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F. TWYMAN

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HEAT TREATMENT OF METAL ARTICLES

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Fig. 1.

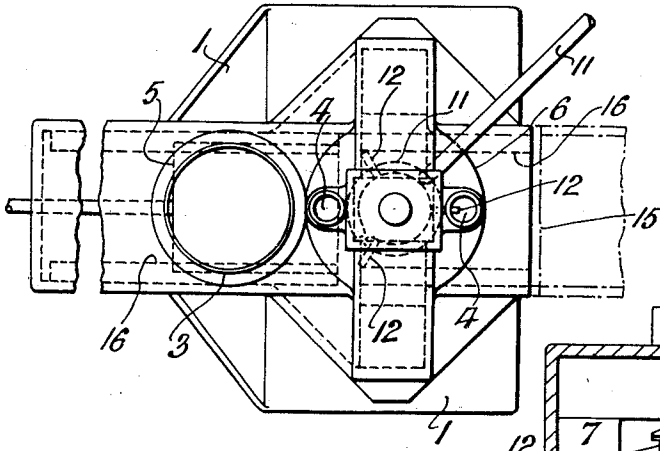


Fig. 2.

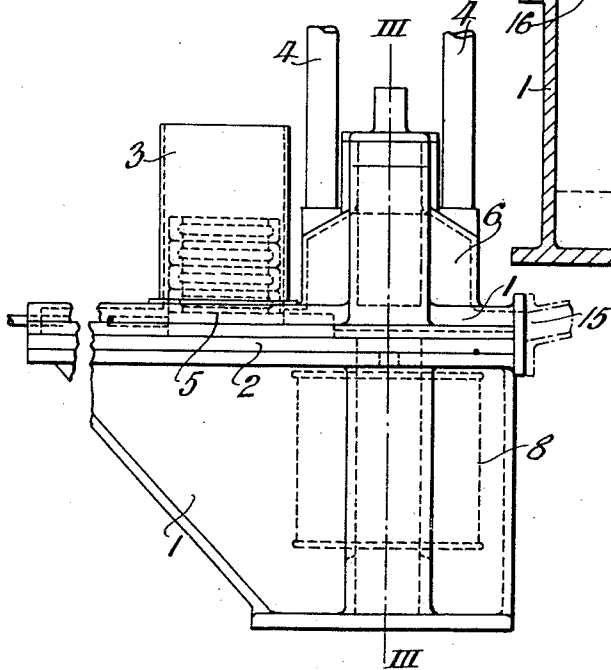
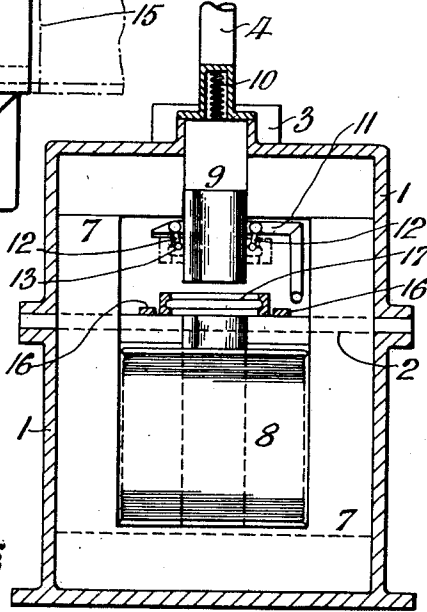


Fig. 3.



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HEAT TREATMENT OF METAL ARTICLES.

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This invention relates to improvements in the heat treatment of metal articles, particularly local treatment, such as surface hardening of, for example, ball races, tires of railway wagons, and the like.

The advantages of heat treatment upon ball races, wagon tires, and other articles, called upon to withstand surface wear as well as internal strains, for the purpose of hardening the wearing surface whilst leaving the interior relatively soft, are well known.

The primary object of this invention is a method of heat treatment which will permit ready control of the heating and cooling in the various parts of the article under treatment, whereby, for example, in the case of hardening the bearing surface of a ball race or wagon tire, a relatively soft interior can be assured without any abrupt change in the physical characteristics at any point between the surface and the interior.

According to the usual practice, the tire or article is heated to the required temperature, and subsequently the part to be hardened is quenched by a spray of water or other rapidly cooling medium. Various methods of heating the article prior to quenching have been proposed, including heating by electricity, in some cases producing intensified local heating by induced eddy currents from a high frequency alternating field.

According to the present invention heat is applied to the article during the cooling period for the purpose of retarding to a desired extent the rate of cooling of one part of the article with respect to another part. For example, the article is heated to the desired temperature by electric induction and then a cooling medium is applied to a part of the article whilst maintaining the electrical heating wholly or in part. That is to say, if surface hardening is required the surface to be hardened is quenched whilst the electrical heating is maintained so that a desired graduation of hardness or relative softness is produced beneath the hardened surface.

The invention enables a plurality of hardness conditions to be satisfied throughout the article. For instance, at the surface of the article any predetermined hardness may be obtained by quenching or chilling, and at the same time a specified hardness may be produced at any other point or points remote from the quenched surface in the interior of the article. The nature of the process pro-

vides that there shall be no abrupt change in hardness on progressing from the surface of the objects into the interior.

In carrying out the invention, the article is conveniently constituted as the whole or part of the secondary or low tension winding of a transformer to whose primary or high tension winding is applied alternating current, preferably of low frequency, say, 75 cycles per second. By this means heating, which is produced by the definite current induced in the article, can readily be maintained wholly or to any desired extent whilst cooling fluid is being applied locally, so that a check to the rate of cooling is produced in other parts of the article.

The extent to which the heating is to be maintained during the cooling or quenching in order to obtain desired graduation of hardness or relative softness between one part of the article and another will of course depend on the thickness and heat conductivity of the metal of which the article is composed. The temperatures of different parts of the article being treated can be determined at any instant by means of thermocouples and any desired differential rate of cooling can be obtained by adjusting the cooperating cooling and heating means.

In carrying out the process upon a succession of articles, the feeding in, the location in the operative position, and the withdrawal of the articles, may be automatically and continuously effected, and these automatic operations may be synchronized with the control, which may also be automatic, of the heating and cooling means. Electromagnetic force generated by the electrical heating means is conveniently employed to move the article into a desired position to be operated upon. Expended cooling fluid is advantageously cooled and recycled for further use, by means of a drainage and circulating system comprising a heat radiator associated if necessary with a refrigerating plant for chilling the cooling fluid.

The method of heating lends itself readily to hardening the object being treated in any desired atmosphere, the object remaining in a reducing atmosphere, for instance, during both heating and quenching.

The preferred apparatus for carrying out the invention comprises a low frequency alternating current transformer whose core is provided with a movable pole-piece for al-

lowing the article to be positioned for the induction of an electric current. The movable pole-piece is normally arranged to leave a gap in the core to allow passage of the article to be treated and when the article is in position and the current switched on the pole-piece is automatically moved to close the gap and at the same time the article is drawn by electromagnetic force into a desired position adjacent nozzles for the projection of cooling fluid.

The above described and certain other features of the invention are illustrated by the accompanying drawings, which show diagrammatically by way of example apparatus adapted for continuous operation in the heat treatment of circular articles, such as ball races.

In the drawings,
Fig. 1 is a plan view of the apparatus;
Figure 2 is a side elevation of the same;
and

Figure 3 is a sectional elevation on the line III—III of Figure 2.

Referring to the drawings, 1 is a casing made to enclose the apparatus and formed from castings of iron, steel, brass or other suitable material. The casing is made in two sections bolted together through a platform 2. The top portion carries a hopper 3 and also two flues 4 which serve as an outlet for exhaust gases or vapours produced in the quenching chamber. The platform supports a reciprocating shifter 5 for transferring rings to be hardened from the hopper to the heat-treatment chamber 6.

7 is the core of a low frequency alternating current transformer, and 8 is the primary winding compactly housed in the casing. The core is built up of laminations and is provided with a movable pole-piece 9 mounted in guides machined in the casing, springs 10 being provided for raising the pole-piece to the raised position shown in Figure 3.

The platform 2 is made in one piece from non-magnetic material, such as brass, and is fitted around the three limbs of the core. In order to repress eddy currents in the platform it is divided by a strip of insulating material.

A quenching device is provided to suit the particular dimensions of the rings it is desired to harden. The device comprises a comparatively large bore tube 11 from which a number of smaller tubes 12 emerge to convey the quenching liquid to a ring 13 provided with nozzles. Each quenching ring is divided by insulation in order to repress eddy currents.

The quenching liquid is arranged to flood the platform 2 to the level of the aperture 15, so that the quenching chamber is sealed except for the flues 4. Quenching may therefore be carried out in any desired atmosphere.

Suitable escapes are provided to keep the liquid at the correct level in the casing, and the overflow may be pumped through a radiator system after which it may be used again. An inclined continuation of the aperture is fitted in order that the rings from the furnace may be extracted through a liquid trap. The level of liquid on the platform 2 is also arranged to close the opening from the hopper 3.

The mechanism for operating the shifter 5, the turning off and on of the quenching liquid, and of the field exciting current may be controlled from a rotary switch gear so adjusted to suit the particular rings being hardened. The switch gear may also manipulate the auxiliary mechanism for closing the magnetic circuit and raising the ring to be hardened in those cases where it would be necessary.

The shifter 5 transfers rings successively from the hopper to heat-treatment chamber moving them between the guides 16 on the platform. Each incoming ring forces the previous ring which has been hardened out of the chamber through the aperture 15.

In operation, which will be described as being automatic, the hopper is first charged with a number of rings, for example, ball races, to be hardened. The shifter 5 moving forward carries the lowest ring into position, as shown at 17, in the heat-treatment chamber, the pole piece 9 being raised by its springs. The electric current is then turned on and this causes the pole-piece to move down and close the gap whilst at the same time the ring 17 is raised by its repulsion from the exciting winding, the field being weaker at the slides of the movable pole-piece than at the pole tip. In its raised position the ring surrounds the quenching ring, 13 whose nozzles then point towards the inner periphery of the ring 17 which is the portion to be hardened.

When the secondary current induced in the ring 17 has raised the temperature of the ring to the desired extent, that is, to above the calescence point, the quenching device comes into operation, but the current is continued so that the outer portions of the ring cool more gradually. When cooled to the desired extent the current is switched off, whereupon the ring falls, the pole-piece is raised and the shifter moves in the next ring for treatment and moves out the hardened ring. The cycle of operations is then repeated.

When once the apparatus has been adjusted and the timing of the operations regulated for a particular size of ring, the only supervision required is that of feeding the rings into the hopper, although this latter may of course be made automatic if desired.

In an experiment upon rings of external diameter 4.25 inches, internal diameter 3.0 inches, and depth 0.5 inches, the primary of the electrical heater was supplied with 2 kw.

power until the temperature of a ring reached 780° C. whereupon the ring was quenched with water at 15° C. sprayed upon its external periphery whilst maintaining the heating at full power. The hardness of the quenched surface was about 550 Brinell units and there was a difference of 150 Brinell units between the hardest and softest sections of the ring. A similar experiment conducted with the heating turned off during the quenching gave a maximum difference of 70 Brinell units between the hardest and softest sections of the ring. By maintaining the heating partly on to various degrees, differences of hardening are obtained intermediate 70 and 150 Brinell units.

What I claim is:—

1. Apparatus for heat treatment of metal articles comprising a transformer having a movable pole piece for allowing the article which comprises the secondary of said transformer to be positioned for treatment by induction, a cooling device positioned about said pole piece, and adapted to operate on the article while the transformer is energized, and a casing for said transformer providing a chamber for the heat treatment operation, said chamber having a platform for supporting and positioning the article to be treated, means for supplying a cooling fluid to said

chamber, and an outlet for the article to be treated in combination with an adjacent hopper and a member adapted when actuated to feed in an article to be treated, said outlet being below the fluid level within the chamber to form a liquid seal therefor.

2. Apparatus for heat treatment of metal articles comprising a transformer having a movable pole piece for allowing the article which comprises the secondary of said transformer to be positioned for treatment by induction, a cooling device positioned about said pole piece, and adapted to operate on the article while the transformer is energized, and a casing for said transformer providing a chamber for the heat treatment operation, said chamber having a platform for supporting the article to be treated, means for supplying a cooling liquid to said chamber, and an outlet for the article to be treated, in combination with a hopper and a reciprocating slide for feeding an article from the hopper to the chamber for treatment and removing the article from said chamber after treatment, said cooling liquid forming a liquid seal for the article outlet.

In testimony that I claim the foregoing as my invention I have signed my name this twenty-first day of March, 1928.

FRANK TWYMAN.