

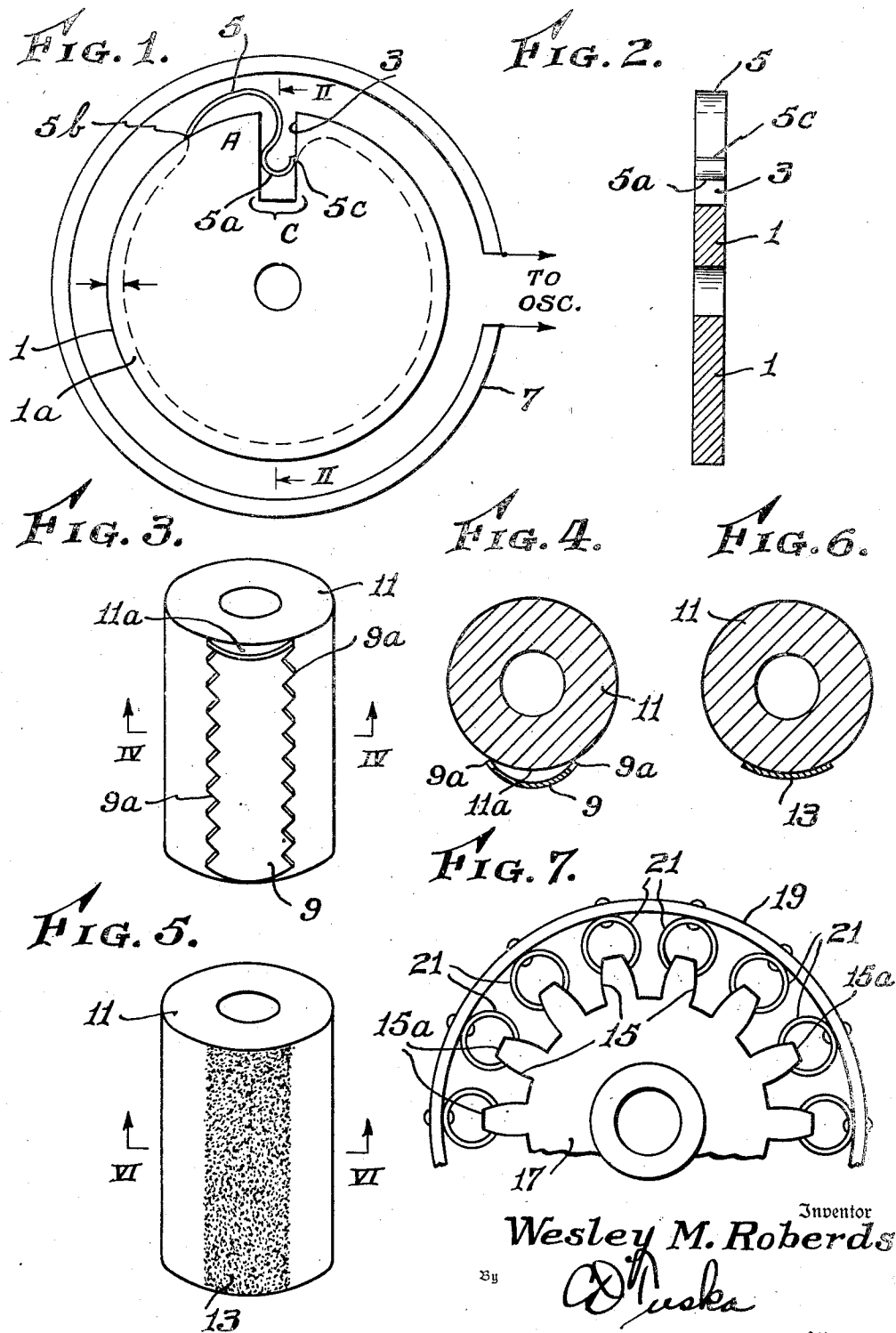
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METHOD OF HEATING GEAR WITH HIGH FREQUENCY CURRENT

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METHOD OF HEATING GEAR WITH HIGH-FREQUENCY CURRENT

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1 Claim. (Cl. 219—13)

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This invention relates to the treatment of metals, and more particularly to the heat treatment thereof for altering the hardness of the metal.

In many fields of use, it is desirable to harden the surface of metals due to the wear which they encounter. Various methods have been proposed heretofore for heating the metal. In connection with metals which are ferrous in nature, it has been proposed to subject them to the influence of an alternating magnetic field which induces eddy currents in the surface and thereby effects heating thereof. In certain cases, it may be desirable to avoid hardening of a particular portion of the metal, and the primary object of my present invention is to provide a novel method which will accomplish this.

More particularly, it is an object of my present invention to provide an improved method of heat treating metals for altering the hardness thereof whereby only predetermined or preselected parts thereof will be hardened within a given or prescribed area.

Another object of my present invention is to provide an improved method as above set forth wherein the parts which it is desired not to harden will be very substantially protected from the heat source.

It is also an object of my present invention to provide an improved method as above set forth which is economical to practice and highly efficient in use.

In accordance with my invention, the parts of the metal article which are to be protected and not heated are covered with a layer of a good, conducting material, such as silver or copper. This conducting layer, which may be electro-deposited on the article, applied thereto in the form of paint or the like, or simply held in contact therewith by mechanical means, constitutes an electrical shield in the form of a shunt around the parts which are to be protected to thereby provide a protective path which may or may not be of lower electrical impedance than the portion or portions of the article which are to be protected. The protective coating should be disposed between the portion of the work to be protected and the induction coil by means of which the magnetic field is applied to the work. Thus, when the article is subjected to a very short exposure in an alternating magnetic field of sufficiently high frequency (for example, at radio frequency), the conducting layer by-passes the induced eddy currents and prevents heating of the underlying material. In addition, since the

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coating materials are usually good heat conductors, they also provide more rapid heat conduction away from the areas to be protected.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claim. The invention itself, however, together with additional objects and advantages thereof, will best be understood from the following description of several ways in which it can be carried out in practice, when read in connection with the accompanying drawing, in which

Figure 1 is an end elevation of an article part of the surface of which is to be hardened and the remaining surface of which is to be protected against hardening in accordance with one form of the present invention,

Figure 2 is a sectional view taken on the line II—II of Figure 1,

Figure 3 is a view partly in elevation and partly in perspective of a cylindrical article treated in accordance with a somewhat different form of my invention,

Figure 4 is a sectional view taken on the line IV—IV of Figure 3,

Figure 5 is a view similar to Figure 3 and showing a slightly different way in which the present invention can be carried into effect,

Figure 6 is a sectional view taken on the line VI—VI of Figure 5, and

Figure 7 is a plan view of a device for applying my present invention specifically to a spur gear.

Referring more particularly to the drawing, wherein similar reference characters designate corresponding parts throughout, there is shown, in Figures 1 and 2, a circular disk 1 of ferrous material having a radial slot 3. Let it be assumed that it is desired to harden all the circumferential surface of the disk 1 except the portion thereof in the region of the corner A and the portion in the region C at the bottom and lower sides of the slot 3. This may be accomplished by first securing to the disk 1 adjacent the regions A and C a member 5 which has low electrical impedance as compared with the metal of the disk 1. The member 5 may be a spring clip, for example, made of copper or the like and may simply be inserted into the slot 3 so that the resilient loop 5a thereof, coacting with the sides of the slot 3, will retain the member 5 in place. The member 5 should contact the disk 1 at least at both its ends 5b and 5c whereby to provide a shunt path around the regions A and C which has good electrically conductive properties.

The assembly may then be placed within a ring-like induction coil 7 connected to a suitable high frequency oscillation generator through a current transformer (not shown) in a manner well known in the art. The generator may be a vacuum tube oscillator operating at radio frequency or at some suitable lower frequency which, like radio frequency, is high enough to effect heating of only a thin, skin or surface layer in the work, and the applicator or coil 7 is as closely spaced to the work as is practicable. The high frequency magnetic field set up by the induction coil 7 induces eddy currents in the disk 1 near the surface thereof to effect rapid heating of a skin surface layer 1a to a temperature sufficient to harden the surface layer. However, in the regions A and C, very little heating will take place by reason of the fact that the eddy currents will be by-passed around these regions through the relatively low impedance path 5. Thus, the heating is confined substantially to the portion 1a and is very largely excluded from the regions A and C. As a result, only the region 1a will become hardened, while hardening of the regions A and C will be avoided. After application of the heat, the disk 1 is, of course, quenched in any suitable manner, or it may be heated rapidly and self quenched as described in the copending application of George H. Brown, Serial No. 421,746, filed on December 5, 1941, and assigned to Radio Corporation of America.

In Figures 3 and 4, the conductive shunt is constituted by a strip 9 of copper, silver, or the like, placed over the area 11a of a cylindrical member 11. The shunt 9 may be formed with serrations, scallops, or the like 9a, whereby it contacts the surface of the cylinder 11 at only isolated points. The shunt 9 may be applied to the cylinder 11 in any suitable manner, as by being clamped against it. When the assembly is subjected to an alternating magnetic field of radio or other suitable high frequency, the entire cylindrical surface of the cylinder 11 except the region 11a thereof becomes heated by electromagnetic induction, since the shunt member 9 becomes the principal path for the eddy currents which are thus shunted or bypassed around the region 11a. The protected area 11a of the cylinder does not particularly show a serrated longitudinal region represented by the serrations or teeth 9a. In any case, it is apparent that the region 11a will not become hardened, and only the remaining cylindrical surface of the cylinder 11 will remain hard after quenching.

Instead of applying to the cylinder 11 a shunting strip such as the strip 9, the area thereof to be protected may be covered with a conductive layer 13, as shown in Figures 5 and 6. For example, a layer of good, conductive paint may be painted on, sprayed on, or applied in any other suitable way, or a layer of good, conductive material may be electrodeposited over the area of the cylinder which is to be protected. The ultimate result approximates the result obtained by an arrangement such as shown in Figures 3 and 4.

In Figure 7 there is shown an arrangement for protecting the tips of the teeth 15 of a spur gear 17. For this purpose, an insulated ring 19 may be provided with a plurality of good electrically conductive, shunting elements 21 corresponding in number to the number of teeth on the gear. Each of the elements 21 may be a spring clip which embraces and firmly engages the outer

regions of the teeth 15. When the assembly is subjected to the influence of an alternating magnetic field of sufficiently high frequency, the eddy currents induced in the gear will heat the surface thereof, including all those portions of the teeth 15 which are not embraced by the shunting elements 21, but the regions 15a thereof which are embraced by the shunting elements 21 will not be substantially heated because the eddy currents will pass through the more highly conductive elements 21. If desired, the ring 19 may be made of electrically conductive material to constitute the applicator or inductive coil coupled to the oscillator. In such case, it will be necessary to insulate each element 21 from the ring 19 to avoid undesirable current paths.

Although I have shown and described several ways in which my present invention can be carried into effect, it will, no doubt, be apparent to those skilled in the art, that the present invention is susceptible to various other modifications. Moreover, it should be apparent that the present invention may be used for hardening metals other than ferrous metals, and that it may be used equally well for annealing metals such as brass or the like wherein certain portions or areas are to be protected from the annealing process, instead of for hardening. Wherever, in this specification and the appended claim, I have referred to heating of "the entire" article, or to heating "all of the metal" I do not necessarily intend to be limited to treatment of 100 per cent of the article or the metal, but only to that part thereof which is to be hardened or annealed, as the case may be, and from which part the hardening or annealing of a portion or section is to be excluded. With the foregoing in mind, I desire that my invention shall not be limited except insofar as may be necessitated by the prior art and by the spirit of the appended claim.

I claim as my invention:

In the method of manufacturing a gear composed of a material adapted to be hardened by heating with alternating current of a sufficiently high frequency to flow in substantially a thin layer at the surface thereof, the steps which comprise placing around the tip portions of the gear teeth conductive shields for the purpose of shunting current around said portions, and causing the high frequency heating current to flow through the remaining portions of said teeth and said shields.

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