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METHOD AND APPARATUS FOR IMPROVING THE PROPERTIES OF STEEL ROPE

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FIG. 1

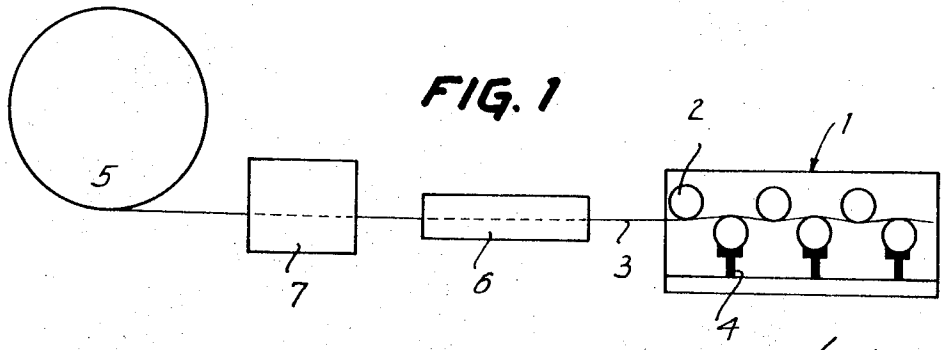
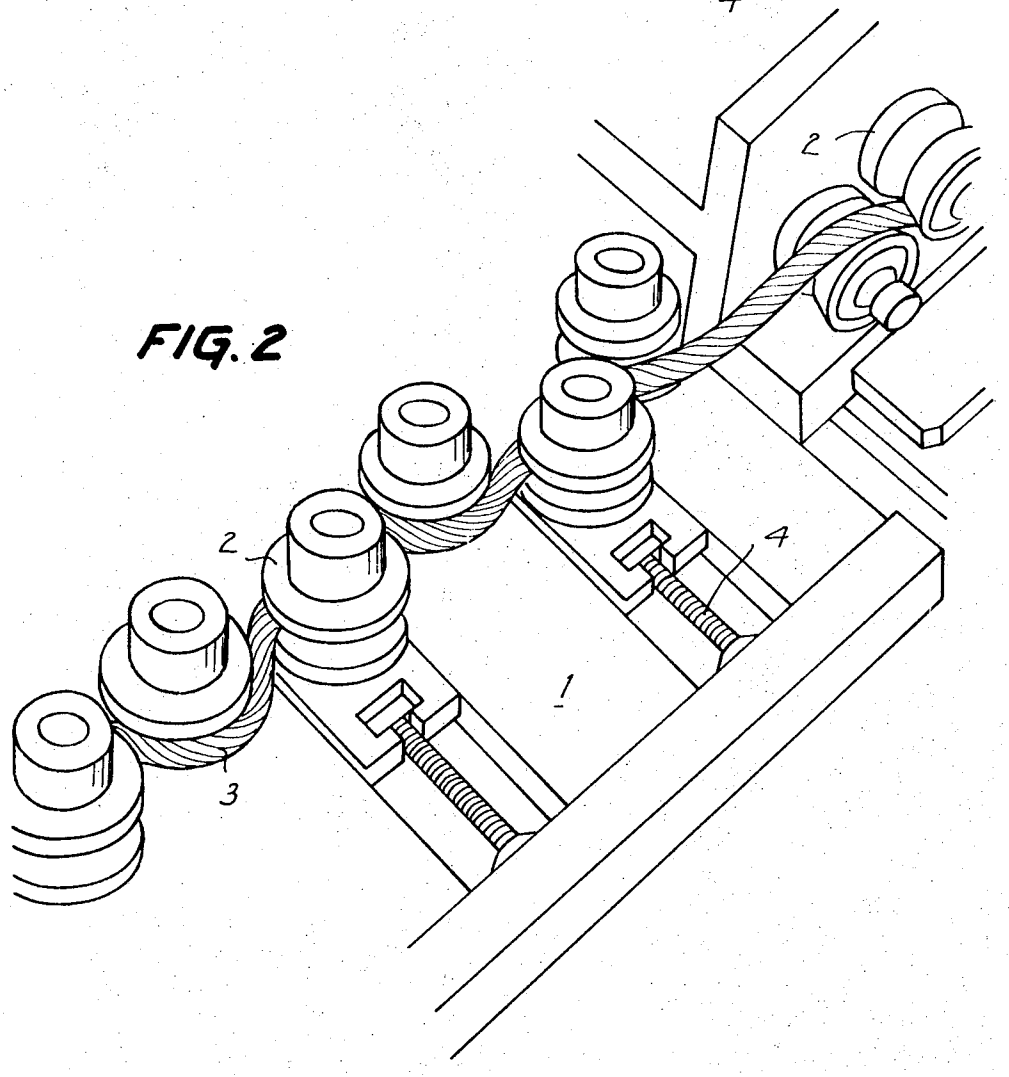


FIG. 2



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METHOD AND APPARATUS FOR IMPROVING THE PROPERTIES OF STEEL ROPE

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ABSTRACT OF THE DISCLOSURE

A method and apparatus for improving the properties of steel rope. The steel rope is subjected to a force of traction which is less than the tension required to break the rope, and while under this tension the rope is passed through a heating zone so that a given degree of stretching will be imparted to the rope. Prior to reaching the heating zone, where a suitable heating means is located, the rope is directed through an undulatory path by an adjustable roller means causing the rope to be sequentially directed along opposed curves, so that in this way prior to reaching the heating means the rope is stressed and preliminarily heated to a given degree. The tension is applied to the rope by winding the latter onto a drum which pulls the rope through the undulatory path and the heating means, and between the heating means and the take-up drum the rope is cooled either by the ambient atmosphere or through forced cooling

BACKGROUND OF THE INVENTION

The present invention relates to steel rope.

In particular, the present invention relates to a steel rope composed of a plurality of wires which are united together, as by being twisted, for example, so as to form a steel cable.

In particular, the present invention relates to the improvement of the properties of such steel rope during the manufacture thereof.

Steel rope or cable are required in many applications to be used under conditions where the rope is subjected to considerable tension. For example in poststressing or prestressing of steel rope, as when it is embedded in concrete beams, for example, the rope is subjected to considerable tension, as is well known in many different types of constructions which are widely used.

It has been found that conventional steel rope of this type does not have an elastic limit which is as high as might be desired and it is not capable of elongating or stretching to the desired degree before it will break. Moreover, conventional steel rope of this type stretches undesirably when subjected to relatively small loads. Moreover, conventional steel cable is not as straight as desired so that it cannot easily be situated within sheaths. In addition, the various wires which make up the rope do not coact together in the best possible manner since some of the wires become loose from the others.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to improve the properties of steel rope so that the above drawbacks will be avoided.

In particular, it is an object of the invention to provide the improvements in any steel rope composed of any number of wires which are united together to form a cable of medium and high carbon content of between 0.30 and 0.90%, and also the treatment of the invention is applicable to suitable steel alloys.

In general, it is an object of the invention to provide a method and apparatus which will substantially improve

the mechanical and physical properties of the steel rope.

Also, it is an object of the invention to provide a method and apparatus which will compensate for any deterioration of the mechanical properties occurring during cold drawing.

In accordance with the invention the steel rope is placed under tension by a suitable traction means while it is drawn through a heating zone of predetermined length with the speed of movement of the rope controlled so that it will be heated for a given period of time, and then the rope is subsequently cooled. Just prior to passage of the rope through the heating means it is passed through a series of adjusting rollers forming an adjusting roller means which provide an undulatory path through which the rope is drawn so that it is sequentially curved in opposed directions thus stressing the rope and heating the latter to a given degree before it is heated by the heating means. The rollers of the roller means are situated so that their axes can be displaced perpendicularly to the rope, thus enabling the rollers to be adjustably situated at a location most suitable to the particular diameter of the rope which is treated. By the use of these rollers the rope is subjected to a high degree of tension which, however, is never higher than 75% of the tension at which the rope will break.

The rope is subjected to tension by being wound onto a traction drum of relatively large diameter forming a reel onto which the cable is wound, so that in this way a take-up means is provided for transporting the rope and maintaining it under tension.

The drum which forms the take-up or traction means is of a relatively large diameter on the order of 200 times the diameter of the rope in the case where the latter is formed from seven wires. In the case where the rope is in the form of a cable formed from nineteen wires, the diameter of the take-up drum will be on the order of 100 times the diameter of the wire rope. The diameter of the take-up drum or reel must be large enough so that its curvature will have no influence on the treated rope. A heating means is situated between the adjustable roller means and the take-up means to form the heating zone through which the rope is drawn. This heating means will elevate the temperature of the rope above the extent to which it has previously been heated by being drawn through the undulatory path provided by the adjustable roller means. The heating means provides for the rope a temperature slightly below that of the critical point of the iron-carbon diagram, this temperature being approximately between 250 and 350° C. However, the particular temperature to which the rope is heated by the heating means will vary in general according to the composition of the steel used in the rope.

The heating can be brought about by any suitable means. Preferably, heating by induction is used, the rope being passed through the interior of suitable coils which have the required number of turns and providing a field of sufficient intensity and with sufficient flux to achieve the required temperature in the rope according to the properties of the rope, such as its size and the like, and according to the speed with which the rope is moved through the induction heater.

However, the heating may be brought about in other ways as, for example, by the direct action of burners or by the indirect action of heating a suitable tube or plate which surrounds or is located adjacent the path along which the rope travels while being under traction. Heating may also be produced by the Joule effect, by causing a current to pass through the rope itself by means of suitable brushes which engage the rope and are located in a suitable electrical circuit, or by any other method or means having a positive heating effect to produce the desired temperature in the rope while it is tensioned.

Finally, before the rope is wound onto the drum which produces the traction or tension in the rope and while the rope is still under traction it is cooled in the space between the heating means and the take-up means. In the event that the space between the heating means and take-up means is sufficient for effective cooling of the rope with the ambient atmosphere, then the ambient atmosphere is used for cooling purposes. However, if the space between the heating means and take-up means, or in other words the distance traveled by the rope between the heating means and take-up means, is not suffifficient to achieve the desired cooling at the speed of longitudinal travel of the rope, positive cooling may be provided by circulating cooling water, air, or the like around the rope with any conventional structure provided for this purpose.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a schematic representation of the method and apparatus of the invention; and

FIG. 2 is a fragmentary perspective detail of the adjustable roller means which provides the undulatory path for the rope.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings, there is schematically illustrated therein an adjustable roller means **1** forming a zone in which the rope **3** is stressed while moving along an undulatory path. This undulatory path is determined by a series of adjustable rollers **2** guided in suitable ways for movement perpendicularly to the rope **3** and capable of being adjusted by rotation of the screws **4**, as schematically illustrated in FIG. 2. If desired the rollers **2** on one side of the rope may have stationary axes of rotation while the rollers **2** on the other side can be moved to predetermined positions in the gaps between the remaining rollers, as indicated in FIG. 2. The screws **4** can be turned by any suitable tools. Moreover, as is shown at the right of FIG. 2, the series of rollers may include one set whose axes are parallel to each other and perpendicular to the axes of the subsequent set such as the set shown at the left of FIG. 2.

Thus, as the rope **3** is drawn along the adjustable roller means **1**, the rope is compelled to move along an undulatory path providing sequential curving of the rope in opposed directions so that the rope is not only under traction but also it is stressed by the sequential opposed curves so that in addition to being stressed the rope is preliminarily heated to a given degree. The adjustment of the roller means **1** will be according to the diameter and characteristics of the rope **3**.

The traction to which the rope **3** is subjected is achieved by way of a take-up means **5** in the form of a drum or reel which is rotated through any suitable drive for pulling the rope through the adjustable roller means **1**. This drum or reel **5** has a relatively large diameter as compared with the diameter of the rope, as set forth above. Thus, the take-up means formed by the drum or reel **5** maintains the rope under continuous tension while transporting the rope through the roller means **1** to the take-up means **5**. In this way it is possible to stretch the rope at the section thereof situated between the adjustable roller means **1** and the take-up means **5**.

The diameter of the drum is on the order of 200–100 times the diameter of the rope according to the increase in the length of the latter and the number of wires of which the rope is composed.

In the space between the adjustable roller means **1** and the take-up means **5** there is an elongated heating means **6** defining a heating zone through which the rope, while under traction, is transported at a given speed, the heating achieved at the heating zone being sufficient to provide

a predetermined stretch in the rope as it is drawn through the heating zone defined by the heating means **6**. As has been indicated above, it is preferred to provide an induction heater for heating the rope by drawing the latter through suitable electrical coils.

Situated between the heating means **6** and the take-up means **5** is a cooling zone **7** where cooling may take place in the ambient atmosphere, although, as was pointed out above, if necessary the cooling can be forced positive cooling as by circulation of a suitable fluid such as chilled air or water in engagement with the rope.

The characteristics of the heating zone, and to a lesser extent of the cooling zone, depend, with respect to their length, temperature, and other details, on various factors such as the speed of movement of the rope, the composition thereof, and the tension to which the rope is subjected by the take-up means **5** during pulling of the rope through the heating and cooling zones as well as initially through the adjusting roller means **1**.

Thus, with the method and apparatus of the invention the following improvements are provided in the steel rope:

(1) The elastic limit is greatly increased.

(2) The extent to which the rope or cable can be elongated or stretched prior to breaking is also increased.

(3) The extent to which the rope will stretch initially under small loads is reduced, since the individual wires which constitute the rope are prefectly connected to each other as a result of the method and apparatus of the invention.

(4) The rope or cable of the invention is in a perfectly straight condition as a result of the treatment thereof with the method and apparatus of the invention, so that laying of the rope in sheaths is greatly facilitated.

(5) The various wires which are united, as by twisting, to form the rope or cable fit each other perfectly as a result of the method and apparatus of the invention.

What I claim is:

1. In a method for improving the properties of a steel rope composed of several wires united together to form a cable which is subsequently to be subjected to tension, the steps of pulling the rope longitudinally through a heating zone of predetermined length for elevating the temperature of the rope to a given degree, maintaining the rope at a constant and continuous tension during movement thereof through the heating zone and while also maintaining the rope moving at a given speed through the heating zone, and simultaneously with said heating and longitudinal movement of the rope subjecting the latter to longitudinal traction sufficiently great to stretch the rope longitudinally without breaking the rope, so that the rope is subjected to the traction while passing through the heating zone, said traction being achieved solely by directing the rope along an undulatory path just prior to passage of the rope through the heating zone so that the rope will be sequentially curved in opposite directions prior to reaching the heating zone, thus stressing and preliminarily heating the rope before it reaches said heating zone.

2. In a method as recited in claim **1** and including the step of winding the rope onto a drum subsequent to passage of the rope through the heating zone with said drum having a diameter on the order of 100–200 times the diameter of the rope, said winding of the rope onto the drum producing the longitudinal pulling of the rope.

3. In a method as recited in claim **1** and wherein the traction applied to the steel rope is on the order of 65–75% of the load at which the rope will break.

4. In a method as recited in claim **1** and wherein the rope is heated to a temperature on the order of 250–350° C., depending upon the characteristics of the rope.

5. In a method as recited in claim **1** and including the step of cooling the rope subsequent to movement thereof through the heating zone while the rope is still maintained under traction so that the rope is still stretched while being cooled.

6. In a method as recited in claim 5 and wherein said cooling is brought about by exposing the rope to the ambient atmosphere.

7. In a method as recited in claim 5 and wherein forced cooling is applied to the rope for cooling the latter subsequent to the heating thereof.

8. In an apparatus for improving the properties of steel rope, adjustable roller means for guiding the rope along an undulatory path, take-up means for taking up the rope and pulling the latter through said roller means to place the rope under traction while it is stressed during pulling through the roller means and heated to a given degree, said adjustable roller means forming the sole means for placing the rope under traction while the rope is pulled by said take-up means, and heating means located between said roller means and take-up means for heating the rope to a predetermined temperature higher than that which is achieved at the roller means, so that the rope is under traction while being heated by said heating means.

9. The combination of claim 8 and wherein a cooling means is situated along the path of movement of the rope between the heating means and take-up means for cooling

the stretched rope while it remains stretched during movement from the heating means to the take-up means.

10. The combination of claim 8 and wherein said take-up means is a rotary drum.

11. The combination of claim 8 and wherein said adjustable roller means is formed exclusively by freely turnable rollers which rotate only in response to pulling of the rope by said take-up means.

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