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METHOD FOR SURFACE HARDENING POLYGONAL STEEL RODS AND PRODUCT TREATED ACCORDING TO THE METHOD

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FIG.1

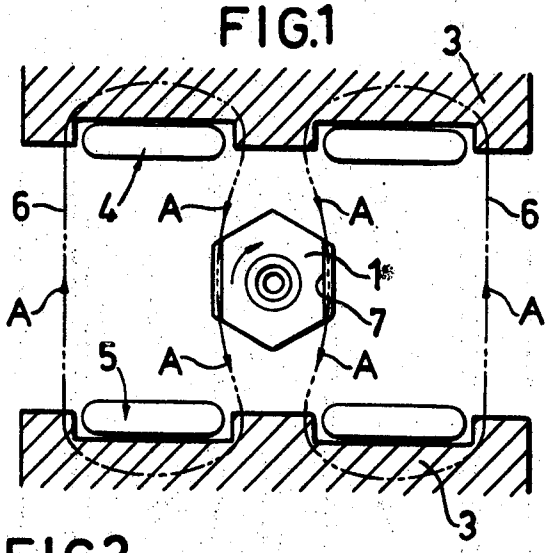


FIG.3

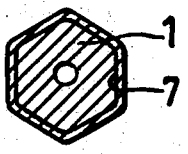


FIG.2

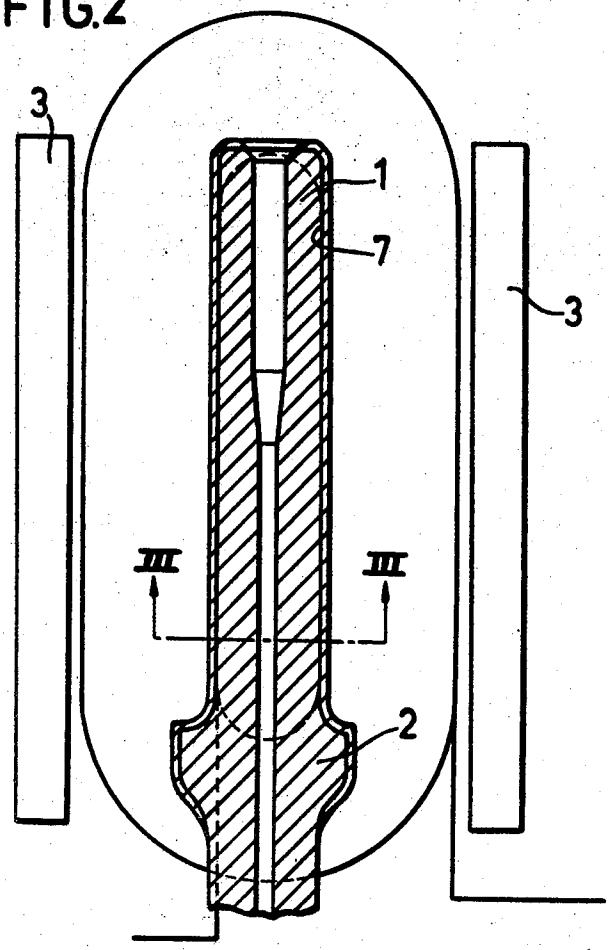
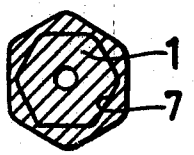


FIG.4



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METHOD FOR SURFACE HARDENING POLYGONAL STEEL RODS AND PRODUCT TREATED ACCORDING TO THE METHOD

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Continuation-in-part of application Ser. No. 375,782, June 17, 1964. This application Apr. 14, 1967, Ser. No. 631,013

Int. Cl. C21d 1/42, 9/22

U.S. Cl. 148—146

3 Claims

ABSTRACT OF THE DISCLOSURE

A method of surface hardening a drill rod having a portion of polygonal cross-section and a thickened portion and which is made up of a low alloy steel having a carbon content not greater than about 0.6%, which includes heating only the peripheral section of the rod to a hardening temperature while simultaneously rotating the rod in a high frequency cross-field heater whose cross-field is substantially perpendicular to the longitudinal extent of the rod to thereby obtain a substantially uniform depth of heating along the longitudinal extent of the rod including the thickened portion and thereafter quenching the rod to obtain a uniformly hardened surface layer along the entire longitudinal extent of the rod.

This application is a continuation-in-part of my application Ser. No. 375,782, filed June 17, 1964, now abandoned.

This invention relates to a method of surface hardening a drill rod having a thickened portion at least partly surrounding the rod.

The surface hardening has as its main object to induce compressive stresses in the material surface in order to increase the fatigue strength, that is to increase the working life of the drill rod. For drill rods usually a low-alloy steel with a carbon content of about 1% is used. This steel, however, cannot always be hardened without formation of small cracks whereby especially the fatigue strength is reduced. According to the invention, however, a low-alloy steel with at maximum 0.60% C is used which is alloyed in known manner, so that it has the necessary toughness after treatment by the method according to the present invention. By this treatment a surface hardness higher than resulting from normal hardening is obtained without causing any formation of small cracks. Hereby the resistance to upsetting and wear is increased substantially at the same time as the fatigue strength is improved considerably.

The method according to the invention is of particular importance in the treatment of drill rods, in view of the fact that these rods when being used for percussion drilling are subjected to alternate compression-tensile stresses of considerable size. This results in many cases in fatigue breaks in the rods, particularly in and about those parts which were heated locally and upset or which otherwise were given a dimension deviating from that of the rod. In these parts so-called stress-raisers are easily caused. As it is especially the size of the tensile stresses which is of decisive importance for the strength of the rods, it is desirable to decrease the effect of these stresses. Such a decrease is obtained by indicating the compressive stresses in the material surface as described above.

It is true that it is known that a decrease in the effect of the tensile stresses can be obtained by prestressing of compression type. A great number of different treating methods were employed for this purpose, for example case-hardening, nitriding and flame-hardening. Disregarding the expensive and time wasting methods of case-hardening and nitriding, the methods used have proved unsuitable for the surface hardening of rod material with polygonal cross-sectional area with or without local change in section or for round section with local change in section. With the help of the present invention it is, however, possible to carry out a suitable treatment of drill rods.

According to another known method a surface hardening is obtained by induction in a longitudinal field heater. In such a heater the depth of penetration of the eddy currents is dependent of the distance between the coil and the rod. If the rod for instance has local changes in section in form of a collar, a shank or the like being located nearer the coil than the rod itself, these local changes become more heated than the rod—the heat penetrates deeper in the material. Thus, in such a heater the heating effect is dependent of the air gap.

By the method according to the present invention a substantially uniform depth of the surface hardening along the rod and the thickened portion is obtained, and said uniformity is independent of the air gap. According to the invention the method comprises: heating only the peripheral section of the rod at the same time as at least a part of the peripheral section of the thickened portion to the hardening temperature by rotating the rod in a high frequency cross field heater having a cross field substantially perpendicular to the longitudinal extend of the rod, thereby obtaining a substantially uniform depth of the heating section along the rod and the thickened portion, and quenching the rod.

The present invention has other advantages that will become apparent from an understanding of the following specification wherein reference is made to the accompanying drawings.

In the drawings:

FIG. 1 is a plane view of a high frequency cross field heater illustrating the position of a drill rod being treated according to the invention,

FIG. 2 is a section taken on the line II—II of FIG. 1 and showing the upper portion of the drill rod sectioned,

FIGS. 3 and 4 are both sections taken on the line III—III of FIG. 2 and illustrating the penetration of heat at different methods according to the invention.

FIGS. 1 and 2 show as an example a hexagonal rock drill rod **1** having a collar **2** and placed in a high frequency cross field heater **3**. The heater is shown schematically and has in the embodiment shown two coils **4** and **5** located by the two poles respectively of the iron core of the cross field heater **3** and connected in parallel. The coils are energized with high frequency alternating current giving a magnetic cross field between the poles. An iron object located between the poles displaces the lines of flux in such a way that the lines are concentrated to the peripheral portion of the object. Eddy currents effected by the cross field are substantially induced in those peripheral portions lying parallel to the direction of the field.

The "outer contour" of the cross field according to the example shown on the drawings is indicated by the broken line **6** and the arrows A indicate the direction of the current at a certain moment. The eddy currents induced in the peripheral layer of the rod material and effected by the cross field cause a heating of the said peripheral section. The line **7** indicates the depth of penetration of the heating section. In the arrangement shown two opposite sides of the hexagonal rod **1** is heated at the same time. The upset collar **2** brings about a displacement of the lines of flux outwardly causing a certain concentration increase which, however, is compensated by the larger mass of the collar. As illustrated in FIGS. 1 and 2 the depth of the heating section along the rod **1** and collar **2** is in spite of the local change in section substantially uniform.

A surface hardening of a ⅞" hexagonal rock drill rod made of low-alloy steel having a carbon content of 0.4% is stated as an example. The rod can be rotated either intermittently (FIG. 3) or continuously (FIG. 4).

In intermittent rotation the rod is placed in the heater in such a way that two opposite sides are parallel to the direction of the field. After holding the rod 0.5 sec., the rod is turned rapidly (maximum time 0.1 sec.) to the next position, that is in a position having two other opposite sides parallel to the direction of the field. One heating rotation is completed when the rod has been turned 180° and consequently two heating rotations when the rod has been turned one rotation. After one rotation of the rod it has in this example been subjected to heating during 3.6 sec. The rod is immediately cooled in preferably water, oil or the like.

In continuous rotation and at a speed of rotation of about 200 r.p.m. the total heating time is about 2 or 3 sec.

The heating is preferably carried out in cross field heaters with machine frequency, that is frequencies up to 12,000 Hz., but also higher frequencies can be used, even radio frequencies.

The length of a dwell as well as how many rotations one uses is of course dependent on and adapted to the rod being worked on and can be varied within a rather large range. However, in the intermittent rotation the turning is very quick while the holding time is longer.

The number of steps of intermittent rotation per heating rotation can be equal to half the number of sides of the polygonal cross-sectional contour of the rod material as described above, or, when the heating in the cross field is carried out on one side the number of steps of the intermittent rotation can be equal to number of sides of the section of the cross-sectional contour of the rod, or the heating can be carried out with only one interruption per rotation of the rod.

I claim:

1. The method of surface hardening a drill rod including a portion of polygonal cross-section and a thickened portion at least partly surrounding the rod, said rod being made of low-alloy steel and having a carbon content not greater than 0.60% comprising: heating only the peripheral section of at least a portion of said rod including at least part of said thickened portion to the hardening temperature while simultaneously rotating said rod in a high frequency cross-field heater having a cross-field substantially perpendicular to the longitudinal extent of said rod, thereby obtaining a substantially uniform depth of heating along the longitudinal extent of said rod including at least part of said thickened portion, and quenching the rod to obtain a uniformly hardened surface layer along the entire longitudinal extent of said heated portion.

2. The method according to claim **1** in which the rod is rotated intermittently.

3. The method according to claim **1** in which the rod is rotated continuously.

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148—150,154; 219—10.41, 10.43, 10.57