

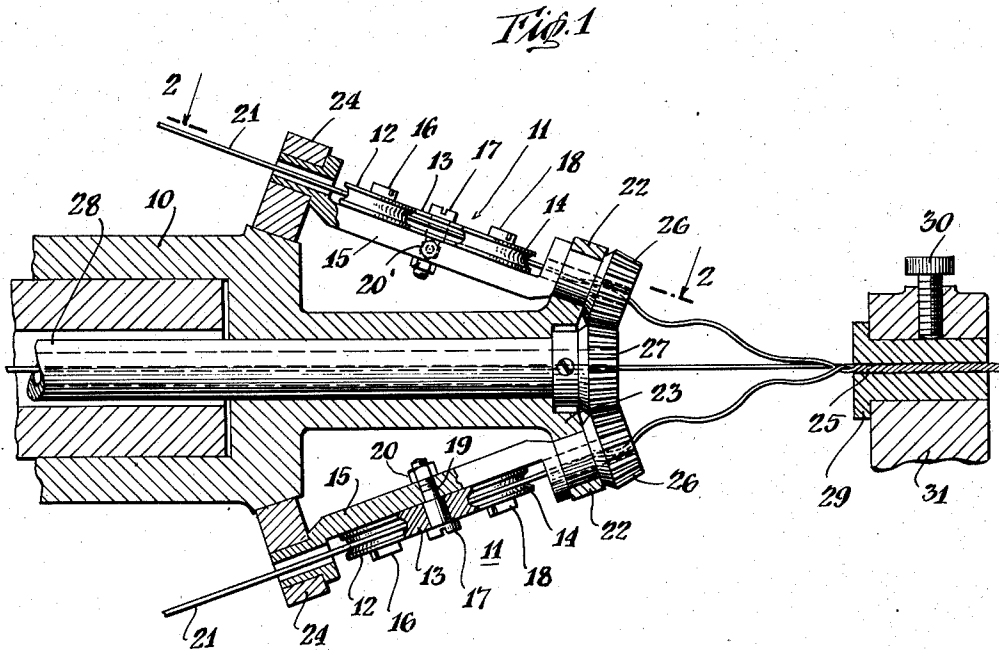
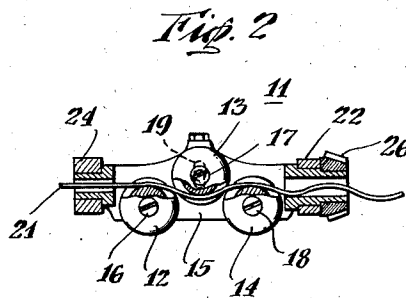
Aug. 11, 1942.

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2,292,971

WELL CABLE TOOL DRILLING LINE AND METHOD OF MAKING SAME

Filed June 12, 1940



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UNITED STATES PATENT OFFICE

2,292,971

WELL CABLE TOOL DRILLING LINE AND
METHOD OF MAKING SAME

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Application June 12, 1940, Serial No. 340,081

6 Claims. (Cl. 57—145)

The present invention relates to wire rope and the like, and more particularly to a new and improved stranded wire rope for use in drilling operations in deep wells, although it is not limited to such use.

In drilling wells by means of a conventional cable tool rig, a drilling tool is suspended in the bore hole on a stranded wire cable known in the art as a drilling line, and the drilling line is reciprocated in the bore hole for the purpose of whipping the drilling tool on and off the bottom of the well. The drilling line in many cases is constituted by a conventional type stranded wire rope which may comprise, for example, a central core of hemp or metal about which are wound a plurality of unperformed strands, generally six, under tension. An unperformed stranded wire rope of this character has the requisite elasticity and springiness to produce the desired whipping action on the drilling tool during the course of the drilling operations.

In drilling operations in deep wells, that is to say wells more than 6,000 or 6,500 feet in depth, it has been found that the weight of the line and the drilling tools produces an excessive concentration of stress at the clamps in the drilling rig at the surface of the earth. Because of these excessive stresses, a rapid and excessive elongation of the rope layers is produced which is accompanied by a corresponding reduction in rope diameter. As a consequence, the rope tends to slip through the clamps, producing severe abrasion of the outer strands and complete pulverization of the hemp core, culminating eventually in complete breakdown of the drilling line at this point.

In order to avoid these difficulties in deep wells, it has been proposed to use as the drilling line a preformed wire rope of the type disclosed in prior Patents No. 1,732,640 and No. 1,781,894. In a wire rope of this character the respective strands are preformed before being laid upon the core to give them the helical conformation which they normally have in the completed rope.

While a wire rope of this character has a greater modulus of elasticity than conventional unperformed stranded wire rope, it does not have the requisite springiness or elasticity to whip the drilling tools on and off the bottom of the bore hole during the drilling operations. For this reason it has not gone into extensive use.

It is an object of the invention, accordingly, to provide a new and improved wire rope which is free from the defects of the prior art mentioned

above and which may be effectively utilized in the drilling of deep wells.

Another object of the invention is to provide a new and improved drilling line of the above character which is sufficiently elastic and springy to whip the drilling tools on and off the bottom of the bore hole, yet which is capable of withstanding the excessive stresses normally produced at the clamps of the drilling rig in the course of drilling operations in deep wells.

A still further object of the invention is to provide a novel method for manufacturing a wire rope drilling line of the above character.

The objects of the invention are attained by forming the drilling line with an upper preformed and stress-free portion having a relatively high modulus of elasticity and a lower unperformed portion having high elastic properties and springiness. In order to prevent the concentration of stress at any particular point on the line, the physical properties of the line are preferably changed from the conventional unperformed state to a preformed state in gradual progressive steps, the transition being carried out preferably in the approximate center of the completed line.

By virtue of this novel construction, the lower portion of the drilling line is sufficiently elastic and springy to whip the drilling tool on and off the bottom of the well while the upper preformed portion of the drilling line, because of its relatively high modulus of elasticity, is able to withstand the weight of the line and the drilling tool without the excessive elongation usually observed when a conventional type, unperformed stranded wire rope is employed. Furthermore, since the physical characteristics of the line are changed from the unperformed state to the preformed state in gradual steps, any undesirable concentration of stress in the drilling line itself is effectively eliminated.

Additional objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawing, in which:

Figure 1 is a view in vertical section illustrating an apparatus for preforming the respective strands prior to their incorporation in a wire rope, and

Figure 2 is a partial view of the apparatus shown in Figure 1, taken along line 2—2, looking in the direction of the arrows, and illustrating the preforming mechanism in detail.

For the sake of simplicity, the invention will be described as embodied in a wire rope drilling line for use in a well of say, about 8500 feet in

depth. In such case, the lowermost 4,000 feet of the line, for example, will be constituted by conventional unperformed wire rope which has the requisite characteristics of elasticity and springiness for drilling operations of this type. From the 4,000 foot point on, the respective strands constituting the wire rope drilling line will be gradually and progressively preformed until at about 4,500 feet, for example, the line will have the characteristics of a fully preformed wire rope, as set forth in the above mentioned prior patents. The line may then be completed by providing an additional 4,000 feet of fully preformed wire rope.

Obviously, the ratio between the length of the unperformed portion and the length of the preformed portion of the rope may be different from that chosen in the example given above. Any suitable ratio may be taken, provided only that the upper portion of the wire rope in the vicinity of the clamps is constituted by fully preformed strands and the lower portion to which the drilling tool is secured is fully unperformed.

Likewise, the length of the transition portion of the rope in which the characteristics of the strands are changed from fully unperformed to fully preformed may be varied over a relatively wide range as desired.

A fully unperformed stranded wire rope may be defined as one in which the strands are laid on the core without any preforming. In such a rope, the respective strands are under tension in the rope lay so that when the rope is cut the strands tend to unravel suddenly.

In a fully preformed stranded wire rope, the respective strands are preformed, prior to being laid upon the core, to give them the helical shape which they will have in the completed rope. The strands in a wire rope of this character do not tend to unravel when the rope is cut.

As a practical matter, it is customary to define the degree of preforming of a wire rope strand in terms of the diameter of the helix formed by a strand as it is removed from the completed rope. By way of example, the pitch and diameter characteristics of a representative drilling line constructed according to the invention are given below.

In a typical drilling line, a stranded wire rope comprising a hemp core having six twisted strands thereon was used. The pitch of the helix formed by the respective strands was taken as approximately 6.5 times the diameter of the rope and the diameter of the helix formed by the fully preformed strands after their removal from the rope was found to be equal to from 92 to 95% of the nominal diameter of the rope. As distinguished from this, the diameter of the helix formed by the fully unperformed strands after their removal from the rope was found to be in the neighborhood of 68% of the nominal diameter of the rope.

It is to be clearly understood that these values are given purely by way of example, since other suitable values may be chosen, depending upon the characteristics desired.

In fabricating a stranded wire rope drilling line, according to the invention, the lower unperformed portion is constructed in the usual manner by winding the respective strands under tension around a core which may be either of hemp or metal. The change in the physical characteristics of the line from the unperformed

state to the fully preformed state may be accomplished by means of the apparatus shown in Figures 1 and 2 of the drawing which is illustrated in greater detail in prior Patent No. 2,036,393.

Referring to Figure 1, a preforming head 10 is shown which comprises a plurality of preforming elements 11, there being as many elements 11 as there are strands in the completed wire rope. As shown in greater detail in Figure 2, each preforming element 11 comprises a set of rolls 12, 13 and 14 rotatably mounted upon a carrier 15 by means of the studs 16, 17 and 18, which are disposed approximately at right angles to the axis of the carrier 15.

The stud 17 for the middle roll 13 is disposed in a slot 19, in which it may be adjustably secured by means of a nut 20 and a set-screw 20'. By regulating the position of the roll 13 with respect to the rolls 12 and 14, the radius of the helical convolution imparted to the strand 21 may be varied, as desired.

The carrier 15 is mounted at one end in a bearing 22, which is provided in a flange 23 formed at the outer end of the head 10. The other end of the carrier 15 is journaled in a bearing block 24 which is supported on the head 10 in any suitable manner, as disclosed in greater detail in prior Patent No. 2,036,393.

In order to form the wire strand component 21 into helical convolutions 25, it is necessary to cause relative rotation between each component 21 and the corresponding preforming element 11 as the component 21 passes therethrough. To this end each of the carriers 15 is provided with a bevel gear 26 which is adapted to engage a bevel gear 27 carried by a hollow shaft 28 which extends through the center of the preforming head 10 and which is driven by suitable variable speed power means. If a six stranded wire rope is desired, then there will be six carriers 15 spaced at equal distances around the preforming head 10.

The completed product may be closed and drawn off through bushing 29 which is secured by a set-screw 30 in a standard 31 by means of any suitable drawing off mechanism, such as that shown in the patent to E. A. Connor, No. 1,513,583.

In fabricating the unperformed portion of the drilling line, the roller 13 will be moved as far as possible away from the rollers 12 and 14 so that no preforming of the components 21 will take place. After the desired length of fully unperformed wire stranded rope has been made and it is desired gradually and progressively to preform the strands of the rope, the roller 13 on each performing element 11 will be moved toward the rollers 12 and 14 in successive steps to produce successive line lengths preformed to different degrees.

When the transition from the unperformed state to the fully preformed state has been achieved, the position of the roller 13 with respect to the rollers 12 and 14 will be maintained fixed until the line is completed by the formation of the desired length of fully preformed wire strand rope.

Although certain specific apparatus has been described above for practicing the method of the invention, it will be understood that other types of apparatus which are well known to those skilled in the art will be suitable for this purpose. Moreover, the definitions and dimensions given above of fully preformed and fully unpre-

formed wire stranded rope are not to be construed as limiting the invention but are given merely by way of example. Any other suitable dimensions may be chosen, in accordance with the invention, depending upon the specific characteristics of the stranded wire rope which are desired.

It will also be understood that the term "strand" may include a solid wire or a plurality of wires twisted together to form a component of the wire rope.

From the foregoing it will be apparent that the invention provides a stranded wire rope drilling line which may be effectively utilized in drilling deep wells, particularly wells which are greater than about 6,000 feet in depth. By providing a lower unperformed portion on the drilling line, the requisite elasticity and springiness for whipping the drilling tool on and off the bottom of the well are attained while the upper portion of preformed wire stranded rope effectively eliminates undesirable stress concentrations and concomitant excessive elongation of the drilling line.

While a preferred embodiment of the invention has been described above, the invention is not intended to be limited thereto, but is susceptible of numerous changes in form and detail within the scope of the appended claims.

I claim:

1. The process of fabricating stranded wire rope having a central core and a plurality of strands laid thereon, which comprises the steps of advancing a plurality of unperformed strands and a central core, laying said advancing unperformed strands under tension upon a given length of the core, applying gradually increasing force to the advancing strands to preform them into helices of different diameter, and laying said preformed strands upon another length of the core.

2. The process of fabricating stranded wire rope having a central core and a plurality of strands laid thereon, which comprises the steps of advancing a plurality of unperformed strands and a central core, laying said advancing unperformed strands under tension upon a given length of the core to produce a relatively elastic and springy rope portion, applying force to said advancing strands to preform them into helices, increasing the force applied to said advancing

strands in successive steps until the helices formed by the strands have substantially the same shape which they normally would have in the completed rope, laying said successively preformed strands upon the core to form a transition rope portion in which the characteristics of the rope are changed from fully unperformed to fully preformed, maintaining the force applied to the advancing strands constant at the value required to fully preform the strands, and laying said fully preformed strands upon another length of the core to provide a relatively stress free or normalized rope portion.

3. A stranded wire rope comprising a core having a plurality of strands laid thereon, said rope having a portion in which the strands have been preformed prior to being laid upon the core, a spaced apart portion in which the strands are unperformed and under tension, and an intermediate transition portion in which the characteristics of the strands vary from unperformed to preformed.

4. A drilling line comprising a core having a plurality of strands laid thereon, said line having an upper load carrying portion in which the strands are preformed prior to being laid upon the core, a lower elastic and springy portion in which the strands are not preformed and under tension, and an intermediate transition portion in which the characteristics of the strands vary successively from unperformed to fully preformed.

5. A stranded wire rope drilling line for use in wells of considerable depth comprising a core having a plurality of strands laid thereon, the strands throughout the entire lower portion of said line being under tension and the strands throughout the entire upper portion of said line being under relatively less stress than the strands in the lower portion.

6. A stranded wire rope drilling line for use in wells of considerable depth comprising a core having a plurality of strands laid thereon, the strands throughout the entire lower portion of said line being unperformed and under tension and the strands throughout the entire upper portion of said line having been preformed prior to being laid on the core.

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