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METHOD OF AND APPARATUS FOR HARDENING GEARS

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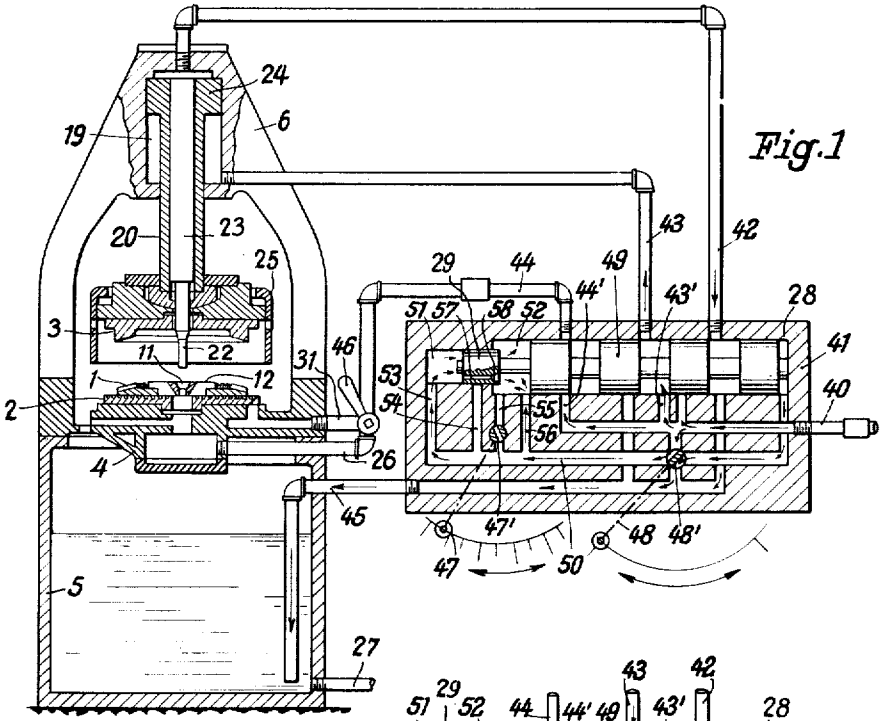


Fig.1

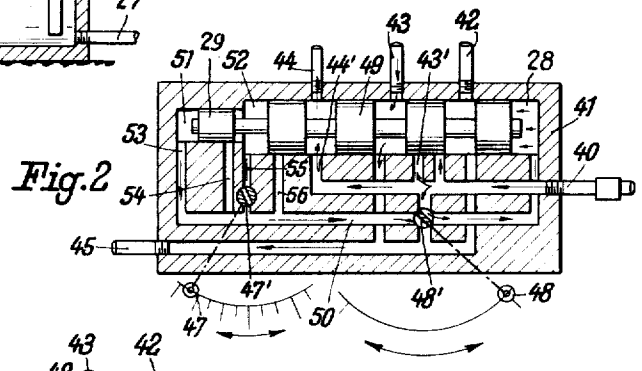


Fig.2

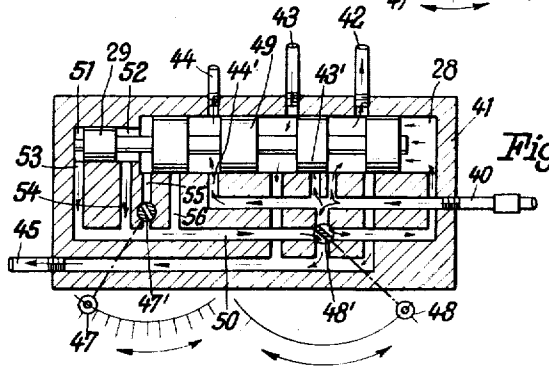


Fig.3

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METHOD OF AND APPARATUS FOR HARDENING GEARS

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Application May 3, 1937, Serial No. 140,536
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6 Claims. (Cl. 266—6)

This invention relates to a method of and apparatus for the automatic hardening of heat treated metal objects. It relates more particularly to the quenching and hardening of gears such as are used in automotive vehicles and the like.

In U. S. Patent No. 1,948,480, granted February 20, 1934, it was pointed out that distortions of gears subjected to oil quenching can be avoided if the gears are held rigidly between clamping dies, and the oil forced around and in contact with the gear while it is held under heavy pressure. Further experimentation has developed the fact that the uniformity of the hardening may be materially increased and the process expedited by practicing the invention about to be described.

Whereas, in the prior patent, it was proposed to clamp the object to be hardened before it was subjected to the action of cooling oil under pressure, it is now found that a much improved and more uniform product may be obtained and the distortion minimized by subjecting the object to be hardened to pre-cooling before it is subjected to heavy pressure in the machine. After the pre-cooling operation, the object is clamped under hydraulic pressure as before and subjected to the further action of the quenching oil under pressure. While it is not strictly essential, it is advantageous to hold the object being treated loosely in the form during the pre-cooling, in order to avoid excessive smoking when the cool oil strikes the highly heated surface of the metal.

The invention will now be described in connection with the accompanying drawing in which:

Figure 1 is a view, mainly in section, of one form of apparatus embodying this invention, the control valve being shown in a position where the clamping means is released;

Fig. 2 is a section of the control valve of Fig. 1, with the parts in position to clamp the work and supply cooling oil thereto; and

Fig. 3 is a view similar to Fig. 2 showing the slide valve in the extreme left hand position as in carrying out the final step of the hardening process.

The hardening machine illustrated herein conforms essentially to that shown and described in prior Patent 1,948,480. It comprises a bed 5 formed as a receptacle for cooling oil and supporting a work table 4. Fixedly mounted on this work table is a bottom swage or die 2 adapted to support an object to be hardened, here shown as a bevel gear 1. The die 2 has a grooved upper surface so as to cooperate with the bottom face of the object to be hardened and form cooling oil channels therewith. Cooperating with the die 2 and the gear 1 is a centering piece 12 suitably constructed to permit passage of cooling oil in contact with all surfaces of the gear or other object to be hardened, and having a conical opening 11 adapted to receive the conical portion above the cylindrical portion 22 of hydraulic plunger 23.

The top 6 of the bed 5 is constructed as a pressure cylinder 19 having a piston 24 mounted therein. Extending from the piston 24 is a tubular stem 20 formed interiorly to receive and guide the plunger 23, and terminating at its lower end in an upper die 3 to engage the top of the object to be treated, and to clamp it in position against the lower die 2 so as to prevent warping of the work during the quenching operation. Also carried by the upper die adjacent the lower end of stem 20 is an enclosing housing 25 adapted to cooperate with the table 4 to enclose the object to be treated.

The piston 24 may be moved up and down by means of pressure oil supplied to the cylinder 19 through one of the pipes 42 or 43. When oil is supplied through pipe 43 the piston is raised as shown in Fig. 1, and when pressure oil is supplied through pipe 42 the piston 24 is lowered so that housing 25 encloses the object being treated and, at the same time, the inner plunger 23 is forced against the centering piece 12 to clamp the object between the two dies.

Either a single or a plural source of pressure oil may be utilized to quench the work and operate the piston 24 and plunger 23. As here illustrated, a single source comprising a pump 62 receiving oil from pipe 27 supplies oil under pressure through a pipe 40 to a control valve 41. The apparatus shown is of the type illustrated in the aforesaid patent. The pipes 42 and 43 are connected to this valve and another pipe 44 is adapted to at times connect the source of pressure oil to one or the other of the pipes 31 or 26, depending upon the position of cock 46. With this arrangement, two types of circulation are possible. When the cock 46 occupies a position to allow oil to enter through pipe 31, the oil circulation about the object being treated is around the outside of the object and then inwardly through the center and to the oil chamber. With the cock in the other position, oil is forced through pipe 26 and the circulation through the table is outwardly from the center. A pipe 45 serves to return oil to the reservoir from the valve 41. Pipe 27 serves to return the used oil from the reservoir to the pump 62 which supplies the inlet 40.

Mounted within the valve casing 41 is a slide valve 49 adapted to control the flow of oil into the pipe 44 and to the pipes 42 and 43. Actuation of the slide valve 49 is brought about by means of a manually operated four-way cock 48' having a handle 48. When the valve occupies the position shown in Fig. 1, pressure oil from pipe 40 passes through opening 43' to pipe 43 holding the piston 24 in its upmost position. Oil above the piston 24 is returned to the oil reservoir through pipe 42, and thence through pipe 45. With the parts in this position, the pipe 44 is blanked, and no oil can be supplied to the work table.

When a work piece, such as the gear 1, is placed on the bottom die 2, the cock 48' is moved to its right hand position as shown in Fig. 2, thereby causing pressure oil from pipe 40 to actuate slide valve 49 and to force that valve toward the left. At the same time, since the pipes 42 and 43 are connected with the discharge, the piston 24 gravitates downwardly until the top die 3 engages the gear 1, and housing 25 encloses the work. Oil forced out of the cylinder 19 below the piston 24 returns through pipe 43 and pipe 45 to the oil reservoir, as shown in Fig. 2. When channel 44' is uncovered, oil also passes from that channel through pipe 44 and into the housing around the work through one or the other of the pipes 31 or 26. As the slide valve 49 moves to the left in Fig. 2, oil from chamber 51 is forced through channels 53 and 50, and pipe 45 back to the reservoir. Small area piston 29 contains a choke opening 57 terminating at one end in a check valve 58. This check valve permits movement of oil from left to right in Fig. 1 but prevents movement from right to left. Consequently, as the slide valve moves to the left, oil passes from chamber 51 and thence back to the reservoir through channels 53, 50 and 45. During movement of the slide valve from right to left whenever pressure in chamber 51 exceeds that in chamber 52, oil flows from chamber 51 to chamber 52 through check valve 58.

The chambers 51 and 52 are of unequal volume and are so arranged that during the pre-cooling operation the movement of slide valve 49 to the left is retarded. This provides means for varying the duration of the pre-cooling step before heavy pressure is applied to the work. As shown in Fig. 1, the slide valve occupies its extreme right-hand position in which piston 29 blanks the discharge channel 54. During the initial movement of slide valve 49 (Fig. 2) from right to left, oil can leave chamber 52 through channel 56 and also through channel 55 and choke 47'. Consequently the slide valve movement is retarded until piston 29 uncovers the channel 54 to afford another oil discharge path to take the place of 56 which is blanked. Movement of the slide valve 49 from left to right can be accomplished by restoring the hand lever 48 to the position of Fig. 1 so that all parts reassume the positions there shown.

It will be clear that during the first stages of the automatic feed motion, the slide valve 49 moves with less velocity than it does during the later stages. In moving from right to left, it closes the supply conduit 43' for the lower cylinder chamber and opens the conduit 44' for the cooling stream. Consequently, the object to be hardened is flooded with liquid during the first working stage and the two cylinder chambers, as well as their conduits 42 and 43, are connected with the discharge so that, at this stage, piston 24 moves down until the top die strikes the object to be hardened without exercising any great pressure upon it. When the slide valve reaches its final position of Fig. 3, the dies are subjected to the full available pressure. The choke 47' can be adjusted by means of lever 47 to control the rate of discharge of liquid from chamber 52 and, hence, to control the extent of duration of the pre-cooling step before full pressure is applied to the dies.

Dropping of the top die against the work in this first stage of the work is not absolutely necessary to the new method because the effective pressure is first exercised during a later stage of the method. This preliminary movement of the die is provided, however, in order that the housing 25, moved downwardly with the top die, may enclose the work and prevent excess development of smoke while the cooling operation is taking place. This preliminary movement of the die also speeds up the quenching operation.

The method defined herein consists essentially of three steps, that is, (1) preliminary cooling of the work, either with or without clamping, (2) clamping the work, and (3) final quenching. Practice of this method results in a uniform satisfactory product free from strains and other flaws resulting from uneven shrinkage of the work during the quenching and cooling of the same. By combining the pre-cooling and clamping steps, the method may be carried out more expeditiously and the formation of smoke lessened. In any event, the pre-cooling step materially improves the process over prior practice, and results in a superior product. The provision of means for varying the duration of the pre-cooling step assures ideal conditions for the treatment of the particular work at hand.

It will be understood that while one particular form of control valve is shown, it may, in practice, assume other equivalent forms capable of carrying out the steps of the process automatically to assure ideal treating conditions.

What is claimed is:

1. The method of hardening a heat treated metal gear which method consists in holding said gear totally enclosed in a chamber while it is in a highly heated condition, and subjecting it to a pre-cooling step by flooding it with a moving bath of cooling oil for a predetermined period of time sufficient to prevent distortion of the gear, clamping the gear rigidly to prevent it from warping as it cools, and then subjecting it to further treatment with cooling oil.

2. Apparatus for hardening heat treated metal gears comprising a work supporting table; a source of oil under pressure; fluid pressure operated means for clamping a gear rigidly on said table; a housing for said table and clamping means, said housing being movable with said clamping means toward and away from said table; piston means for causing actuation of said clamping means; automatic piston valve means for causing quenching oil to be supplied in a moving stream to the work on said table at a predetermined time before the operation of said clamping means, and for causing further quenching of said work subsequent to the operation of said clamping means, both of said means including the same piston; and manually operable means for initiating operation of the said piston.

3. Apparatus for hardening heat treated metal gears comprising a work supporting table; a

source of oil under pressure; fluid pressure operated means for clamping a gear rigidly on said table; a housing for said table and clamping means, said housing being movable with said clamping means toward and away from said table; piston valve means for causing actuation of said clamping means; automatic piston valve means for causing quenching oil to be supplied in a moving stream to the work on said table at a predetermined time before the operation of said clamping means, and for causing further quenching of said work subsequent to the operation of said clamping means, both of said means including the same piston; manually operable means for initiating operation of said piston; and manually operable means for varying the relation between the quenching and clamping operations.

4. Apparatus for hardening heat treated metal gears comprising a work supporting table; a source of oil under pressure; oil pressure operated means for clamping a gear rigidly on said table; a housing for said table and clamping means, said housing being carried by said clamping means toward and away from said table; automatic distributing valve means for controlling the flow of cooling oil from said source to said table to quench said gear and for controlling the operation of said clamping means; manually operable means for initiating the operation of said valve means to either clamp or release the work; and other manually operable means for varying the timed relation between the quenching and clamping operations.

5. The method of hardening a heat treated metal gear which method consists in subjecting the gear while it is in a highly heated condition and free to move, to pre-cooling in a moving stream of oil for a predetermined length of time sufficient to equalize the metal stresses and prevent distortion of the gear, clamping the gear rigidly to prevent it from warping as it is further cooled, and then subjecting it while clamped to further cooling in a moving stream of cooling oil.

6. The method of hardening a heat treated metal gear which method consists in subjecting the gear while it is in a highly heated condition and totally enclosed in a chamber, to pre-cooling in a moving stream of oil for a predetermined length of time just sufficient to prevent distortion of the gear, clamping the gear rigidly to prevent it from warping as it is further cooled, and then subjecting it while clamped to a final quenching in a moving stream of cooling oil.

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CERTIFICATE OF CORRECTION.

Patent No. 2,166,731. July 18, 1939.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 63, claim 2, after the word "piston" insert valve; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of September, A. D. 1939.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

source of oil under pressure; fluid pressure operated means for clamping a gear rigidly on said table; a housing for said table and clamping means, said housing being movable with said clamping means toward and away from said table; piston valve means for causing actuation of said clamping means; automatic piston valve means for causing quenching oil to be supplied in a moving stream to the work on said table at a predetermined time before the operation of said clamping means, and for causing further quenching of said work subsequent to the operation of said clamping means, both of said means including the same piston; manually operable means for initiating operation of said piston; and manually operable means for varying the relation between the quenching and clamping operations.

4. Apparatus for hardening heat treated metal gears comprising a work supporting table; a source of oil under pressure; oil pressure operated means for clamping a gear rigidly on said table; a housing for said table and clamping means, said housing being carried by said clamping means toward and away from said table; automatic distributing valve means for controlling the flow of cooling oil from said source to said table to quench said gear and for controlling the operation of said clamping means; manually operable means for initiating the operation of said valve means to either clamp or release the work; and other manually operable means for varying the timed relation between the quenching and clamping operations.

5. The method of hardening a heat treated metal gear which method consists in subjecting the gear while it is in a highly heated condition and free to move, to pre-cooling in a moving stream of oil for a predetermined length of time sufficient to equalize the metal stresses and prevent distortion of the gear, clamping the gear rigidly to prevent it from warping as it is further cooled, and then subjecting it while clamped to further cooling in a moving stream of cooling oil.

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