May 4, 1948. H. B. GILSON 2,440,716

HEATING OR FLAME HARDENING APPARATUS

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Fig. 1.

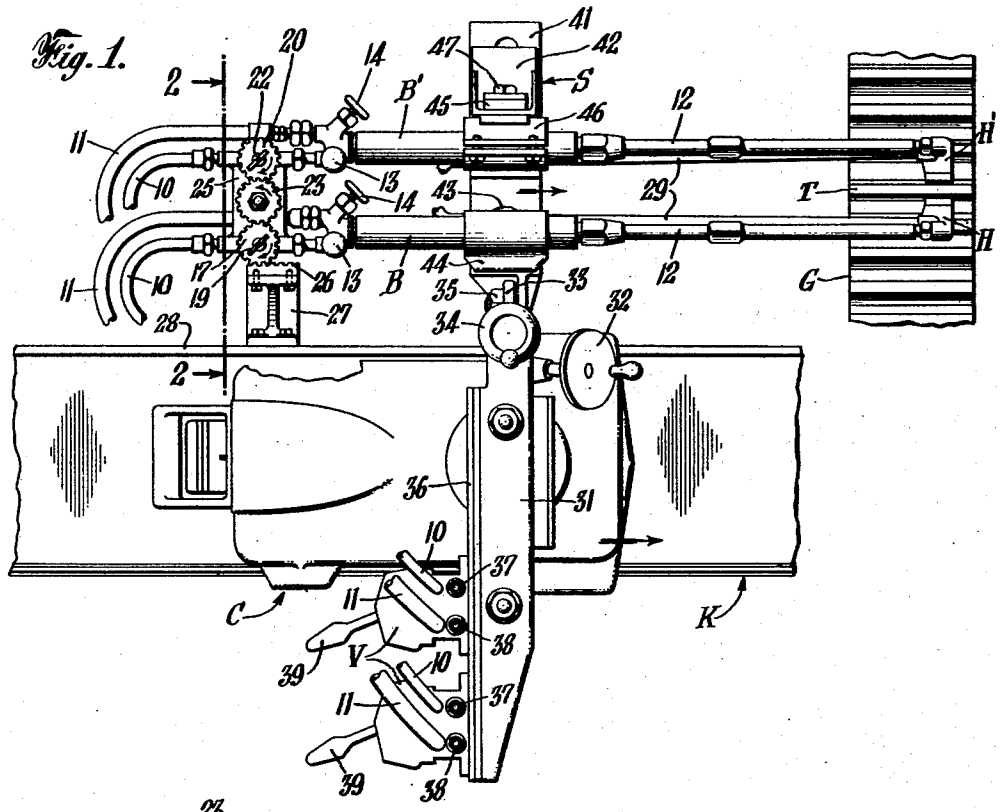
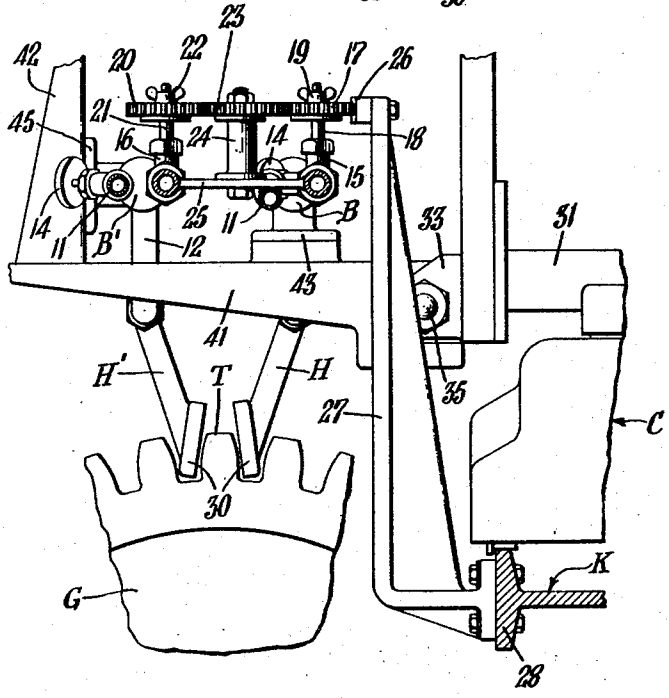


Fig. 2.



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HEATING OR FLAME HARDENING APPARATUS

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5 Claims. (Cl. 266—5)

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This invention relates to apparatus for heating surfaces of metal articles by high temperature heating flames, and more particularly to apparatus for flame hardening articles such as gear teeth, the ends of which tend to become overheated.

In flame hardening articles, such as gear teeth, in the usual manner, one or more high temperature heating flames are directed against successive portions of either or both wearing surfaces of the gear tooth, to heat such successive surface portions to a temperature at or above the critical range. The heating flames are followed by quenching jets which cool the heated surface portions at a sufficiently rapid rate to harden the same. For simplicity of apparatus and operation, it is desirable to effect a substantially constant relative speed of traverse of the heating flames across the surfaces. However, with a relatively constant speed of traverse, there is a tendency for the ends of the gear tooth to become overheated, since there is less metal at the ends to conduct heat away. When the end of the wearing surface of a gear tooth is overheated, there may be a disparity in hardness between the end and the remainder of the tooth surface, and also a tendency for the end of the tooth to chip, spall, or crack. Thus, it is desirable to heat the end of a wearing surface of a gear tooth, or similar portions of other metal articles, to substantially the same temperature as the remainder of the surface.

Heretofore, an increase in the rate of relative speed of traverse has been utilized to cause less heat to be applied to surface portions which tend to become overheated, but in order to achieve the necessary accuracy in speed control, a complicated set-up or expensive governing apparatus must be used. Consequently, an object of this invention is to provide apparatus for heating or flame hardening in which the amount of heat applied to a surface portion which tends to become overheated is reduced, but in which a relatively constant rate of traverse may be maintained.

Among other objects of this invention are: to provide apparatus for heating or flame hardening a surface of a metal article, by which the tendency for any portions of such surfaces to become overheated is avoided; to provide such apparatus which is easily controlled and effective in operation; and to provide such apparatus which comprises a relatively inexpensive addition to existing apparatus for heating or flame hardening surfaces of metal articles, particularly gear teeth and the like.

Further objects and novel features of this invention will become apparent from the following description and accompanying drawing, in which:

Fig. 1 is a plan view of conventional apparatus

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for flame hardening the wearing surfaces of gear teeth, but equipped with parts added thereto in accordance with this invention; and

Fig. 2 is an enlarged partial end elevation of the apparatus of Fig. 1, partially in section taken along line 2—2 of Fig. 1.

In the apparatus of this invention, high temperature heating flames produced by a combustible mixture of oxidizing gas, such as oxygen, and a fuel gas, such as acetylene, are preferably utilized; and the temperature and intensity of the heating flame or flames is lowered as any surface portion, which would otherwise tend to become overheated, is traversed. In accordance with this invention, the intensity of the heating flame or flames is lowered by reducing the amount or pressure of oxidizing gas or oxygen which, with the fuel gas, forms the combustible mixture producing the heating flames.

The invention may be carried out by the apparatus illustrated in the drawing, which includes a pair of blowpipes B and B' provided with heads H and H', each of which is adapted to direct heating flames followed by quenching jets against one of the opposite sides or wearing surfaces of a tooth T of a spur gear G. The blowpipes B and B' are mounted, by a support S, on a carriage C which runs along a track K and in a direction parallel to the sides of tooth T. Blowpipes B and B' are supplied with an oxidizing gas, such as oxygen, and a fuel gas, such as acetylene, by hoses 10 and 11, respectively, which lead from a pair of quick-acting valves V. Valves V are used in turning on the oxygen and acetylene at the beginning of each forward or hardening movement of carriage C, and in shutting off the heating gases as soon as each tooth has been treated.

Blowpipes B and B' may be any conventional type, each provided with a suitable mixer for forming a combustible mixture of oxygen and acetylene which passes to heads H and H' through tubes 17, by which heads H and H' are supported. The normal amount of oxygen passing to the mixer in either blowpipe is controlled by a regulating valve 13, while the normal flow of acetylene to either mixer is controlled by a regulating valve 14.

In accordance with this invention, and in order to reduce the amount or pressure of oxygen supplied to the mixers within the blowpipes without affecting the setting of oxygen regulating valves 13, control valves 15 and 16 are interposed between the ends of hoses 10 and regulating valves 13. Control valves 15 and 16 are adapted to be partially closed at any desired point along the path of travel of carriage C. For this purpose, a pinion 17 is secured to stem 18 of control valve 15 by a wing nut 19, while a similar pinion 20 is secured to stem 21 of control valve 16 by a wing nut 22. So that valves 15

and 16 may be partially closed simultaneously and in equal amounts, and so that pinions 17 and 20 will always rotate in the same direction, an idler pinion 23 is interposed between pinions 17 and 20. Idler pinion 23 is rotatably mounted on the upper end of a post 24, in turn mounted upon a plate 25, the opposite ends of which are secured to the bodies of control valves 15 and 16 in any suitable manner, such as by welding, as shown. Of course, idler pinion 23 may be supported for rotation in any other suitable manner, as will be obvious to those skilled in the art.

For rotating pinions 17 and 20 in the direction of the arrows, as shown, at any desired point along the path of travel of carriage C, and thereby partially close control valves 15 and 16, a rack 26 is secured in a horizontal position to the upper end of a bracket 27, the lower end of which is secured to a flange 28 of track K. Rack 26 may be secured to bracket 27 and bracket 27 to flange 28 in any suitable manner, such as by bolts, as shown.

As soon as pinion 17 engages stationary rack 26, the amount or pressure of oxygen supplied to blowpipes B and B' will begin to be reduced, and when the end of the tooth T is reached the amount of oxygen will be further reduced. Thus, the longitudinal position of rack 26 and bracket 27 is preferably such that control valves 15 and 16 will be partially closed when heads H and H' reach the end of tooth T. For instance, rack 26 may be so positioned that pinion 17 will engage the rack when the heating flames are at a distance of about 5/8 in. from the end of tooth T. (In the drawing, this distance, as well as the relative size of pinions 17, 20, 23 and rack 26 have been slightly exaggerated for the cake of clarity.)

As soon as the heating flames reach the end of tooth T, both the oxygen and acetylene are turned off by valves V. The quenching fluid, normally water supplied to heads H and H' by tubes 29, may be left on during both the hardening and return strokes of carriage C, or the quenching water may be turned off as soon as the quenching jets pass the end of the tooth.

While apparatus other than that described above may be used to reduce the amount or pressure of oxygen supplied to blowpipes B and B', a particular advantage of the arrangement shown is that when the carriage C is returned to the starting position, preparatory to treating the next tooth, rack 26 will cause pinions 17 and 20 to re-open valves 15 and 16. Consequently, no adjustment of oxygen regulating valves 13 is necessary to begin treatment of the next tooth.

There are many advantages in lowering the temperature and intensity of heating flames by reducing the supply of oxygen, particularly in flame hardening operations. For instance, should it be attempted to lower the intensity and temperature of the heating flames by reducing the supply of both oxygen and fuel gas, the velocity of the combustible mixture jets producing the heating flames will tend to be reduced to a point below the rate of flame propagation, and backfires and/or flashbacks will result. A backfire, which is a popping back of the flame into the blowpipe, momentarily stops the operation; while a flashback, which is a sustained burning of the mixture within the blowpipe, completely stops the operation. Again, should it be attempted to reduce the heating effect of the flames by reducing the amount of

fuel gas, the heating flames will then be highly oxidizing and will tend to attack a surface heated to an elevated hardening temperature. Each of the above disadvantages is obviated by reducing the amount or pressure of oxygen and providing thereby a carburizing or excess acetylene flame. Furthermore, although the resulting flames will be carburizing in effect, the amount of time during which the flames are applied to the surface is relatively short. Thus, no appreciable carburizing effect will be produced, since the reaction of a carburizing flame on highly heated surfaces is much slower than that of a highly oxidizing flame.

Heads H and H' may be of any suitable type, but it is preferred to use heads of the type disclosed in Roger O. Day application Serial No. 169,373, filed October 16, 1937, now Patent No. 2,224,006. Such heads are particularly adapted for hardening the wearing surfaces of gear teeth, and are provided with a lower end 30 of reduced thickness adapted to fit in the valley between gear teeth. Such heads are also provided with two rows of combustible mixture outlets and two rows of quenching fluid outlets which extend substantially from the bottom to the top of the gear tooth. The combustible mixture outlets are spaced more closely together at the lower end of each row, and at increasing distances apart toward the upper end of each row, so that a greater amount of heat is applied adjacent the base of the gear tooth and an increasingly lesser amount toward the top of the tooth. This compensates for the tendency for a greater amount of heat to be conducted from the base of the tooth into the body of the gear, and also prevents the top of the tooth from becoming overheated.

The carriage C may be any conventional type of mechanism, such as the self-propelled wheel carriage shown in U. S. Patent No. 2,183,605. The track K may be an I-beam, as shown, or any other suitable track, such as a channel, along which the carriage may move.

The carriage C, as shown, is provided with a horizontally adjustable slide 31, which may be moved to any desired position by a hand wheel 32, and is also provided with a vertical slide 33 adjustable by means of a hand wheel 34. The blowpipe support S is attached to vertical slide 33 by a bolt 35, while valves V are mounted upon a suitable bracket 36, secured to horizontal slide 31. Inlets 37 and 38 of valves V are connected with suitable sources of oxygen and acetylene, respectively, or other oxidizing gas and fuel gas. Handles 39 of valves V also may be connected by a common lever, if desired, for simultaneous operation.

Blowpipe support S may be any suitable type adapted to permit the positioning of blowpipes B and B' so that heads H and H' are disposed in the desired relation with respect to the wearing surfaces of tooth T. Blowpipe support S may be similar to the support disclosed in the aforementioned application Serial No. 169,373, now Patent No. 2,224,006, but other supports may be used, such as disclosed in the application of Roger B. White, Serial No. 169,379, filed October 16, 1937, now Patent No. 2,224,007.

As illustrated herein, blowpipe support S comprises a horizontal arm 41, one end of which is secured to slide 33 by bolt 35. A slotted vertical arm 42 is movable along arm 41 and may be secured thereto in any desired position by a bolt (not shown) which extends through the slot in

arm 41. A slide 43, to which blowpipe B is secured by a clamp 44, is similarly adjustable along horizontal arm 41. A second slide 45, to which blowpipe B' is secured by a clamp 46, is movable vertically along arm 42, and may be secured in any desired vertical position by a bolt 47, which extends through the slot in arm 42. Through slides 43 and 45, and clamps 44 and 46, blowpipe B may be adjusted horizontally and radially, while blowpipe B' may be adjusted vertically and radially. Thus, heads H and H' can be placed in any desired relationship with respect to the wearing surfaces of a gear tooth to be hardened, while the support S, with the blowpipes B and B' mounted thereon, may be adjusted horizontally or vertically as a whole, by hand wheels 32 and 34.

To prevent bracket 27 from being struck by blowpipe support S when the carriage C is at the extreme left hand or starting position, blowpipes B and B' may be moved to the left in clamps 44 and 46, as shown. Of course, rack 26 may be supported in any other suitable manner, in case there is any possibility of support S or any other part striking bracket 27 when the carriage is moved back to the starting position.

While the apparatus described is particularly adapted to harden the wearing surfaces of gear teeth, it will be understood that one, or more than two, blowpipes may be used, and that such blowpipes may be provided with suitable heads for treating other types of surfaces. Also, rack 26 may be placed in any desired position to engage pinion 17 and lower the intensity of the heating flame or flames at any desired point along the path of traverse. Furthermore, should it be desired to lower the intensity of the flame, and then raise the intensity of the flame as soon as a surface portion tending to become overheated is passed, suitable changes may be made. For instance, in treating a flat surface of a plate or bar which has a slot or cutaway portion on the opposite side from the surface being treated, a suitable rack may be placed to engage pinion 20 and thereby open valves 15 and 16, after they have been partially closed by rack 26. With such a setup, the intensity of the heating flame or flames is lowered as the surface portion directly opposite the slot or cutaway portion is being treated, while the intensity of the heating flame or flames is raised as soon as the surface portion opposite the slot is passed. Thus, previous and subsequent portions of the surface are heated to the same extent, while the portion opposite the slot is heated to a lesser extent.

It will also be understood that this invention may be utilized in heating operations other than flame hardening and in treating articles other than gear teeth; and that various changes in the apparatus, other than those indicated, may be made which will not depart from the spirit and scope of this invention, as defined in the appended claims.

What is claimed is:

1. Apparatus for flame hardening a surface of a metal article, a portion of said surface having a tendency to become overheated, such apparatus comprising a movable carriage; a blowpipe mounted on said carriage and provided with a mixer for forming a combustible mixture of oxygen and fuel gas and also provided with a heating head adapted to direct against said surface at least one high temperature heating flame produced by the combustion of said mixture; two adjustable valves for severally adjusting the flow of fuel gas and oxygen to said mixer to initially

produce a desired combustible mixture; a third control means for partially closing said third valve; and means for actuating said third valve control means at a predetermined point in the path of travel of said carriage.

2. Apparatus for flame hardening a surface of a metal article as defined in claim 1, in which said third valve control means comprises a pinion and said actuating means includes a rack mounted in a stationary position and operative to engage said pinion at a predetermined point in the path of travel of said carriage.

3. Apparatus as defined in claim 1, in which said carriage is movable forward and rearward along a path adjacent said article and said actuating means is constructed and arranged to partially close said third valve at a predetermined point in the path of forward travel of said carriage and to re-open said third valve during subsequent rearward travel of said carriage.

4. Flame hardening apparatus comprising a heating torch having a tip and a mixer in which oxygen and fuel gas are brought together and supplied to the tip; two adjustable valves for severally initially adjusting the flow of fuel gas and the flow of oxygen to said mixer, to initially produce a desired combustible mixture; a conduit through which oxidizing gas is supplied to the torch; a third valve controlling the oxidizing gas flow through said conduit; and means for operating the third valve progressively in response to displacement of the torch to vary the intensity of the flame, to change only the supply of oxidizing gas during a flame hardening operation.

5. In an apparatus for heating a metal surface, a blowpipe constructed and arranged to produce a mixture of fuel and oxidizing gases to provide a heating flame, two adjustable valves for severally initially adjusting the flow of fuel gas and the flow of oxygen to said heating flame, means for effecting relative movement between the blowpipe and the metal surface, means including a third valve for reducing the flow of the oxidizing gas only and without varying the flow of the fuel gas to reduce the intensity of the heating flame, and means for operating said third valve at a predetermined point in the movement between the blowpipe and the work surface.

HIRAM B. GILSON.

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Certificate of Correction

Patent No. 2,440,716. **May 4, 1948.**

HIRAM B. GILSON

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 2, line 42, for "tubes 17" read *tubes 12*; column 3, line 39, for the word "cake" read *sake*; column 6, line 1, after "a third" insert *valve for controlling the flow of oxygen through one of said adjustable valves to said mixer*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of July, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.