surface apparatus according to claim 1 wherein the mast means of said lifting device are provided with guides for securing the verticality of the rigid part of the drill string at its upper position corresponding to that of the beginning of the drilling operation.

8. A surface apparatus according to claim 1 wherein said vertical mast means are pivotally mounted for movement around a horizontal pivot axis and comprise pulley means substantially in alignment with the bore hole and vertically movable jaws suspended from a cable passing on said pulley means and wound on a winch, a flexible tubing of said drill string comprising a plurality of tube lengths detachably connected to each other by coupling

sleeves each formed of two coupling elements, said jaws being adapted to grasp said coupling elements of the ends of tubing lengths and means for pivoting said mast means from a vertical to a substantially horizontal position, so as to engage said tubing portion into the path between said endless chain means, the height of said vertical mast means above its pivot axis being at least equal to the distance between said axis and the farthest end therefrom of said endless chain means, said pivot axis, being perpendicular to the direction of said path.

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