Oct. 3, 1950 F. S. DENNEEN ET AL 2,524,044

APPARATUS FOR HEAT-TREATING GEAR TEETH

Filed Aug. 10, 1944 2 Sheets-Sheet 1

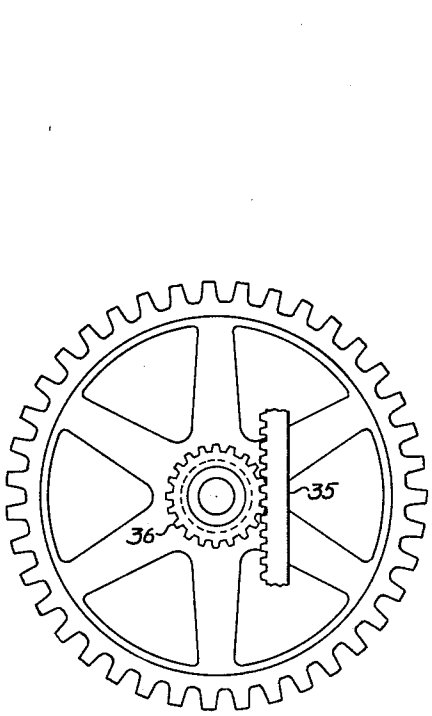



Fig. 4




Fig. 1

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Filed Aug. 10, 1944 2 Sheets-Sheet 2

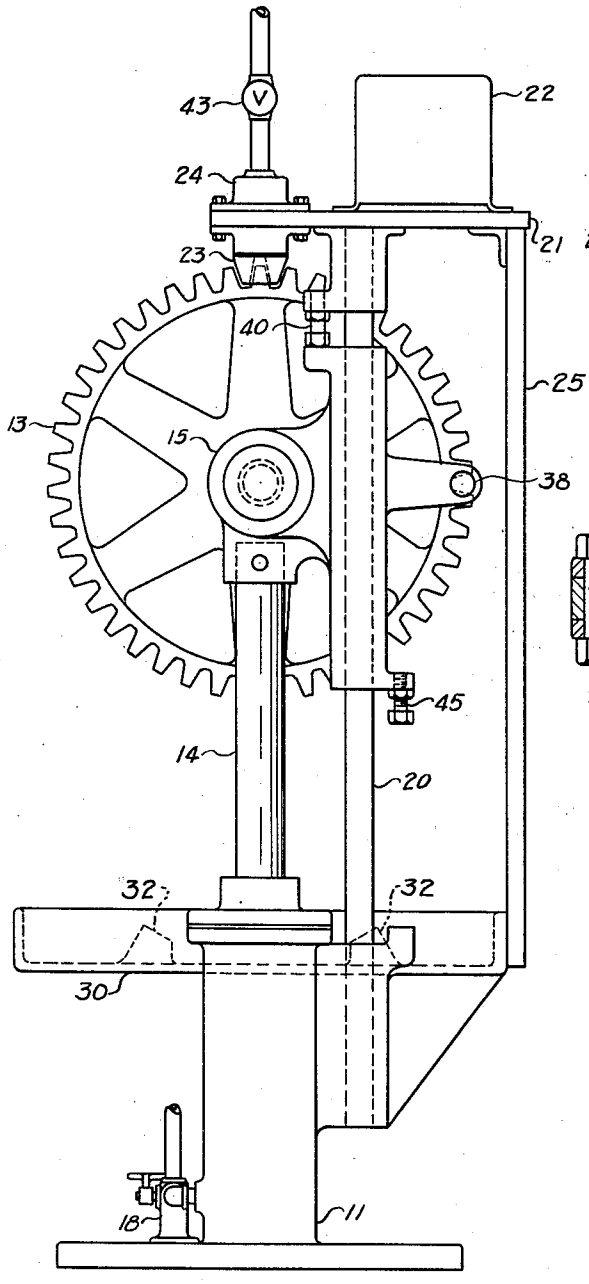



Fig. 2

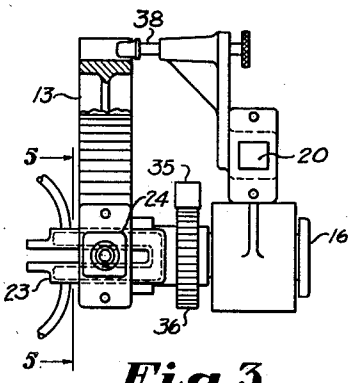



Fig. 3

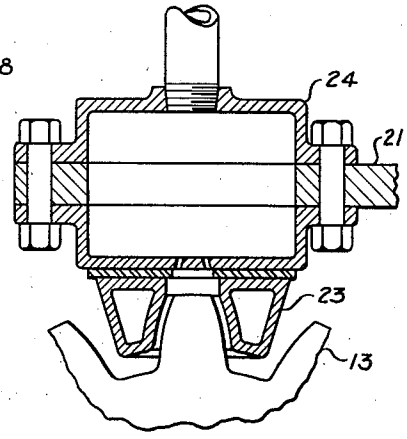



Fig. 5

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# UNITED STATES PATENT OFFICE

2,524,044

## APPARATUS FOR HEAT-TREATING GEAR TEETH

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Application August 10, 1944, Serial No. 548,888

1 Claim. (Cl. 266—4)

1

The present application as a continuation in part of our co-pending application Serial Number 389,847, filed April 23, 1941, now Patent Number 2,356,150, issued on August 22, 1944, is directed to apparatus and method for heat treating gear teeth. The apparatus shown in this application comprises an inductor closely related to that shown in the former application and the quenching mechanism employed is similar. However, other means is employed for accomplishing relative movement of inductor and gear to bring the inductor into heating relation with successively heated teeth of the gear, and supplemental controlled cooling is provided.

Heretofore, it has been customary to move the inductor toward and away from the parts of large gears and similar articles being heat treated as in the above co-pending application in which the inductor is hinged to move out of proximity with the surface zones of the teeth and to move past the quenching members employed, the quenching being completed while the inductor is in heating position. Such heating and quenching can be applied successfully on only some types of material and usually a subsequent and further heat treatment is required to reduce internal stresses and to avoid surface cracks resulting from such stresses.

The chief object of this invention has been to provide means for hardening in rapid succession surface zones of the teeth of a large gear. A further object has been to provide means for cooling after hardening such surface zones. A further object has been to provide power means for moving the gear and means to hold the gear accurately in position after movement. An additional object has been to provide a compact apparatus easily operated by unskilled labor. Other objects will become apparent from the following description.

One of such objects is the provision of a new and improved apparatus for heat treating gear teeth comprising the combination of a mounting unit for the gear being treated, including a spindle, and a tooth-treating unit including an induction heater and quenching means associated therewith, the heater and associated quenching means being positioned above the spindle for heating and quenching a tooth of the gear on the spindle, the tooth-treating unit further including a cooling bath positioned below the spindle opposite the heater and quenching means, the combination also including means for effecting relative reciprocable movement between the mounting unit and the tooth-treating unit to bring the gear into successive engagement, with the induction heater and quenching means at the upper position and the cooling bath at the lower position. The combination also includes means, including a one-way switch, for turning the gear

2

approximately 180 degrees when the gear and cooling bath approach each other, thereby bringing the tooth just treated into the cooling bath and the opposite tooth into position to be moved into operative relation with the induction heater and quenching means.

With these and other objects in view, this invention then consists of the method herein explained and of apparatus for accomplishing this method. The annexed drawings and following description set forth in detail one form of the apparatus embodying the invention, which apparatus may be constructed in many ways within the scope of the appended claims.

In the said drawings:

Fig. 1 is a front elevation showing the preferred form of our apparatus.

Fig. 2 is a side elevation as indicated at 2—2 of Fig. 1.

Fig. 3 is a section at 3—3 of Fig. 1.

Fig. 4 is a section substantially at 4—4 of Fig. 1.

Fig. 5 is an enlarged section at 5—5 of Fig. 1.

Referring now to the drawings an apparatus comprises the base 11 having an upper part serving as a cylinder in which a piston 12 serves as means for elevating a gear 13, the teeth of which are to be hardened. The gear forms no part of the present invention but, of course, should preferably be formed of a material having quench hardening characteristics, which characteristics also generally include tempering characteristics should the quench hardened surface be held at an elevated temperature for any length of time. Piston rod 14 at its upper end carries the gear support 15, this support being provided with a stub shaft 16 of such size as to enter the bore of the hub of the gear and turn with it. Valve 18, which may be foot or hand operated, serves as means for supplying pressure fluid to raise the piston 12. To control the movement of the gear 13 and to relieve the piston rod 14 of bending loads, a guide bar 20 is provided which passes through and guides the gear support 15. The bar 20 is secured to the side of the cylindrical part of base 11.

At the upper end of bar 20 is a platform 21 adapted to carry the heating mechanism which comprises the transformer 22 and the inductor 23 with its associated quenching chamber 24 attached to a part of this platform. Additional frame members such as bar 25 serve to provide rigidity to the structure supporting the platform 21. A tank 30 is attached to a side of base 11 and a moving platform or loading table 31 is supported on the tank or on some other convenient part of the apparatus. The tank is provided with blocks or lugs 32 in its bottom to support and locate the gear while inserting in and removing shaft 16 from the bore of the gear hub.

To rotate or index the gear to each new posi-

tion in heating successive teeth, a rack 35 is provided which is supported at its lower end on the base 11 or tank 30 and which meshes with pinion 36. This pinion is carried on shaft 16 by means of a free wheel or roller clutch mechanism arranged to rotate the shaft only while the gear descends. An indexing lock 38 having an actuating spring serves as means for holding the gear in its rotated position.

*Operation*

The apparatus above described is normally operated as follows:

The gear 13 whose teeth are to have their wearing surfaces zone hardened is placed on table 31 by means of a suitable hoist, the table being adjusted to bring the gear into such position as to be easily rolled or slid into position on the lugs 32 in the tank, these lugs being so located as to bring the gear into a central position with the center of the bore of its hub lying opposite the line of travel of the shaft 16. Shaft 16 is brought to correct elevation by operating valve 18 and the gear is then slid or otherwise moved along lugs 32 to cause the shaft to enter the bore of the gear, where it is secured by means of the nut on the end of the shaft.

By fluid pressure from valve 18 applied under piston 12 the wheel support 15 is raised elevating the gear to bring one of the gear teeth into the space between the sides of inductor 23, the indexing lock 38 having been adjusted to so engage another tooth as to bring the tooth to be hardened into correctly spaced relation with the two sides of the inductor. The adjustable stop screw 40 limits the movement of the gear to prevent the inductor members from entering too deeply into the tooth spaces. With the tooth in place in the inductor, switch 41 is closed and current of relatively high frequency is applied to the inductor to rapidly heat the surface zones of the tooth, after which quenching fluid is applied by valve 43 which admits such fluid at a relatively high pressure to quenching chamber 24 from where it is projected onto and along the sides of the tooth by suitably directed orifices leading from this quenching chamber. Quenching is usually interrupted while the temperature of the surface zones is still relatively high. The temperature at which the tooth is heated will, of course, depend upon its metallurgical characteristics and the final metallurgical characteristics desired. For most steels this temperature is in the neighborhood of 1550° F. This temperature may be secured by adjusting either the rate of power input to the inductor or the length of time of power input, or both. Similarly the amount and degree of quench will be determined by the hardness which it is desired to obtain after the final tempering operation. It is impossible to state the exact amount of quench necessary as it will vary radically between different grades and kinds of steel and on the character of the final hardened surface. Pressure is at once released from beneath piston 12 which permits the gear to descend. Rack 35 by its engagement with pinion 36 and the over running clutch in the pinion cause the gear to turn approximately 180° in its descent bringing the partly quenched tooth into liquid provided in tank 30 which controls the removal of the remainder of the heat, a part of the heat having been removed by radiation and conduction during the descent. The rate of descent is controlled by valve 18 to regulate the time during which the radiation and conduction



take place and thus the amount of heat being removed during the descent. The temperature of the liquid in the tank 30 is so regulated as to leave the gear tooth in a properly hardened condition. Adjustable stop screw 45 limits the depth to which the gear teeth can enter the liquid in tank 30.

By means of the rack and pinion and the stop screw adjustment the descent of the gear after hardening the second tooth causes it to rotate one tooth space less than 180° to bring the inductor into heating relation with a tooth adjacent to the tooth first hardened. These steps are repeated until all teeth have been hardened.

Other forms may be employed embodying the features of our invention instead of the one herein explained, change being made as regards the means and the steps herein disclosed, provided the elements stated by the following claim or equivalent of such stated elements be employed, whether produced by our preferred method or by others embodying steps equivalent to those stated in the following claim.

We therefore particularly point out and distinctly claim as our invention:

In an apparatus for heat treating gear teeth, the combination of a mounting unit for the gear being treated, including a spindle, a tooth treating unit, including an induction heater and quenching means associated therewith, said heater and associated quenching means being positioned above said spindle, for heating and quenching a tooth of the gear on the spinde, said tooth treating unit further including a cooling bath positioned below said spindle opposite said heater and quenching means, means for effecting relative reciprocal movement between said mounting unit for the gear and said tooth treating unit, for bringing the gear being treated into successive engagement with the induction heater and quenching means at the upper position and the cooling bath at the lower position, and means, including a one-way clutch, for turning said gear approximately 180° when said gear and said cooling bath approach each other, thereby bringing the tooth just treated into the cooling bath and the tooth opposite the tooth just treated, into operative relation with said induction heater and quenching means.

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