Oct. 31, 1939. J. D. JUDGE 2,178,281

METHOD FOR HARDENING CAMSHAFTS AND THE LIKE

Filed Oct. 9, 1935

FIG. 1

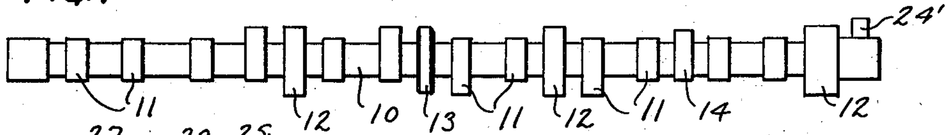


FIG. 2

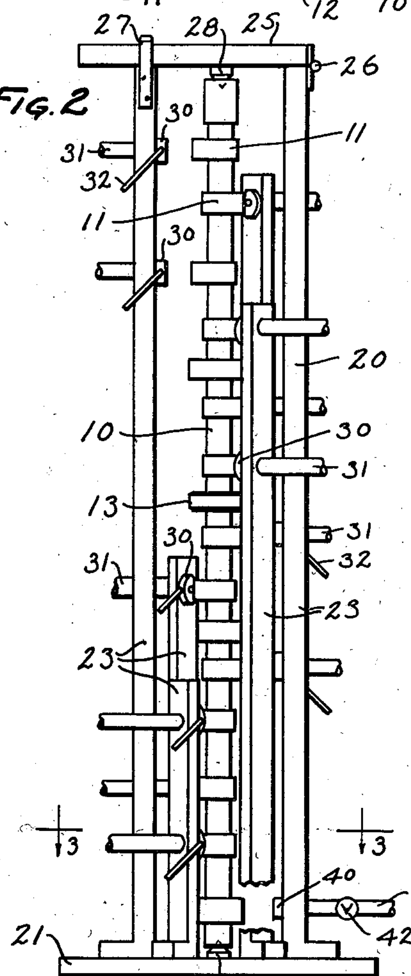


FIG. 3

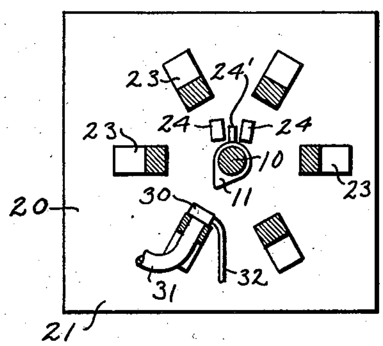


FIG. 4

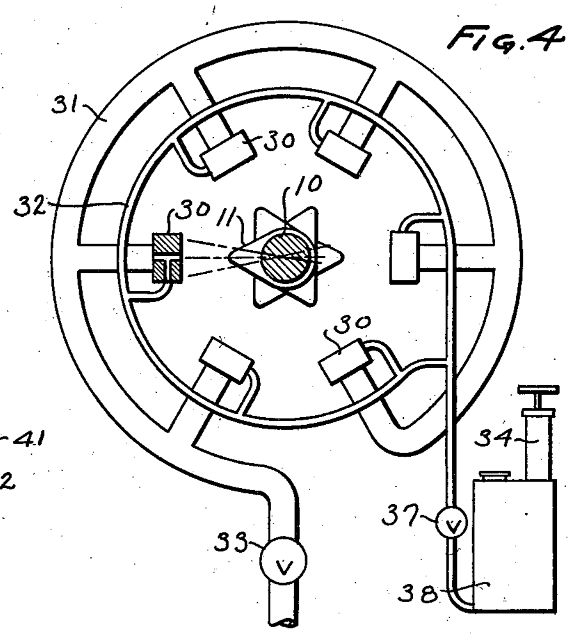
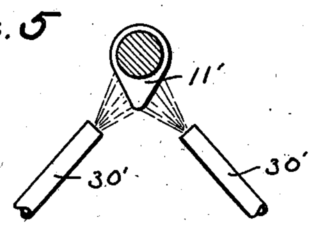


FIG. 5



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METHOD FOR HARDENING CAMSHAFTS AND THE LIKE

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1 Claim. (Cl. 148—21)

This invention relates to the art of heat treating, and more particularly to the differential treatment of heat treatable cast iron camshafts and the like.

One of the principal objects of the invention is the provision of a simple and effective method of differentially heat treating cast iron articles such as camshafts and the like to alter the physical characteristics of such articles to different and desired degrees at spaced points therein.

Another object of the invention is the provision of a method of differentially treating cast iron camshafts to import the desired hardness to localized areas thereof and to refine the material at other portions.

A further object of the invention is the provision of apparatus for carrying out this method.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawing and the appended claim.

In the drawing, which discloses a preferred embodiment of the invention—

Fig. 1 is an elevational view of a camshaft of the character upon which this invention is practiced;

Fig. 2 is a side elevational view of a supporting structure used in the heat treatment of the camshaft of Fig. 1;

Fig. 3 is a transverse sectional view as indicated by the line 3—3 of Fig. 2;

Fig. 4 is a diagrammatic showing of one stage of the heat treating operation; and

Fig. 5 is a diagrammatic showing of a modified arrangement of the quenching jets.

The drawing, in which like characters of reference designate like parts throughout the several views thereof, illustrates a method of heat treating articles of cast iron, and more particularly for treating camshafts which have been cast from an iron that is subject to heat treatment. The use of such materials, heat treated in accordance with the present invention, widens the field of usage of cast iron by permitting the substitution of this relatively inexpensive material for the more costly steels. "Meehanite" is the material preferably used in accordance with this invention, this material being a cast iron in which the graphite is controlled by adjusting the chemical composition to a point where the casting would normally be white iron, and then causing all carbides over the amount necessary for pearlite to decompose into diffused particles of graphite by the addition of measured amounts of calcium silicide.

In utilizing such materials for camshafts, of which an illustrative example is shown at 10 in the drawing, and which comprises integrally formed cams 11, bearings 12, a gear 13, and an eccentric 14, the difference in the physical requirements of the different parts of the shaft necessitates a differential treatment so that those parts subject to extreme wear will have the required hardness and those other portions, such as the bearings, gear, etc., will be refined to the desired degree but permitting the machining of these parts after this refining has taken place.

In the practice of this invention the cam shaft is heated to a suitable temperature above the critical temperature, the localized areas required to be hardened very hard are then subjected to a localized water mist quenching operation which is of such character that the hardening extends over only a desired limited area and depth, after which the entire article is subjected to a quenching operation to fix or retain the properties currently existing in the shaft. The relationship of the successive steps of the treatment is such that during the initial quenching of the localized areas, such as the cam lifts, the temperature of the remaining portions falls from the initial high temperature at which localized quenching begins to suitable temperature such that subsequent rapid quenching of these remaining portions results in a desired toughening and refining of such character that the last quenched parts remain machinable.

In order that the hardening may be of controlled extent and depth, the initial quenching operation which serves to harden the localized areas is arranged to be readily controllable so that the rate of heat transfer, while quite fast so as to afford a quenching operation to induce the desired degree of hardness, is regulated in accordance with the proportioning and bulk of the article. That is to say, the absorption of heat by the quenching medium at the localized areas is at a controlled rate, and is coordinated to the transfer of heat into those portions of the shaft from the shaft parts not then subjected to quenching so that hardening of the quenched parts occurs only to the desired extent and depth. The rate of heat change through the critical temperature is sufficiently fast that hardening occurs, but is at such a rate that in the interval during which the remainder of the shaft is cooling to a desired temperature for quenching the hardened area is restricted as desired.

Hardening of this character obtains through the use of water charged air blasts which are simultaneously directed only against the portions of the cams that are to be hardened. The characteristics of the blast, that is, the temperature of the air and the quantity of water entrained therein is coordinated to the physical proportions of the shaft to thereby regulate the quenching rate. A complete treatment of the shaft occurs with one heating thereof.

To carry out this method of heat treatment, and to properly and accurately direct the quenching blasts to the desired points, a frame 20 is provided which is arranged to hold the heated shaft in a predetermined positioning or range of positioning. As shown, the frame comprises a base 21 having means centrally located thereon as indicated at 22 for the reception and centering of one end of the camshaft 10, which is mounted vertically in the frame. The base 21 carries two spaced locating lugs 24 which cooperate with a lug 24′ fixed on the camshaft to position the camshaft in predetermined approximate position permitting some limited variation in position about the camshaft axis. Angularly spaced with respect to the center support 22, and projecting upwardly from the base 21, are a plurality of arms 23; each of which has provision for supporting nozzles in proper operating relationship with the cam areas that are to be hardened. Additional support is provided for central location of the shaft within the holding frame and is shown as comprising an arm 25 pivotally mounted at 26 from one of the upstanding arms 23 and arranged to be held in latching engagement with another of the arms as indicated at 27. The pivotally movable arm 25 is provided with shaft engaging means such as the centering pin 28 which interfits a centering hole in the end of the cam shaft.

The upstanding arms 23 are shown as being of different heights; the extent of these arms being determined by the positioning of the cams which in turn govern the positioning of the nozzles carried by the different arms and which direct the quenching blasts. The nozzles, which are located in predetermined position coordinated with the cam positionings, are each attached to a source of air under pressure and to a fluid supply for introduction of a water stream or mist directly against the cam lifts. To clarify the showing of Fig. 2 the complete conduit connections to the plurality of nozzles has been omitted and only short conduit sections are illustrated to avoid a multiplicity of lines thereon. As shown, each of the nozzles 30 has a conduit 31 and a conduit 32 connected respectively to a source of air under pressure and a water supply tank. As shown in the diagrammatic illustration of Fig. 4, all of the air conduits 31 have a common connection to a control valve 33 which is connected to any suitable air pressure source. The water conduit 32 has a valved connection 37 to a water supply tank 38 which is preferably provided with means such as pump 34 for creating a suitable small pressure. The arrangement of the nozzle may be such that water or a mixture of water and air in the desired proportions is supplied under pressure by regulation of valves in the supply lines, or the arrangement may be such that the water is entrained in the air blast merely by an aspirating action. The arrangement of each nozzle is such that it is accurately positioned with respect to the cam lift associated therewith when the lug 24′ is positioned midway between lugs 24, so that the air blast is directed against the point of the cam lift as is shown in Fig. 4. Limited movement of the shaft about its own axis while the blast is effective provides a hardened surface adjacent the point of the cam as well as hardening the point itself.

In the practicing of this invention the camshafts are first heated to a temperature above the critical temperature. When using a material of the character mentioned the critical temperature on cooling is of the order of 1350° F. The temperature to which the camshaft is raised is of the order of 1600° F. Quenching of the localized areas, or cam lifts, that are to be hardened takes place from a temperature that approximates this high temperature and continues until the temperature of the remaining portions of the shaft has fallen to a point at which suitable refining and toughening will occur. The temperature at which the second quenching occurs is selected in accordance with the required hardness properties for any particular work piece, but is preferably at a temperature of the order of 1000° F. for the particular material referred to.

As mentioned in general terms above, the quenching blast on those parts that are to be greatly hardened continues while the remainder of the shaft is cooling to a suitable temperature for quenching, and it will be apparent that proper regulation of the quenching blasts as by adjustment of their time of duration will control the characteristics of the other parts of the shaft, when those other parts are quenched as by immersion in water. On shafts in which the areas to be hardened are large as compared to the bulk of the shaft the rate of heat transfer will be different than in shafts wherein the hardened areas are small as compared to the general proportions of the shaft. In either instance the rate of heat transfer produced by the water blasts is such as to provide a temperature drop rapid enough to produce hardening.

The duration and rate of the localized water blast quench is such that when the untreated portions have reached a suitable temperature, those portions which have been subjected to the localized hardening quench will have dropped to a low temperature of the order of 200° F. In order that an objectionable drawing of the hardened areas may not occur the second or immersion quench takes place very quickly after discontinuing the quenching blasts and before an objectionable heat transfer can take place within the shaft toward the hardened areas.

The time interval between the initial quenching of the parts that are to be very hard and the subsequent quenching of those parts that are to be toughened and refined may vary somewhat, depending on the character of the work piece. The temperature of the work piece begins to fall as soon as it is removed from the furnace. Those parts subjected to localized quenching may have a very rapid temperature change. The rate of temperature change of those parts not subjected to quenching will be influenced by the nearness of such parts to the quenched areas, by the relative bulk of the quenched and unquenched parts, by radiation, by the accessibility of the parts to air conduction and such factors. In order that the subsequent quenching may occur at a proper temperature, or at properly related temperatures in the work piece, it may be desirable in some instances as, for example, in a bearing or in a part of the shaft of large bulk which will have a slow normal cooling, to induce a more rapid cooling by artificial means such, for example, as by directing one or more air blasts on the particular parts of the work piece. The rate of temperature change resulting from the application of the air blast is such as to not produce a quenching action, and it may be so regulated that at the termination of the initial quenching the temperature of the part or parts subjected to the air blast will be a proper one for subsequent quenching. The air blast may also function to accelerate the temperature drop of certain portions so that upon subsequent quenching those parts will be at a lower temperature than other parts not subjected to initial quenching so that at the time of subsequent quenching several different temperatures exist in the work piece and correspondingly different degrees of hardness will result from quenching.

As an illustration of the application of an air blast attention is directed to Fig. 2 wherein one of the arms **23** of the frame **20** is shown as having a nozzle **40** that is directed toward the shaft bearing portion **12** which stands at the lower part of the shaft as mounted in the frame. The nozzle **40** has a connection **41** to the source of air supply and to provide a desired regulation of the air flow and coordinated rate of temperature change a valve may be incorporated as indicated at **42**. It is pointed out that the single nozzle shown is but an illustrative example and that a plurality of the nozzles may be used and may be positioned as desired.

The bearing **12**, being of relatively large bulk as compared to the remainder of the shaft, and being more remotely positioned with respect to the water mist quenching blasts than the gear **13** for example would have a normal cooling at a slower rate than the gear referred to. The application of an air blast at this point affords a regulated temperature drop permitting subsequent quenching at a desired temperature.

Localized hardening of the cam lifts may be accomplished by the use of a plurality of quenching blasts directed at different portions of a cam as well as by the use of a single blast with accompanying cam movement as described above.

Referring now to Fig. 5, an arrangement is shown incorporating a cam **11'** with which is associated two nozzles **30'** that are placed on opposite sides of the cam point so that quenching blasts are directed simultaneously to both sides of the cam. The positioning of these nozzles may be altered in accordance with the desire to harden more or less of the cam surface.

Treatment of the character described makes possible the use of relatively inexpensive cast iron in fields of service heretofore restricted to more costly steels. Materials of the character mentioned have a Brinell hardness as cast of about 210. These materials are capable of being hardened up to a Brinell reading of 500. Through the use of the hardening blasts as described the hardness of the material may be readily increased to 475 on the Brinell scale which is suitable for the purpose specified. The subsequent toughening quench results in a Brinell hardness of the order of 270 which is adequate to provide a desired wear resistance to the bearings, gears etc. while retaining those parts in a state that is readily machinable.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claim.

What is claimed is:

The method of heat treating a camshaft of heat-treatable cast iron which comprises heating the camshaft above its critical temperature, then subjecting only the cam lifts to a rapid quenching operation through the critical temperature and to a temperature of only a few hundred degrees F. by air and water for hardening the cam lifts, rotatably moving the camshaft through a small angle while said rapid quenching operation is effective, cooling the remaining portions of the camshaft at a slower rate to a point somewhat below the critical temperature, and then quenching the entire shaft by immersion.

JOSEPH D. JUDGE.