Sept. 24, 1940. J. D. JUDGE 2,215,724

APPARATUS FOR HARDENING CAMSHAFTS AND THE LIKE

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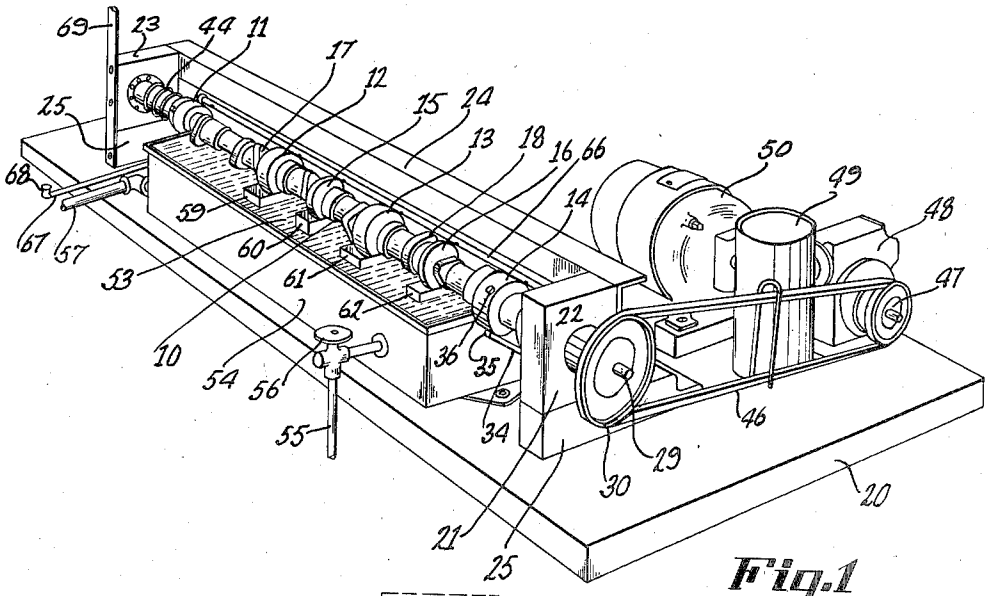



Fig. 1

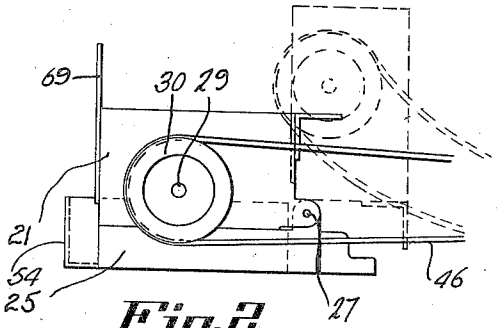



Fig. 2

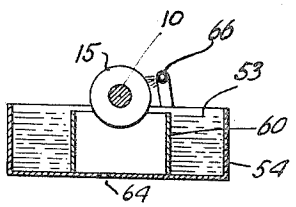



Fig. 3

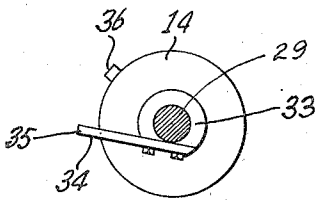



Fig. 6

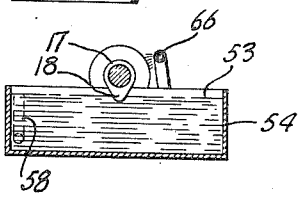



Fig. 4

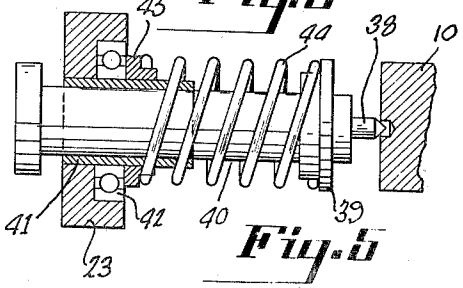



Fig. 5

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## APPARATUS FOR HARDENING CAMSHAFTS AND THE LIKE

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5 Claims. (Cl. 266—6)

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

One object of the invention is the provision of a simple apparatus for differentially heat treating articles of the character mentioned to provide different and desired degrees of hardness at different spaced portions of the article, and permitting a large number of articles to be treated in a given time and in an efficient manner.

Another object of the invention is the provision of an apparatus especially useful for rapidly quenching the cam lifts or tips of camshafts while other portions of the shaft are subjected to a differential treatment to obtain a desired hardness, the apparatus having provision for shielding certain portions of the camshaft from engagement with the quenching liquid so that those portions may be cooled more slowly and receive a machinable surface.

Another object of the invention is the provision of an apparatus of the character mentioned having means for rotating the camshaft about its own axis, the drive means being automatically rendered operative and inoperative as the camshaft is moved towards and away from the quenching liquid.

Other objects and advantages of the invention will be apparent from the following description, the appended claims and the accompanying drawing in which—

Fig. 1 is a perspective view showing an apparatus embodying the present invention for differentially treating the different portions of a shaft;

Fig. 2 is a side elevation of a portion of the apparatus, showing the shaft supporting frame in dotted lines in loading position;

Fig. 3 is a transverse section through the pan and through one of the bearing portions of the shaft;

Fig. 4 is a transverse section through the pan and one of the cams;

Fig. 5 is a longitudinal vertical section through the spring pressed shaft holding center; and

Fig. 6 is a transverse section through the drive shaft section adjacent the end of its supporting block and showing the driving connection for the camshaft.

The drawing, in which like characters of reference designate like parts throughout the several views thereof, shows an apparatus for differentially heat treating different portions of shafts and the like, made of cast iron or other similar heat treatable material, and more particularly for treating camshafts which are cast from heat treatable cast iron such as "Meehanite," this material being cast iron in which the graphite is controlled by adjusting the chemical composition to a point where the casting would normally be cast white, 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. However, it will be understood that other heat treatable cast iron articles may be treated in accordance with the present invention.

In the illustrative example of the invention, the apparatus is adapted for heat treating a camshaft 10, having bearing portions 11, 12, 13 and 14, a portion 15 which is subsequently machined to provide a driving gear, and an eccentric portion 16. The shaft is also provided with a series of cams 17, herein shown as 12 in number, and adapted to operate the inlet and exhaust valves of an engine. Each cam is provided with a cam lift or tip 18.

Mounted on a suitable supporting base 20 is a shaft carrying frame 21 including bearing blocks 22 and 23 arranged at opposite ends of the frame and rigidly interconnected by a longitudinally extending bar 24, shown in the form of an angle iron. The lower ends of the bearing blocks 22 and 23 rest on fixed carrying members 25, the blocks 22 and 23 having horizontal hinged connections, as indicated at 27, to the carrying members 25 so that the blocks 22 and 23 together with the bar 24 may be moved from their normal lowered position indicated in Fig. 1 to a raised loading position indicated in dotted lines in Fig. 2, in which the camshaft may be applied or removed.

In the bearing block 22 is an anti-friction bearing rotatably supporting a short shaft 29 which is suitably held against axial movement. One end of the shaft 29 projects outwardly beyond the end of the bearing block and is provided with a pulley wheel 30. The other end of the shaft 29 projects inwardly and is provided with a centering cone adapted to fit into the countersink in the end of the camshaft. This end of the shaft 29 is also provided with a flange 33 to which is fixed a driving arm 34, having a laterally projecting foot 35 which is adapted for abutting engagement with a lug 36 cast on the bearing portion 14 of the camshaft. As the wheel 30 is rotated it will thus be apparent that the projecting foot 35 on the rotatable arm 34 engages the lug 36 and pushes the same ahead of it so that

the camshaft will be rotated around its own axis.

The other end of the camshaft is carried by a centering cone 38 which projects from a disk 39 provided on a shaft section 40 which is mounted for axial sliding movements in a sleeve 41. The latter is mounted by means of anti-friction bearing 42 for rotation in the block 23 as shown in Fig. 5. Spring 44 bears at one end against the pressure ring 45, and its other end engages the disk 39 so that the pointed cone 38 is held yieldingly in engagement with the countersink at the end of the camshaft. As the length of the camshaft changes, due to the large change in temperature produced during the quenching operation, the centering cone 38 automatically accommodates itself to the length of the shaft so that the shaft is held with its axis normally located in a predetermined position.

The pulley wheel 30 is connected by means of a transmission belt 46 to a drive wheel 47. The latter is driven through suitable reduction gearing contained in a gearing reducing box 48, and through a set of miter gears in the gear housing 49, from a drive motor 50. The speed reduction effected through the miter gears and the gear reducing drive is such that the speed of the motor shaft, which is preferably about 1725 R. P. M. provides a speed of the pulley wheel 30 of the order of 144 R. P. M., the speed of the work being chosen to give the desired depth of hardened structure in accordance with the composition of the metal.

The camshaft carrying frame 21, when moved about its horizontal hinge axis 27 to the position indicated in dotted lines in Fig. 2, may be readily supplied with a camshaft which has been heated to the proper temperature. The heated camshaft may be handled by tongs so that one end of it is supplied to the end of the centering support on the inner end of the shaft 29, and the shaft section 40 pulled outwardly against the spring 44 and the centering cone 38 then brought into engagement with the other end of the camshaft. Means are provided to control the transmission of power to the work piece; for example when the frame is raised, the center of the wheel 30 is brought closer to the pulley wheel 47 and the belt 46 is thus slackened sufficiently so that the wheel 30 does not rotate. However as soon as the frame is lowered to its normal operative position indicated in Fig. 1, the movement of the wheel 30 away from wheel 47 tightens the belt 46, and the shaft is thus rotated about its own axis when in this lowered position.

In its lowered position, the tips or rises 18 of the various cams dip into a quantity of water or other suitable coolant 53 contained in a pan 54 which is mounted on the base 20. The cooling liquid is supplied to the pan through an inlet pipe 55 having a control valve 56 which controls the rate of supply, and the liquid flows out from the tank through a discharge pipe 57 which may extend into the pan and reach upwardly as indicated at 58 in Fig. 4 so that its open upper end is positioned at the desired level. This level is such that the body portions of the camshaft are just above the liquid, but the tips of the cams move through the liquid as shown in Fig. 4 as the shaft rotates.

The bearing portions 11 and 14 at the end of the shaft are positioned outside of the pan. The bearing portions 12 and 13 and the other enlarged portions of the shaft, namely the gear portion 15 and eccentric portion 16, are prevented from contacting with the coolant 53 by means of cups or shields 59, 60, 61 and 62, which are wide enough to accommodate these bulky or enlarged parts of the camshaft, and which are provided with outlet openings 64 so that any water that might find its way into the shields may be drained.

Arranged along one side of the camshaft is an air pipe 66, suitably fixed on the upper side of the pan, and supplied with air under pressure through a supply pipe 67 having a suitable control valve 68 for controlling the rate of air flow. The pipe 66 is provided with air discharge openings arranged opposite the enlarged or bulky portions 11, 12, 13, 14, 15 and 16 of the camshaft, the other parts of the pipe being imperforate. Air blasts are thus directed directly against the outer surfaces of these enlarged portions of the camshaft to provide a gradual cooling action effective to gradually lower the temperature of those bulky portions of the shaft in which the heat would normally be retained for a longer time, the air blasts however being regulated so that the surface portions of the bearings, gear, etc. are not made extremely hard and remain machinable.

In hardening the tips of the camshaft in accordance with the present invention, the camshaft is heated to a temperature of about 1600° F. and is then brought from the furnace and applied to the supporting frame with the latter in its raised position, and with the coolant in the pan 54 at the desired normal liquid level. The frame is then lowered, preferably by means of an upstanding handle 69, and when its lowered position is reached the driving arm 34 will be rotated by the tightened belt, pushing the lug 36 on the camshaft around so that the shaft will be rotated. The tip portions of the cams will thus be moved through the quenching liquid, which is preferably at normal room temperature, and these quenching portions of the cam will thus be quite rapidly cooled through the critical temperature, which is of the order of 1350° F. when using material of the character mentioned. The rate of heat change through the critical temperature of those portions of the camshaft which dip into the coolant is quite rapid, and sufficiently fast so that an extremely hard surface is given to the tip portions of the cams. The camshaft continues its rotation, maintaining the cam tips at a temperature of several hundred degrees, until the other portions of the camshaft are reduced in temperature, at a comparatively slow rate, until the body portion and bulky portions of the camshaft are at a temperature below the critical, and of the order of 1000° F. As the cam tips are kept cool after they are quenched, and made extremely hard, the character of the structure forming those quenched parts is fixed. The other portions of the camshaft, which are cooled slowly in air, are not too hard to be machined readily, as they are not cooled rapidly through the critical temperature. The enlarged bearing portions, gear, etc. on the camshaft, which are cooled by the air blasts issuing from the holes in air pipe 66 are reduced to a temperature of the order of 1000° F. by the time the main body portion of the camshaft is at that temperature, so that the time required for the quenching and fixing of the cam tips is not excessive, and the overall time of the operation is shortened without producing a hardening quenching action on the bearings, gears, etc.

As soon as the temperature of the camshaft body has fallen to about 1000°, the frame is raised and the camshaft promptly removed and then

quenched by submerging the same in water or a suitable quenching liquid which fixes the properties of the material and holds the toughness and medium hardness currently existing in the body portion of the camshaft but without producing an extremely hard or brittle characteristic of the metal. This prompt quenching of the entire camshaft also prevents the residual heat of the body portion of the shaft from drawing the hardness of the cams.

Treatment of the character described makes possible the use of relatively inexpensive cast iron of the character mentioned in fields of service that usually require more costly steels. These cast iron materials are capable of being hardened to provide cam tips with a Brinell reading of about 500, while the toughened and refined body portions of the camshaft which have been rapidly quenched from a temperature of about 1000° F., several hundred degrees below the critical, produce a Brinell hardness of the order of 270 which is adequate to provide the desired strength to the body portions of the shaft and produce bearings and gear portions that are readily machinable and not of a brittle character.

It will be obvious that the apparatus mentioned may be capable of use over long periods of time without requiring particular attention or repair, and makes it possible to very rapidly handle a large number of parts in a short time, as only about three minutes or so is required for each complete operation.

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 claims.

What is claimed is:

1. Apparatus of the character described comprising a pan for quenching liquid, means for maintaining quenching liquid in said pan at a predetermined normal level, a frame having means for rotatably supporting a camshaft to be treated, means supporting said frame for movement of the camshaft from a horizontal position removed from the quenching liquid into a predetermined horizontal position in which the lower side of the shaft throughout the major portion of its length is spaced above the normal liquid level and with the cams projecting down into the liquid, means for rotating said shaft to move the cams through the liquid while other parts of the shaft remain entirely above the liquid level, and means providing air chambers open at the top and extending down below the liquid level for receiving portions of the shaft of enlarged diameter and shielding the same from the quenching liquid.

2. Apparatus of the character described comprising a pan for quenching liquid, means for maintaining quenching liquid in said pan at a predetermined normal level, a frame having means for rotatably supporting a camshaft to be treated, means supporting said frame for movement of the camshaft from a horizontal position removed from the quenching liquid into a predetermined horizontal position in which the lower side of the shaft throughout the major portion of its length is spaced above the normal liquid level and with the cams projecting down into the liquid, means for rotating said shaft to move the cams through the liquid while other parts of the shaft remain entirely above the liquid level, means providing air chambers open at the top and extending down below the liquid level for receiving portions of the shaft of enlarged diameter and shielding the same from the quenching liquid, and means for directing localized blasts of air against enlarged portions of the shaft received in said air chambers to gradually cool such portions.

3. Apparatus of the character described comprising a pan for quenching liquid, means for maintaining quenching liquid in said pan at a predetermined normal level, a frame having means rotatably supporting opposite ends of a camshaft having cams and other enlargements, with the camshaft axis in a lowered position above the normal level of liquid in the pan and with projecting parts of the cams projecting down into the liquid, means for moving said frame to a loading position raised from the pan, power means for rotating the shaft, means for automatically starting rotation of the shaft by movement of the frame to its lowered position, means in said pan for shielding said other enlargements of the shaft from dipping into the liquid, and means for supplying cooling air to said other enlargements.

4. Apparatus of the character described comprising a pan for quenching liquid, means for maintaining quenching liquid in said pan at a predetermined normal level, a frame having a plurality of axially spaced shaft supports adapted to carry a camshaft to be treated, said frame having a normal lowered positioning in which the shaft axis is horizontally arranged above the normal level of liquid in the pan with the cam tips projecting into the liquid, means for supporting said frame for movement of the shaft axis to a horizontal raised position above the pan, drive means for rotating said shaft on its axis, and means for automatically starting the rotation of the shaft by movement of the frame towards its normal lowered position.

5. Apparatus of the character described comprising a pan for quenching liquid, means for maintaining quenching liquid in said pan at a predetermined normal level, a frame having a plurality of axially spaced shaft supports adapted to carry a shaft to be treated, said frame having a normal lowered positioning in which the shaft axis is arranged above the normal level of liquid in the pan with projecting portions of the shaft projecting into the liquid, means supporting said frame for movement of the shaft axis away from the pan, power drive means for rotating said shaft, said drive means and shaft having a spacing which is increased as the frame is moved towards its normal position, and a transmission belt for driving said shaft from said power drive means and of such length as to be rendered effective automatically as a power transmitting element between the shaft and the power drive means by movement of the frame into its normal lowered position.

JOSEPH D. JUDGE.