Feb. 10, 1948. F. O. HESS 2,435,923

HEAT TREATING APPARATUS

Filed Dec. 14, 1944

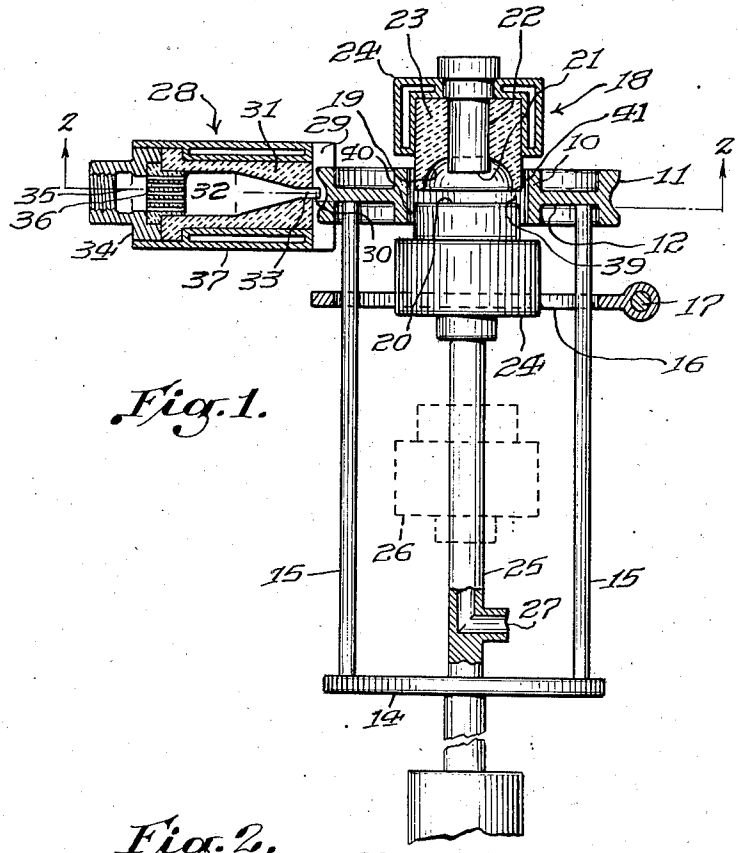

Fig. 1.

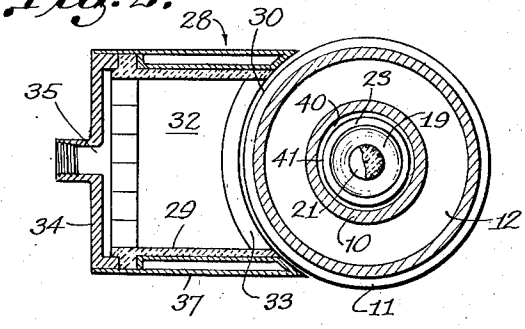

Fig. 2.

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Patented Feb. 10, 1948

2,435,923

UNITED STATES PATENT OFFICE

2,435,923

HEAT-TREATING APPARATUS

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Application December 14, 1944, Serial No. 568,149

4 Claims. (Cl. 263—2)

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My invention relates to heat treating metallic bodies, especially ferrous metallic bodies containing carbon, and it is an object of the invention to provide an improvement for selectively heat treating metallic bodies by radiant heat, as will appear from the following description and accompanying drawing forming a part of this specification. In the drawings Figure 1 is a more or less diagrammatic illustration of the apparatus for practicing the invention; and Figure 2 is a view taken on line 2—2 of Figure 1.

In the drawing, apparatus embodying the invention is shown for selectively heat treating the hub and rim portions 10 and 11, respectively, of a pulley wheel 12 formed of ferrous metal. The wheel 12 during heat treatment is adapted to be supported in a horizontal position on work supporting structure including a plate 14 and a number of posts 15 extending upwardly therefrom. The wheel 12 rests upon the upper ends of the posts 15 of the supporting structure which is adapted to be rotated in any suitable manner (not shown).

The work supporting structure is also adapted to be lowered from the position shown in the drawing so that a heat treated wheel may be removed from the posts 15 and another pulley wheel positioned on the posts. To facilitate removal of a heat treated wheel an annular ring 16, which is pivoted at 17, is normally held in a horizontal position in any suitable manner below the upper ends of posts 15. When the posts 15 of the work supporting structure are moved downwardly, the heat treated wheel 12 is held back on the ring 16 as the upper ends of the post 15 pass below the ring. When this occurs, the ring 16 may be tilted downwardly about the pivot 17 to permit the heat treated wheel to slide into a body of quenching liquid or into position for spray quenching, so as to harden the heat treated hub and rim portions 10 and 11, respectively.

The hub portion 10 is adapted to be heated by a heating unit 18 comprising a pair of gas-fired radiators 19 and 20 in face to face relation. The radiators 19 and 20 are alike, and, as diagrammatically shown, each is of parabolic form and includes a distributor cap 21 which is connected to a nipple 22 extending to the rear of a block 23 of ceramic material forming the radiator. The blocks 23 may be provided with hollow jackets 24, through which a suitable cooling liquid is circulated, to prevent excessive heating of the rear portion of the blocks 23.

The top radiator 19 is stationary while the bottom radiator 20 is mounted at the upper end of a hollow post 25 which is vertically movable, whereby the bottom radiator 20 may be lowered from the position shown in the drawing to the dotted line position at 26 below the ring 16. Such vertical movement of the bottom radiator 20 is necessary in order to allow the heat treated pulley 12 to be lowered onto the ring 16 in the manner described above. A suitable gas mixture is delivered to the radiators 19 and 20 from a source of supply, and the mixture for the bottom radiator passes upwardly thereto through the hollow post 25 to which the gas mixture is supplied at 27.

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The rim portion 11 is adapted to be heated by one or more heating units 28 each of which extends for about 75° about the rim of the pulley wheel 12. The heating unit 28 includes a refractory lining 29 which is closely adjacent to the rim portion 11 and conforms to the curvature of the latter to provide a narrow gap 30 therebetween. The lining 29 is formed by a hollow structure 31 of ceramic material providing a combustion chamber 32 having a restricted outlet 33. The restricted outlet 33 is in the form of a narrow slot which is midway between the top and bottom edges of the lining 29 and extends lengthwise of the lining to regions closely adjacent the ends thereof.

The hollow refractory structure 31 is secured to a hollow base member 34 forming an inlet chamber 35, and between the inlet chamber 35 and combustion chamber 32 is provided an orifice wall having a plurality of orifices or openings 36 therein. In order to prevent excessive heating of the structure 28, a hollow jacket 37 is provided about the latter through which a cooling liquid may be circulated.

When a pulley wheel 12 is to be heat treated, it is positioned on the posts 15 in the manner shown in the drawing adjacent to the heating units 18 and 28. The gas mixture is supplied under pressure from the source of supply to the radiators 19 and 20 in each of which a number of small gas streams are produced by the caps 21. Combustion of the gas streams is effected at the caps 21 to produce a number of gas flames, and the heat developed by such combustion heats the radiators to a highly radiant condition. The radiators 19 and 20 are closely adjacent to each other to provide a narrow space 39 therebetween which restricts outward flow of the heated gases from the combustion space formed by the radiators, so that combustion may be accomplished in the radiators at a pressure above that of atmos-

pheric. The excess pressure maintained in the combustion space, together with the highly radiant condition of the radiators to which the gas mixture is subjected, intensifies the combustion reaction to produce heated gases at a very high temperature which pass through the narrow space 39 into the gap 40 between the inner surface of hub 10 and the refractory linings 41 at the outer surfaces of the blocks 23 adjacent to the space 39.

The lining 41 formed at the outer side surface of each block 23 is associated with the radiators 19 and 20, and, since the heated gases are discharged into the gap 40 at a temperature practically equal to the temperature in the radiators and when the chemical reaction of combustion is substantially completed, the linings 41 are heated to a highly radiant condition by the heated gases which sweep over the lining at a high velocity and in intimate contact therewith. Radiant heat waves are projected from the incandescent linings 41 to the inner surface of hub 10 at close range thereto to effect heating of the latter. In addition, heat is liberated from the high temperature gases which spread out in the gap and come in contact with the inner surface of the hub 10, so that radiant heating of the hub is augmented by convection heating.

When a mixture of air and ordinary city gas is employed, for example, the linings 41 may be heated to a white incandescent temperature of 2850° F. or higher and practically equal to the temperature at which combustion is accomplished in the radiators 19 and 20. Under normal operating conditions the narrow kerf-like space 39 between the radiators may develop such a back pressure that the gases in the combustion space formed by the radiators may be maintained at a pressure varying from ten to sixty inches of water column in excess of the pressure at the discharge end of the outlet formed by the space 39.

Thus, by maintaining the pressure of the heated gases in the space 39 at a pressure above that of atmospheric, the rate of supply of the gas mixture to the radiators 19 and 20 is adjusted so that combustion may be accomplished at the radiators at a correspondingly higher pressure. The combined radiant and convection heating contributes to the rapid rate of heat transfer to the work and the fast heat penetration effected. In heating a work piece like the hub 10, for example, in which the gap 40 may be in the neighborhood of ¼ to ½ inch, the hub can be heated to the critical hardening temperature of 1550° F. to 1650° F. in about a minute or less when using a mixture of air and ordinary city gas.

While heating of the hub portion 10 is being accomplished by the heating unit 18, the rim portion 11 may be heated at the same time by the heating unit 28. The gas mixture is supplied under pressure to the inlet chamber 35 of heating unit 28 and passes through the openings 36 into the chamber 32 in which combustion of the small subdivided gas streams is accomplished. The flames maintained in combustion chamber 32 effect such heating of the inner refractory wall surface of the chamber that the latter is heated to a highly radiant condition. Due to heating the inner wall surface of chamber 32 to a high incandescent temperature, and subjecting the gas mixture entering the chamber to intense heat radiated from the incandescent wall surface, substantially complete combustion of the gas mixture is accomplished in the chamber 32 before the mixture reaches the restricted outlet 33. From the restricted outlet 33 is discharged a high velocity jet or stream of heated gases consisting substantially entirely of heated products of combustion.

When a mixture of air and ordinary city gas is employed and such mixture is introduced into the combustion chamber at a temperature of about 70° F., the gases are heated to a temperature of 2850° F. and higher. Due to such heating the gases expand over six fold and at a rate directly proportional to increase in absolute temperature. In view of the fact that the combustion of the gas mixture is accomplished practically entirely within chamber 32 and the gases undergo considerable expansion, relatively large volumes of heated gases are discharged from chamber 32 in the form of a gas stream having an average velocity of 700 feet per second and even higher. As in the operation of the heating unit 18 just described, the restricted outlet 33 may develop such a back pressure that the gases in chamber 32 may be maintained at a pressure varying from ten to sixty inches of water column in excess of the pressure at the discharge end of the outlet. By maintaining the chamber 32 at such an excess pressure, the rate of combustion in the chamber is accelerated and the temperature at which combustion takes place is increased, so that heated gases are made available for heating work pieces to the hardening temperature in the shortest length of time possible.

The high temperature stream of heated gases produced by heating unit 28 is utilized to accomplish selective heat treating in an open arrangement by causing these heated gases to heat to a highly radiant condition the refractory lining 29. Such heating of the lining 29 is accomplished by providing the narrow gap 30 between the lining and the rim 11 of the pulley wheel 12. When a mixture of air and ordinary city gas is employed, the lining 29 may be heated to a white incandescent temperature of 2850° F. and higher. Such heating of the lining is accomplished by the gases which spread out and completely fill the gap 30. In addition, these high temperature gases, which flow at a relatively high velocity, come in intimate contact with the surface portions of rim 11 to be heated and contribute to the high rate of heat transfer to the work.

In view of the foregoing, it will now be understood that an improvement has been provided for heat treating and hardening metallic bodies by combined radiant and convection heating in what may be referred to as open arrangements. Further, the heat may be applied to the work uniformly and in relatively short heating times. In view of the relatively short heating times required and the fact that many heat treating and hardening operations can be accomplished with gas mixtures of air and ordinary gas, like city gas and natural gas, for example, considerable economy is effected in heating work to elevated temperatures in accordance with the invention.

This application is a division of my copending application Serial No. 482,697, filed April 12, 1942, entitled "Heat treatment," which is turn is a continuation-in-part of my copending application Serial No. 459,680, filed September 25, 1942, entitled "Method of and apparatus for heat treating metallic bodies."

While a single embodiment of the invention has been shown and described, it will be apparent that modifications and changes may be made

without departing from the spirit and scope of the invention, as pointed out in the following claims.

What is claimed is:

1. Apparatus for heat treating a surface of a cylindrical-shaped metallic body, such as the hub or peripheral surface thereof, for example, comprising rotatable means for supporting the body, structure including a wall having a face or lining adapted to be positioned face to face with and overlying the surface at close range thereto, said lining being at least as wide as the surface and curved so that, when it is positioned closely adjacent to the surface, a narrow gap is formed therebetween, the portion of said lining adapted to overlie the surface being formed entirely of high temperature refractory material, said wall having an elongated slot intermediate its edges in a plane transverse to the axis of the cylindrical-shaped body when the latter is supported in a heating position by said rotatable means, and means communicating with said slot for producing heated products of combustion from a combustible gas mixture and for flowing such products of combustion through said slot only when the chemical reaction of combustion of the mixture is substantially completed and while the products of combustion are practically at the temperature at which combustion is accomplished, said lining being heated to a highly incandescent condition by the heated products of combustion passing into the gap through the slot to effect radiant heating of the surface when the body is being rotated which is augmented by heat liberated from the products of combustion passing through the gap in intimate contact with the surface.

2. Apparatus for heat treating a cylindrical surface of a metallic body comprising rotatable means for supporting the body, structure including a wall having a curved face or lining adapted to be positioned closely adjacent to and overlying the surface so that a narrow gap is formed therebetween, the portion of said lining adapted to overlie the surface being formed entirely of high temperature refractory material, said wall having an elongated slot intermediate its edges in a plane transverse to the axis of the cylindrical surface when the body is supported in a heating position by said rotatable means, and means for producing heated products of combustion from a combustible gas mixture and flowing such products of combustion through said slot only when the chemical reaction of combustion of the mixture is substantially completed and while the products of combustion are practically at the temperature at which combustion is accomplished, said lining being heated to a highly incandescent condition by the heated products of combustion passing into the gap through the slot to effect radiant heat heating of the cylindrical surface when the body is being rotated which is augmented by heat liberated from the products of combustion passing through the gap and in intimate contact with the surface.

3. Apparatus for heat treating work comprising rotatable means for supporting the work, structure including a wall having a curved face or lining adapted to be positioned closely adjacent to the work so that a narrow space is formed between it and the work it overlies when the work is being rotated, the portion of said lining adapted to overlie the surface being formed entirely of high temperature refractory material, and a surface of means for producing heated products of combustion from a combustible gas mixture and utilizing such heated products of combustion only when the chemical reaction of combustion is substantially completed and while the products of combustion are practically at the temperature at which combustion is accomplished to heat said lining to a highly incandescent condition to effect radiant heating of the work when the latter is moved with respect to said lining by said rotatable means.

4. Apparatus for heat treating work comprising rotatable means for supporting the work, structure including a wall having a curved face or lining adapted to be positioned in a plane substantially parallel to the axis of said rotatable means and closely adjacent to the work so that a narrow space is formed between it and a surface of the work it overlies when the work is being rotated, the portion of said lining adapted to overlie the surface being formed of high temperature refractory material, and burner means for producing heated products of combustion from a combustible mixture and utilizing such heated products of combustion only when the chemical reaction of combustion is substantially completed and while the products of combustion are practically at the temperature at which combustion is accomplished to heat said lining to a highly incandescent condition whereby, when the work is moved with respect to said lining and burner means by said rotatable means, heating of the work is effected by heat radiated from said lining and by the heated products of combustion.

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Certificate of Correction

Patent No. 2,435,923. February 10, 1948.

FREDERIC O. HESS

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 6, lines 9 and 10, claim 3, strike out the words "a surface of" and insert the same after "and" and before "the" in line 6, same claim; 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 27th day of April, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.