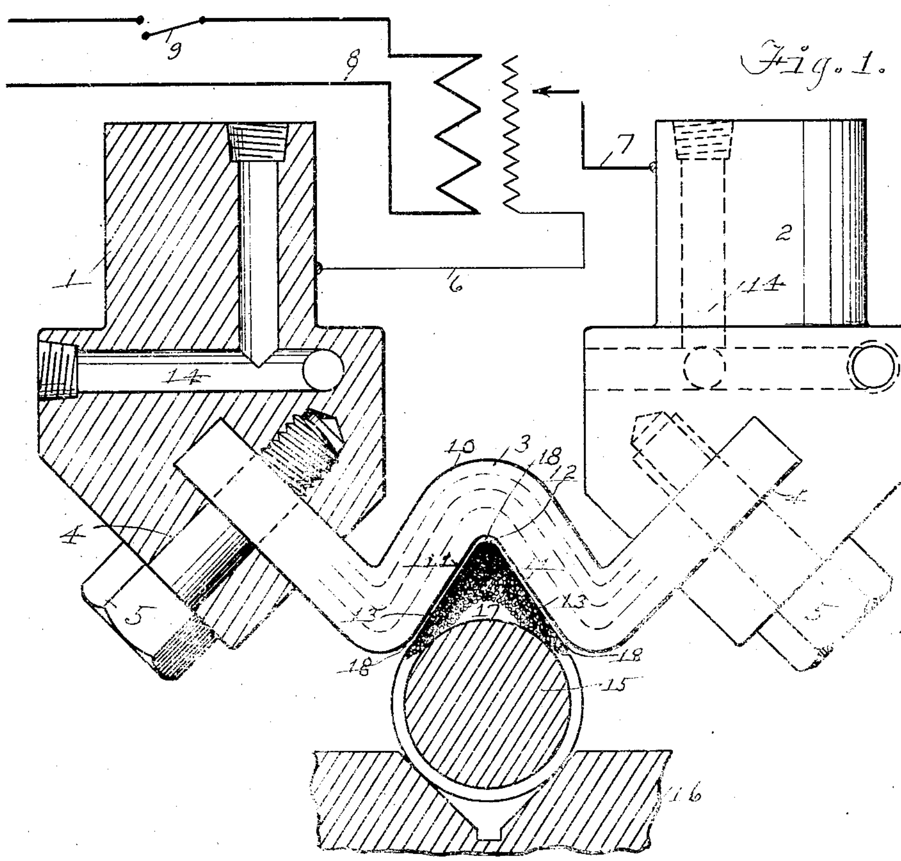
Oct. 31, 1939. C. W. DAKE 2,178,201

METHOD OF HARDENING FERROUS BODIES

Filed Jan. 6, 1937

Fig. 1.



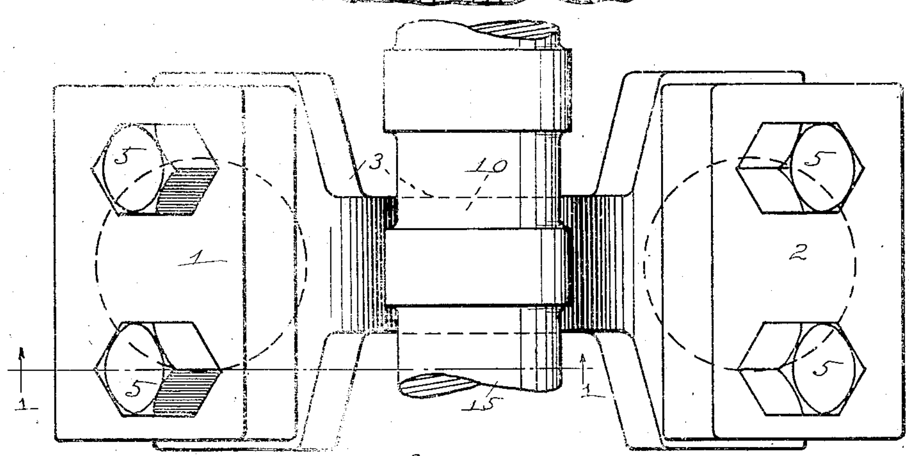


Fig. 2.

Witness
Geo. L. Chapel

INVENTOR.
Charles W. Dake
BY Rice and Rice
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,178,201

METHOD OF HARDENING FERROUS BODIES

Charles W. Dake, Grand Haven, Mich., assignor to Campbell, Wyant and Cannon Foundry Company, Norton Township, Muskegon County, Mich., a corporation of Michigan

Application January 6, 1937, Serial No. 119,357

6 Claims. (Cl. 148—21)

The present invention relates to methods of hardening ferrous bodies, particularly segregate portions thereof, as the wear surfaces of the integral cam portions of shafts employed in internal combustion engines and the like; and its object is, generally, to provide an improved method whereby such surfaces may be readily, quickly and economically heated sufficiently and then cooled to harden the same to a considerable depth, especially in areas of the cams which must sustain greater wear, and without involving other portions of said bodies; so that, in this particular use for example, the cam portions may be hardened to resist wear while the body of the shaft will remain unhardened and thus easily machined and resistive to the torsional and other breaking stresses to which it is subjected in use.

Various methods have been practiced for hardening ferrous cams and the like: In one method, steel shafts forged with their integral cams in suitable dies have been heated in furnaces after they have been machined, to carburize the surfaces of the cams and thereupon quenched as by a cooling fluid to harden the same. This method is objectionable because the heating of the shaft as an entirety deforms the same somewhat requiring it to be straightened before the final grinding and polishing of its bearings, and such carburizing produces a thin hardened surface on the cams—a few thousandths of an inch—which when the cams are ground to finished condition may become broken and scale away from the softer metal beneath under the stress and strain of use.

In another method the shafts and their cams are cast in a mold provided with chill members so placed that the cams are cast in contact therewith to be chilled or cooled thereby. This method is objectionable because the cams are thereby made very hard which necessitates much difficult machining thereof, and this method is not economical on account of the loss and necessary replacement of such chill members in casting. In another method the shaft with its cams cast of suitable iron is placed in a device similar to an electric welder, and an electric current is passed through the portion of the cam to be hardened. This and other similar methods are uncertain and unreliable because the proper temperature to which the cam is to be subjected is governed by the visual observation and variable judgment of the operator as to the color of the cam heated by the resistance of the cam's metal to the passage of the electric current therethrough. And in another method the cams are heated by the flame of a gas torch. This method is objectionable because the heating is slow and depends also on the uncertain observation and judgment of the operator. These objections are obviated or minimized in my method.

My present invention consists in flowing a current of electricity, preferably a high frequency alternating current, in a resistor unit placed in close proximity to the portions of the cam to be heated for hardening, but not through the cam. The cam is heated by radiant heat from the resistor unit heated by its resistance to the flow of electricity, and by eddy currents generated within the cam by the rapid directional changes of the electric current in the resistor unit, and while so heated, cooling the cam by applying a current of cool air or spray of cool water to the cam; and my means or apparatus for carrying out said method consists of an electric resistance unit shaped in conformity with the cam's wear surfaces and in electrically insulated relation thereto, and means for flowing a current of electricity, preferably a high frequency alternating current, in said unit.

The above objects and any other and more specific objects hereinafter appearing are attained by my method, more particularly described in the body of this specification; and an illustrative preferable means or apparatus whereby the method may be carried out is hereinafter particularly described and is illustrated by the accompanying drawing, in which:

Figure 1 is an elevational end view of means or apparatus for carrying out my hardening method, certain parts thereof and the body of a cam shaft being sectioned vertically on line 1—1 of Figure 2; and

Figure 2 is a bottom plan view of the same.

The apparatus as thus illustrated includes a pair of spaced electric conductor members 1, 2, preferably of copper, electrically connected at their lower ends by the heating member 3, preferably of high heat-resisting steel, whose ends are seated in slots 4 in the lower ends of the members 1, 2 and tightly held therein by threaded bolts 5. The upper ends of members 1, 2 are electrically connected, and as shown are preferably connected for transmission of an alternating high frequency current by the indicated transformer having the secondary or induced current wires 6, 7 connected to members 1, 2 respectively, and the primary current wire 8 with a circuit opening- and closing-switch 9 and a suitable generator or source of electric energy.

The members 1, 2 have cross sectional areas great enough to provide a high degree of electric transmission therethrough, but the member 3, or its middle portion 10, has a cross sectional area restricted to provide resistance to the flow of current sufficient to heat said member (or its said portion 10) to a high degree. This member or its said portion is so shaped that its angularly disposed lower surfaces 11, 11 extend parallelly with, and in spaced close proximity to, the cam's high point 12 and its other wear surfaces 13 on the opposite sides of said point, in order that the current passing through the electric resistance member 3 will heat the same and by radiation from its surfaces 11, 11 will heat the cam's wear surfaces. The members 1, 2 desirably have passages 14 for a cooling fluid.

The illustrated apparatus is operated to carry out my process in the following manner. The cam shaft 15 is placed on a suitable support 16 below the member 3, with the cam 17 positioned between said member's surfaces 11, 11 and slightly spaced at 18 therefrom. This space 18, shown somewhat exaggerated for the sake of clearness in Figure 1, serves to electrically insulate the shaft and its cam from the member 3. The primary circuit 8 being closed, induces a current in the secondary circuit which current heats the member 3 and by radiation therefrom quickly heats the cam's said wear surfaces to a considerable depth, and the high frequency alternating current flowing in the member 3 generates eddy currents within the cam and assists in the rapid heating thereof.

While a high frequency alternating electric current is thus preferable, a direct electric current for heating member 3 may be used with good results.

The thus heated and changed portion of the cam (somewhat exaggerated for the sake of clearness) is shown in black at the cam's wear surfaces and progressively less black inwardly therefrom, and as extending to its greatest depth at the cam's high point but decreasing in depth progressively from said point. This result is due to the fact that the surfaces 11, 11 of member 3 converging toward the cam's high point heat the cam at and adjacent said point to a great depth and to a high degree; but said surfaces 11, 11, diverging from the high point to a constantly increasing distance apart, heat the cam's surfaces 13, 13 to a comparatively less depth and lower degree progressively toward the body of the shaft.

The cam's wear surfaces are thus heated and hardened in areas and to depths where such hardening is most necessary to withstand the wear and stress of use, and are heated and hardened in areas and to less depths where wear-withstanding quality is less necessary, while the body of the shaft remains practically unheated and therefore not deformed, and unhardened and therefore easily machined and able to sustain torsional and other stress.

When the cam with the moldings and adhering thereto is inserted into the apparatus, the sand acts as an electric insulator; and a film of oxidation may be formed by the heat on said member's surfaces 11, 11 thus insulating the cam therefrom.

Cast iron of commerce has a carbon content sufficient to harden the cam by my process, and in any case a sufficient amount of carbon may be incorporated in the ferrous material for hardening the same for the intended use. The desired degree of heating of the cams may be attained by varying the amperage or quantity of the electric current or by varying the space between the cam and the member 3 of the apparatus.

The member 3 is heated sufficiently (i. e. to about 2000 degrees Fahr.) to heat the cams above their lower critical point (i. e. 1300 degrees Fahr. in iron or 1450 degrees Fahr. in steel). This heating of the cams may be accomplished in about five to ten seconds. The work, removed from the apparatus is cooled by exposure to atmosphere, or more rapidly by means of a spray of cool water.

The frequency change of the alternating current referred to should exceed five hundred reversals of direction of flow per second of time; and a unidirectional pulsating electric current may be employed in place of an alternating current.

This application is a continuation-in-part of my application Ser. No. 736,481, filed July 23, 1934.

The described and illustrated means or apparatus for carrying out said method is made the subject matter of my separate or divisional application.

I claim:

1. A method of hardening the camming surfaces of cast ferrous cams in segregate relation to their integral shafts, which includes the acts of radiantly heating the cam's high point and caming surfaces at its opposite sides by resistance to an electric current directed parallelly with said surfaces and in insulated relation thereto, and then cooling the cam.

2. A method of hardening the camming surfaces of carbon-containing ferrous cams in segregate relation to their integral shafts, which includes the acts of preparing an elongated electric resistance conductor with a lateral concave portion whose surface conforms with the convex camming surfaces of the cam to be hardened, holding the cam in said portion with its camming surfaces in electric insulated relation to said portion's surface, passing an electric current through the conductor to heat the cam by radiation therefrom, and then cooling the cam.

3. A method of hardening the camming surfaces of carbon-containing cast iron cams in segregate relation to their integral shafts, which includes the acts of radiantly heating the cam's high point and camming surfaces at its opposite sides above their lower critical point by resistance to an electric current directed parallelly with said surfaces and in insulated relation thereto, and then rapidly cooling the cam.

4. A method of hardening the camming surfaces of cams and the like having an apex and mutually inclined camming portions at the opposite sides thereof, in segregate relation to the cam's shaft, which method includes the acts of preparing an electric resistance heating member with a concave portion whose surface conforms with the convex camming surface of the cam to be hardened, holding the cam in said portion with its camming surface in electric insulated relation to said conductor's said surface, passing an electric current through said member to heat said heating member and thereby to heat the cam by radiation therefrom, and then rapidly cooling the cam.

5. A method of hardening the camming surfaces of cams and the like having an apex and mutually inclined camming portions at the op-

posite sides thereof, in segregate relation to the cam's shaft, which method includes the acts of preparing an electric resistance heating member with a cancave portion whose surface conforms with the convex camming surface of the cam to be hardened, holding the cam in said portion with its camming surface in spaced relation to said conductor's said surface, passing an alternating electric current through said heating member to heat the same and thereby heat the cam by radiation therefrom, and then rapidly cooling the cam.

6. The method of hardening cams having their major constituent cast iron integrally cast with a cast metal supporting shaft, which method includes providing an electrical heater bar shaped to conform with the camming surfaces of the cam, placing the cam in closely spaced relation to the heater bar, causing the heater bar to be heated by passing alternating currents of electricity through the heater bar to heat the same and cause a magnetic field to be set up around the bar and in the cam whereby the cam will be heated conjointly by radiation from the bar and eddy currents generated within the cam by said magnetic field, and then rapidly cooling the cam.

CHARLES W. DAKE.