Nov. 10, 1925. 1,561,041

J. W. WHITE

HEAT TREATMENT OF GEARS OR THE LIKE

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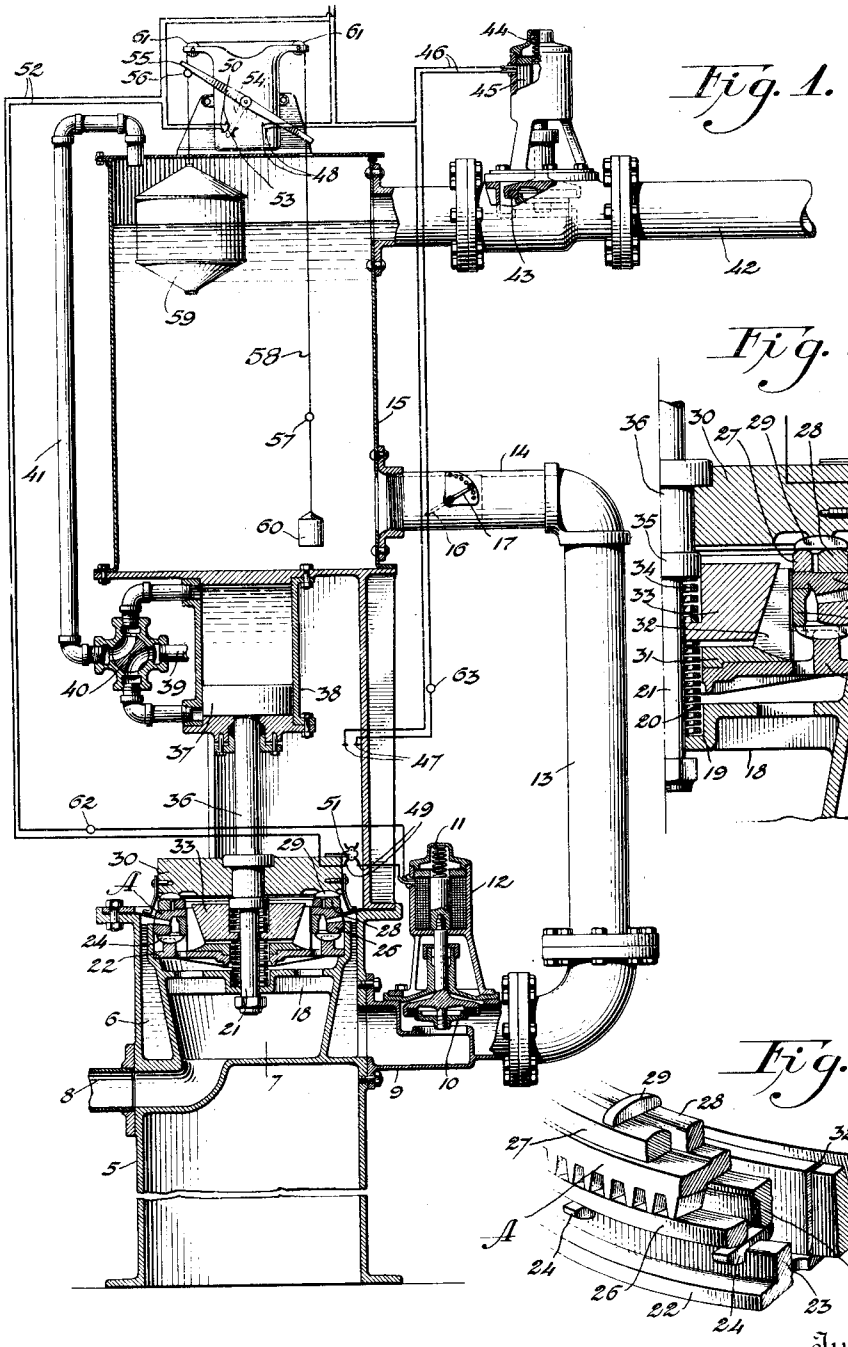


Fig. 1.

Fig. 2.

Fig. 3.

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Fig. 4

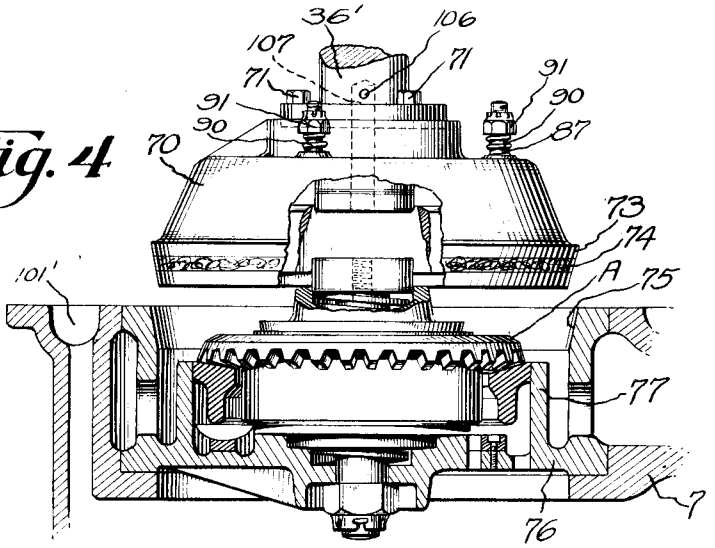
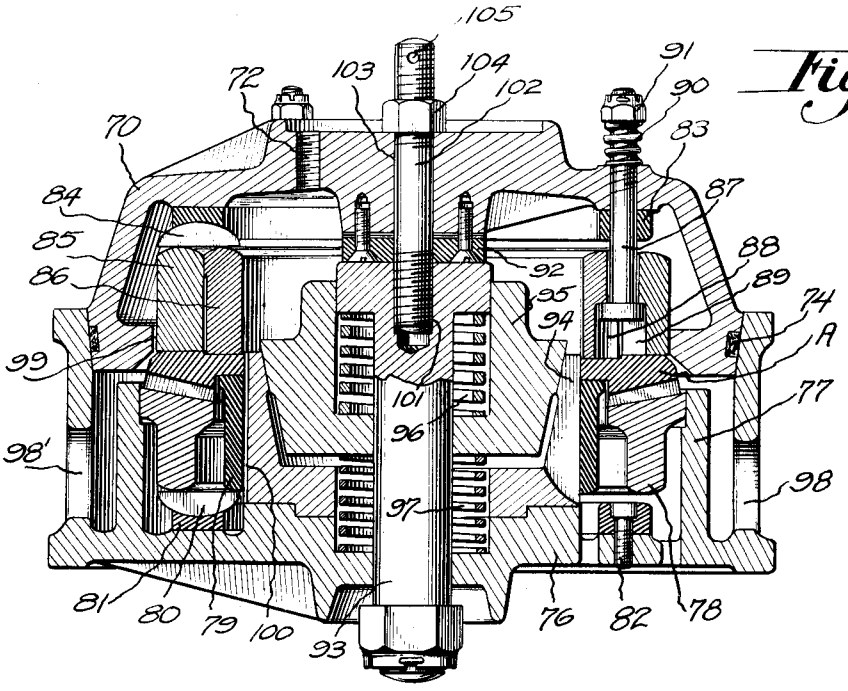


Fig. 5



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UNITED STATES PATENT OFFICE.

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HEAT TREATMENT OF GEARS OR THE LIKE.

Application filed December 1, 1920. Serial No. 427,600.

To all whom it may concern:

Be it known that I, JOHN W. WHITE, a citizen of the United States, and a resident of Detroit, county of Wayne, and State of Michigan, have invented certain new and useful Improvements in Heat Treatment of Gears or the like, of which the following is a full, clear, concise, and exact description, such as will enable others skilled in the art to which the invention relates, to make and use the same, reference being made therein to the accompanying drawings, which form a part of this specification.

The invention relates to a process and apparatus for the treatment of articles, such as gears, with a fluid material, as for example for the purpose of hardening the gear or a portion thereof.

The principal object of the invention is to provide a method and apparatus whereby articles may be subjected to a heat treatment of a high degree of uniformity by the application of a fluid medium thereto.

A further object is to provide for the treatment of articles or portions therof by the passage of a fluid medium thereover as distinguished from the insertion of or submersion of the article in the treating fluid.

A further object is to provide for the treatment of predetermined portions only of the articles by suitable limitation of the surfaces to which the fluid medium is applied.

A further object is to provide for the control, preferably by automatic means, of the amount of treating fluid to be utilized in each operation, thereby contributing to the accuracy and uniformity of the results.

A further object is to provide means whereby the article under treatment may be securely clamped during the application of fluid medium thereto, whereby warping while under treatment may be minimized.

A further object is to provide clamping means for articles, such as ring gears, whereby minor variations in dimensions, such as inaccuracies in machining, may be accommodated.

With the above and other objects in view, as will appear more fully from the following description, the invention comprises the features of novelty herein described and such modifications and variations thereof as fall within the scope of the concluding claims.

In the heat treatment of metal articles for the purpose of imparting thereto certain properties of hardness or temper, as, for example, in the treatment of gears by heating the same and then cooling by means of a fluid medium such as oil or water, it has been customary to dip or submerge the heated article in a bath of the cooling or quenching medium. As a result the medium employed has access to all portions of the article although it may be desirable in some instances, as in the hardening of gear teeth, to confine the action to a portion only of the article. Furthermore, the treatment is quite likely to produce distortion of the articles by reason of unequal heating or cooling or variations in the character of the material. A further defect in the usual treatment is that the bath of treating medium changes in temperature during the operation and uniformity in the temperature to which the articles are submitted cannot be maintained.

In order to overcome these defects I propose, 1st, to clamp the article firmly so as to prevent warping and, if desired to limit the area treated, to expose only the portion to which the treatment is to be applied; 2nd, to cause a predetermined quantity of medium of a predetermined temperature to flow over the said portions during a definite, regulable period of time. By thus placing under control the primary factors determining the character and effect of the treatment practical uniformity may be obtained together with almost any desired variation in the details of the treatment.

In the accompanying drawings in which is illustrated one embodiment of means for carrying out the process outlined above,

Figure 1 is an elevation, for the most part in vertical section, showing a machine adapted especially for the treatment of ring gears.

Fig. 2 is a fragmentary vertical section on an enlarged scale;

Fig. 3 is a perspective view of a portion of the clamping means;

Fig. 4 is a fragmentary elevation, partly in section showing a modified form of clamping mechanism, and

Fig. 5 is a vertical sectional view showing the clamping mechanism of Fig. 4 removed from the machine.

In the drawings 5 indicates a frame

which may be of any character suitable to support the machine parts. In the upper portion of the frame is a chamber 6 of annular form within which is a second chamber 7 having an outlet 8 leading to a cooler or to any suitable point of storage or disposal of used treating fluid. The fluid is supplied to annular chamber 6 by a pipe connection 9, the flow of fluid through the connection being controlled by a valve 10, which is arranged to be closed by a spring 11 and opened by a solenoid 12. Treating fluid may be supplied through a pipe 13 having a connection 14 leading from tank 15. A butterfly valve 16 mounted in the connection 14 and adjustable to any desired position by the handle 17 provides a means for varying at will the rate of flow of the fluid from the tank and to the treating chamber.

Within the chamber 7 is a spider 18 having a socket 19 for the reception of a spring 20, and an aperture in the base of said socket serving as a guide for the pin 21. Above the spider 18 is a perforated base plate 22 supported upon a shoulder or ledge in the wall of the chamber 7. In an upwardly extending flange 23 on plate 22 are formed concave seats in which are mounted slippers or equalizers 24. Rings 25, 26, mounted respectively upon the inner and outer ends of the equalizers 24 are appropriately formed to support the article to be treated, as in this case, the ring gear A, a space being left between the rings through which the treating fluid may flow. Another pair of rings 27, 28, are arranged to rest upon the upper surface of the article and may be pressed downwardly to clamp the article by means of another set of slippers or equalizers 29 fitting within concave seats in the ram 30. It will be noted that the rings 27, 28, and the ring 25 are adapted to prevent to any desired extent the contact of the treating medium with the portions of the gear other than the teeth. In treating articles of other shapes it will be understood that similar provision may be made by suitably varying the contour of the supporting and clamping means whereby the cooling or treating fluid may be permitted to contact with the desired portions only.

In order to apply clamping pressure to the internal surface of the ring gear and assist in preventing distortion thereof I have provided an expansible member comprising a plate 31 resting upon the base plate 22 and having an upwardly extending flange fitting within the ring gear and slotted at frequent intervals about its periphery, two opposite slots being shown in Figure 1, and one, designated by the numeral 32, being shown in Figures 2 and 3 whereby a large number of narrow up-standing resilient fingers are provided, and the disc as a whole is rendered sufficiently resilient so that it can be forced outwardly against the gear. To apply such expanding force I utilize a disk 33 having a bevelled periphery adapted to engage the similarly bevelled interior of the slotted flange of plate 31. The under side of this disk is engaged by the spring 20, and a spring 34 is seated in a recess in the upper surface. The pin 21, which passes freely through an aperture in the center of disk 33, is provided with a head 35 against which the spring 34 abuts at its upper end. The rod 36, which carries the ram 30 is arranged to engage in its downward movement the head 35 forcing the pin downwardly against the resistance of springs 20 and 34. The spring 34, which is much stiffer than spring 20, thereupon causes the bevelled disk 33 to be forced downwardly and the internal clamping member to be thereby applied to the ring gear. Upon the upward movement of the ram the spring 20 will lift the disk 33 and permit the release of the clamping member.

In order to seal the annular chamber 6 against escape of treating fluid a resilient flange 137 may be mounted at the upper end of the chamber and arranged to be engaged by a leather or similar packing hood 138 which may be reinforced by springs 139.

The rod 36 is secured at its upper end to the piston 37 operating in cylinder 38 and adapted to be actuated by a fluid pressure medium, preferably water, supplied through the pipe 39 and the four-way valve 40. If the medium employed for treating the gears or other articles is the same as that used in actuating the piston and ram then the exhaust from cylinder 38 may lead to the tank 15, as indicated, through the pipe 41.

The tank 15 is arranged to be filled with liquid from any suitable source of supply through pipe 42, a valve 43 being interposed which valve is adapted to be actuated by a spring 44 and solenoid 45 in a manner similar to that already described with reference to valve 10. The temperature of the liquid will be regulated and maintained uniform by any usual or desired form of heating or cooling apparatus.

In order to provide for automatic control of the filling and emptying valves in proper sequence I have devised the electric control system shown diagrammatically in Figure 1, it being understood that the invention is in no way concerned with the specific details of the electrical elements, per se. Electric conductors 46, adapted to be connected to any suitable source of current supply, are arranged to join in series the winding of solenoid 45 and the pairs of contacts 47 and 48. Other conductors 52 are similarly arranged to join in series the winding of solenoid 12 and the pairs of contacts 49 and 50. A circuit closing device 51 carried by the

ram 30 is adapted to close the circuit through conductors 46 at contacts 47 when the ram is in its upper position and to close the circuit through conductors 52 at contacts 49 when in its lower position. Another circuit closing device 53 is arranged to be actuated in any convenient manner in response to the level of liquid in tank 15 and to bridge the contacts 50 when the tank has been completely filled or filled to the desired level, and the contacts 48 when the tank has been emptied to the predetermined extent desired.

As one means for operating the circuit closer 53 I have shown the circuit closer as carried by an arm 54 arranged to be actuated by the two-armed lever 55. This lever is so mounted as to be actuated to the extreme positions in which it will cause the bridging of contacts 50 or 48 respectively by tappets or buttons 56 and 57 adjustably mounted upon the flexible member 58, the latter being connected at one end to a float 59 and at the other end to a weight 60, and passing over suitable guides 61. Incandescent lamps 62, 63, may be placed in circuit with conductors 52 and 46 respectively to indicate to the operator when the tank has been emptied or filled.

The operation of the control system is as follows:—Assuming that the tank 15 has been filled and that a gear to be hardened, which has previously been heated to the desired temperature, has been placed in position with reference to the clamping devices, the attendant will operate valve 40 to a position to admit pressure medium above the piston 37 and thereby cause the ram 30 to be lowered and the gear to be clamped. The lowering of the ram will bring the circuit closer 51 in position to bridge the contacts 49. The circuit being already closed through contacts 50, current will flow through the winding of solenoid 12 and open valve 10, thus permitting the cooling liquid to flow from tank 15 at such rate as is fixed by the previous adjustment of valve 16. When now a definite amount of liquid has flowed from the tank, as determined by the position of button 57, the lever 55 will be actuated to break the circuit at contacts 50, thereby permitting the valve 10 to be closed by spring 11. The lamp 62 will also be extinguished, thus indicating to the attendant that the hardening operation has been completed. The valve 40 may now be reversed to permit pressure medium to enter under the piston 37, thereby lifting the ram 30 to its upper position, which will result in the bridging of contacts 47. Contacts 48 having already been connected by the movement of lever 55, the valve 43 will be actuated to permit the flow of liquid into the tank which flow will be interrupted by the closing of the valve when the circuit is broken at contacts 48 due to the action of button 56 as the float rises. The lamp 63 will give an indication to the attendant that the supply of treating liquid has been replenished.

The liquid supplied through the valve 10 will rise in the annular chamber 6 and overflow through the spaces between the gear teeth, and, escaping therefrom between the rings 25 and 26 and the perforations in base plate 22, will flow away through chamber 7. It will be seen therefore that a definite amount of treating fluid of a predetermined and substantially constant temperature may be caused to contact for a predetermined time with the desired area of the article under treatment, thereby assuring practical uniformity in and control of the effects produced.

It will be noted further that the method herein described offers the advantage of permitting the rapidity of the cooling or quenching operation to be greatly accelerated because of the rapid movement of the cooling medium, and also obviates the necessity for any agitation of the articles in the quenching bath or of the bath itself. Furthermore, the entire body of treating medium may be caused to pass in heat-exchanging relation to the article undergoing treatment.

In Figs. 4 and 5 I have shown in detail a form of clamping mechanism slightly different from that already described. In this form the rod 36′, corresponding to rod 36, is provided with a flanged head secured to ram 70 by bolts 71, the ram having tapped holes 72 to receive the bolts. The ram is formed at 73 with a conical or beveled peripheral portion provided with a packing material at 74 and adapted to fill the correspondingly shaped interior flange 75 of the base plate 76. The base plate is also provided with an upstanding annular flange 77 adapted to guide and position the lower external clamping ring 78. This ring and the lower internal clamping ring 79 are supported upon the equalizers 80 which rest in concave seats in the fulcrum ring 81 secured to the base plate as by screws 82.

To the inner face of the ram 70 is secured the upper fulcrum ring 83 upon which are seated the equalizers 84. The upper clamping rings 85, 86, are held against the equalizers and the latter in their seats by bolts 87 slidably mounted in apertures in the ram and with their heads located in recesses 88, 89, formed respectively in the adjacent edges of rings 85, 86. Springs 90 acting upon nuts 91 act to retain the upper clamping elements yieldably in position.

To the lower face of the ram is secured centrally the impact plate 92 adapted to engage the head of pin 93 and force the same downwardly as is done with pin 21 in the form first described, thereby causing the expansion of the slotted flange 94 to clamp the

inner edge of the ring gear, the beveled disk 95 being forced downwardly by the spring 96 as the pin descends. Upon the upward movement of the pin the spring 97 will lift the disk and release the internal clamp as previously described.

The cooling or quenching medium which enters the base of the clamp through apertures 98, 98′ flows upwardly around the annular flange 77, and over the exposed surface of the article, for example, the teeth of the ring gear, thence downwardly between the lower clamping rings and away through the perforated base. Passages 99 are provided through which a small portion of the medium may flow upwardly, over the upper clamping rings, and downwardly through passages 100, thus cooling the upper clamp elements.

It will be noted that the surfaces 73, 74, and packing 75, provide an efficient sealing means for preventing escape of the quenching medium upwardly around the ram. Whatever leakage may occur at this point, however, or around the bolts 87, may be carried away by an annular channel 101′, which drains to the exit side of the treating chamber.

The seats for both the upper and lower sets of equalizers 24, 29, or 80, 84, are preferably so situated with reference to the clamping rings which are engaged thereby that the pressure on the rings is distributed proportionally to the area of the clamped article engaged by the ring, or to the pressure that it is desired to exert upon the portions of the article engaged by the respective rings. The larger ring 78, for example, may be supported by the equalizer at a less distance from the seat or fulcrum than the smaller ring 79. Thus it will be possible to distribute the clamping pressure uniformly over the area of the article, or, if desired, to vary the distribution in accordance with the requirements for exertion of greater pressure on some portions than on others.

In the head of the pin 93 is a screw-threaded socket 101 adapted to receive a threaded rod 102. A hole 103 is provided in the ram through which the rod may extend and the upper end of the rod is screw-threaded to receive a nut 104. A transverse aperture 105 is drilled in the upper end of the rod and a corresponding aperture 106 is drilled in the piston rod 36′. A socket 107 is also provided in the lower end of rod 36′ in alignment with aperture 103 and adapted to receive the upper end of rod 102.

When it is desired to remove the clamping mechanism as a whole from the machine, either for storage or for substitution of mechanism adapted to fit articles of different character, the bolts 71 are removed and the rod 36′ raised, the clamping mechanism being left in its lowermost position. The rod 102 is then inserted through aperture 103 and threaded into socket 101. The rod 36′ may now be lowered and a key or pin inserted in apertures 105, 106. If now the piston rod be again raised the whole clamping mechanism will be lifted from the treating chamber. By lowering the mechanism upon some support, removing the pin from apertures 105, 106, raising the piston rod, and applying nut 104, the clamping members are all secured together in a compact unit convenient for shipping or storage.

It will be understood that the structural details may be varied widely without departing from the spirit of the invention and the scope thereof, as set forth in the claims, and therefore I do not desire to be limited to the specific mechanism described.

I claim:—

1. The process of treating toothed gears by the application of a quenching fluid thereto comprising the confining of the gear in a fixed clamping structure adapted to prevent warping and exposing only the toothed portions of the gear, and causing a definite and predetermined quantity of fluid to flow over the exposed portions.

2. The process of treating portions of a toothed gear which comprises supporting the gear in a clamping means adapted to expose only the toothed portions to be treated and causing a predetermined quantity of cooling fluid to flow over the said toothed portions.

3. In gear-hardening apparatus the combination of means for clamping a toothed gear, said means arranged to expose substantially the toothed portion only of the gear, a source of supply for a treating fluid, and means for directing a definite and predetermined amount of the fluid to the gear so as to cause the fluid to flow uniformly over the exposed portion.

4. In combination, a treating chamber, means for supporting therein an article to be treated, means for directing to said chamber a treating liquid to cause the same to flow uniformly over the surface of said article, a reservoir for treating liquid, and means for automatically interrupting the flow of liquid from said reservoir when a predetermined quantity has passed through the chamber.

5. In heat-treating apparatus the combination of means for supporting an article to be treated, a reservoir adapted to deliver measured quantities of treating fluid means for automatically interrupting the flow of said fluid when a predetermined quantity has been delivered, and means for directing the fluid from said reservoir and arranged to cause all of the fluid coming from said reservoir to pass in close proximity to the surface of said article.

6. In combination, a treating chamber, means for supporting therein an article to be treated, a reservoir for treating liquid, means for causing liquid to flow from said reservoir over the surface of said article, and means responsive to the level of liquid in said reservoir and adapted to deliver measured charges of liquid to said chamber.

7. In a heat-treating apparatus, a treating chamber, a clamping means therein comprising a pair of annular devices for engaging an article, equalizing means engaging and adapted to distribute pressure to said annular devices, and reciprocating means for applying pressure to said equalizing means.

8. In clamping mechanism for heat-treating apparatus, the combination of a pair of annular devices for engaging an article, equalizers for supporting said annular devices, fulcrum means for supporting said equalizers, one of the devices being supported upon the equalizers at a distance from the fulcrum points less than the distance at which the other is supported, and means for applying pressure to said annular devices.

9. In clamping mechanism for heat-treatment of ring gears, or the like, the combination of a plurality of clamping rings adapted to engage the sides of the ring gear, a clamping device adapted to engage the interior of the gear, and means for applying pressure to said rings and for expanding said device to clamp the gear.

10. In clamping mechanism for heat-treatment of ring gears, or the like, the combination of a plurality of clamping rings for each side of the gear, one of said rings engaging the faces of the gear teeth, equalizing devices for distributing the pressure between the rings, and means for applying pressure thereto.

In testimony whereof I affix my signature.

JOHN W. WHITE.