

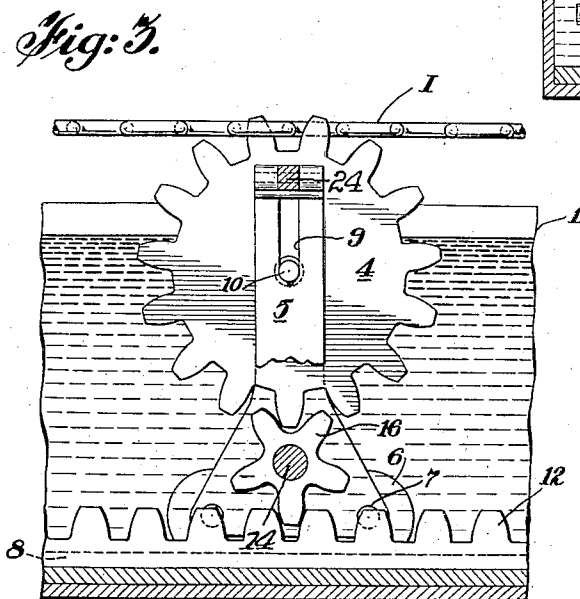
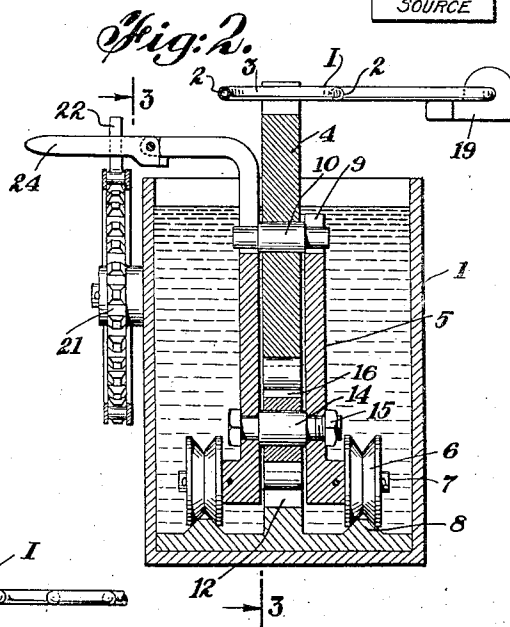
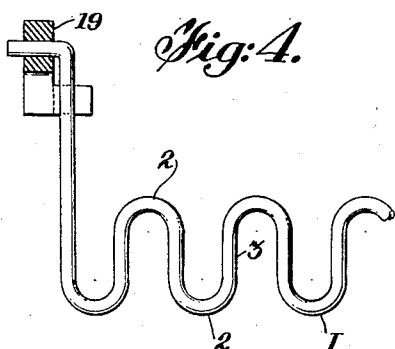
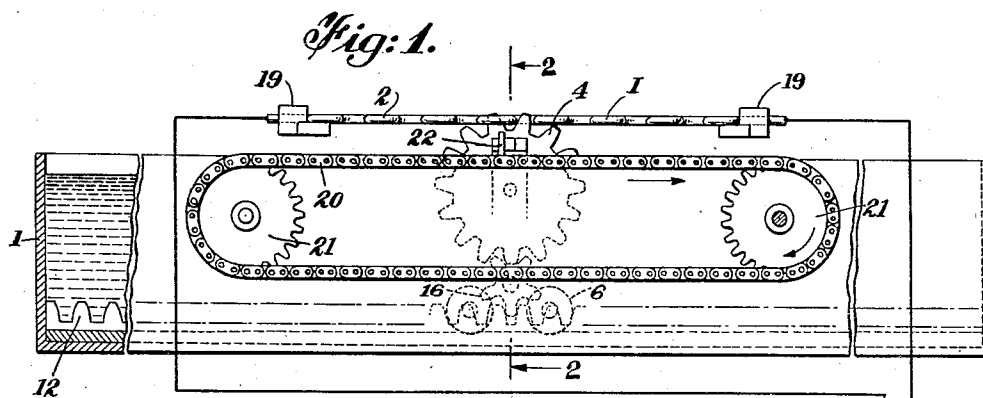
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PROGRESSIVE INDUCTION HEATING APPARATUS

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PROGRESSIVE INDUCTION HEATING
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This invention relates to apparatus for the induction heating and hardening of gear teeth and the like and is specially directed to the production of an improved apparatus designed for the progressive inductive heating of gear teeth and rapid quenching in a suitable cooling medium as required for obtaining a maximum degree of hardening. It is accordingly adapted for inductive heating of the gear teeth in succession or progressively so as to effect substantial economies in the energy and power consumption and with the generation of heat in the work surfaces at a higher rate for the given power output while permitting this desirable method of heating and quenching to be effected rapidly and in a continuous process or operation.

The present improvements may desirably employ an induction heating element specially designed to operate with a high degree of heat concentration and rapid rate of heating by the employment of ultra-high frequency currents in the megacycle range. This frequency may desirably be in the order of from 5,000,000 to 15,000,000 cycles from which it is possible to reduce the heat treatment time to a period of one second or less.

The above-described and other features and advantages of the present improvements will be more fully understood by reference to the accompanying drawing wherein like reference characters of the description are applied to the corresponding parts in the several views.

In the drawing:

Fig. 1 is a view in elevation of the heating and quenching apparatus according to one embodiment of the present invention with a portion broken away.

Fig. 2 is a central vertical cross-sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a partial view thereof in vertical longitudinal section;

Fig. 4 shows a portion of the heating element on an enlarged scale.

In the preferred embodiment of the invention as shown, 1 indicates a suitable elongated tank to contain the quenching liquid as indicated which may be any desired coolant such as oil, water or brine. Associated with the tank structure and extending longitudinally thereof there is provided an induction heating element 1 as here shown of a sinuous form having alternately reversed loops 2 connected by straight portions or tangents 3 positioned horizontally and extending transversely of the tank in equally spaced relation. The heating element is positioned centrally above the tank in spaced relation to the surface

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level of the cooling medium as indicated. The heating element is supported so as to be stationary during the inductive heating operation, and the work-piece to be treated, a gear 4 as here shown, is rotated and longitudinally advanced with relation thereto so as to successively position its teeth between the inductor tangents 3 and in spaced relation therefrom for inductive heating.

For supporting and advancing the gear to be treated in accordance with the invention, it is detachably fitted to a movable carrier arranged to support the gear within the bath with the major portion thereof immersed in the cooling liquid. It is further designed to effect the rotation of the gear as it is advanced to maintain proper indexing or registration of the teeth with the inductor tangents or active sections in properly spaced relation thereto. To this end, a carriage 5 is formed as shown of connected side plates, provided with grooved rollers 6 journaled on bearing pins 7 to ride on parallel rails 8 positioned at the bottom of the tank. The upper ends of the carriage side plates are formed with end bearing slots 9 to receive a bearing pin 10 fitted to the bearing aperture of the gear whereby it is supported on the carriage for longitudinal movement of the gear, a rack 12 is provided, centrally positioned in the bottom of the tank and extending longitudinally thereof. To effect the required rotational movement of the gear, a rack 12 is provided, centrally positioned in the bottom of the tank end extending longitudinally thereof. The rack as shown is formed integral with the guide rails 8. Journaled upon a bearing pin 14, which is also a connecting pin for the carriage side plates and retained by nut 15 threaded thereon, is an idler or intermediate gear 16 meshing at its underside with the stationary rack and at its upper side with the teeth of the work piece gear 4. Accordingly as the carriage is progressed longitudinally of the tank the gear 4 will be rotated to have progressive registration with the active portions 3 of the inductor. The spacing of the inductor portions 3 as will be understood, correspond to the spacing of the re-entrant portions of the gear teeth substantially at the pitch line.

As best shown in Fig. 4, the inductor at its end portion is mounted on a suitable insulated support having a gearing shoulder 18 for supporting the inductor in operating position. The length of the tank and associated rack 12 is such as to extend beyond the co-operative position with the inductor to give clearance at each end thereof for the vertical positioning of the gear 4 within

the carriage bearings and to permit easy removal thereof after treatment.

To transmit the required uniform motion to the carrier during the inductive heating operation a suitably driven drive chain 20 is provided carried by driven sprockets 21 and provided with an upwardly extended finger or detent 22. The detent is positioned to engage co-acting latch or finger 24 pivotally carried by the carriage side plate as shown and adapted to be swung upwardly out of engaging position during periods of assembly of the gear in position and during return shift of its carriage. The sprockets are positioned to effect release of the carriage at the extreme end positions of the movement of the latter for convenience in assembling and removing the gears under treatment.

The rate of speed of the drive chain is governed to determine the duration of exposure of the gear teeth to the inductive heating and the level of the cooling medium in its spaced relation to the inductor will determine the time interval of quenching which will occur promptly upon completion of the heating operation.

There is accordingly provided an improved apparatus adapted materially to facilitate the progressive heating and quenching of gear teeth and the like by a continuous production method with the interval between the heating and quenching reduced to a minimum thereby to substantially reduce the heating of internal layers by heat conduction from the surface or current carrying layer of the portion under treatment.

While there is shown an approved embodiment of the features of the invention it will be understood that various modifications may be made therein without departing from the scope of the invention as defined in the claims. Also, while the improved apparatus may be employed as described to effect the quick quenching of the treated portions after heating it will be appreciated that it may be used to advantage for feeding the gears in proper registration with the inductor without the liquid quenching in instances where the character of heating as related to the sectional area of the gears is such as to have self-quenching hardening action or for purposes of controlled tempering of a previously hardened gear.

What is claimed is:

1. An apparatus for progressive induction heating and quenching of work-pieces of the character described comprising in combination with a tank and a quenching liquid therein, a longitudinally extending inductor element supported above the quenching liquid and in close spaced relation thereto and having active portions formed for close spaced registration with the surfaces to be treated, a traveling support for the work movable within the tank to pass beneath the inductor, means for journalling a work piece for rotative movement on the support in a position partially submerged in the quenching liquid and means to effect rotation of the work piece as it is progressed along said inductor element in register with the active portions thereof, and means for energizing the inductor element.

2. An apparatus for progressive induction heating and quenching of work-pieces of the character described comprising in combination with a tank and a quenching liquid therein, a longitudinally extending inductor element supported above the quenching liquid and in close spaced relation thereto and having active portions formed for close spaced registration with

the surfaces to be treated, a travelling support for the work movable within the tank to pass beneath the inductor element, a work piece journalled for rotative movement on the support in a position partially submerged in the quenching liquid and means to effect rotation of the work piece as it is progressed along the inductor element in register with the active portions thereof, and means for operating said support at the end of its travel to position the work piece clear of the inductor element for removal thereof, and means for energizing the inductor.

3. An apparatus for induction heating and hardening of the character described comprising in combination with a tank and a quenching medium therein, a longitudinally extending inductor element supported above the quenching medium and in close spaced relation thereto and formed for close coupling registration with the surfaces to be treated, a travelling support for the work movable longitudinally of the tank, means for journalling a work piece for rotative movement on the support in a position with a portion thereof immersed in the quenching medium and means to effect rotation of the work piece as it is progressed beneath the inductor consisting of a rack extending parallel to said inductor element and supported within the tank and a pinion journalled in the movable support in mesh with the rack and connected to rotate the work piece as it is progressed along said rack, and means for energizing the inductor element.

4. An apparatus for the inductive heating and quenching of gear teeth comprising an elongated tank and a quenching liquid therein, a longitudinally extending inductor element supported above the quenching liquid in close proximity thereto, a carriage support movable longitudinally of the tank and formed for detachably supporting a work-piece gear in position to pass beneath the inductor element, means to advance the carriage longitudinally of the tank comprising journalled sprockets, an endless chain carried thereby to be parallel to the tank, a detent carried by the chain, a co-acting shiftable detent supported on the carriage for engagement with the chain detent, said sprockets being positioned for releasing the carriage engagement at the respective ends of the carriage travel and means for rotating the gear as it is progressed along the inductor element consisting of a rack extending longitudinally of the tank, a pinion journalled in the carriage to mesh with the rack and with the work piece gear, and means to energize the inductor element.

5. An apparatus for induction heating and hardening of gears and like work pieces comprising a quenching tank and a cooling medium therein, an inductor element of sinuous form supported above the cooling medium and formed for spaced registration into the reentrant portions of the work piece, a traveling support for the gear movable longitudinally within the tank and having a bearing support to rotate the work piece to position it in spaced registration with the inductor element, a pinion journalled in said support for meshing engagement with the work piece and a longitudinally extending rack supported within the tank in position to be engaged by the pinion to rotate the work piece in register with the inductor element during movement thereof longitudinally of the tank and said rack being extended forwardly and rearwardly of the inductor element to provide clearance positioning of the work piece at the respective ends of its longitudinal movement, and means for energiz-

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ing the inductor element with a high frequency current.

6. An apparatus for induction heating and hardening of the character described comprising in combination with a tank and a quenching medium therein, a longitudinally extending inductor element supported above the quenching medium and in close spaced relation thereto and formed for close coupling registration with the surfaces to be treated, a traveling support for the work movable longitudinally of the tank, means for journalling a work piece for rotative movement on the support in a position with a portion thereof immersed in the quenching medium and means to effect rotation of the work piece as it is progressed in a horizontal direction beneath the inductor consisting of a longitudinal rack extending in said direction and supported within the tank, and a pinion journaled in the movable support in mesh with the rack and connected to rotate the work piece as it is progressed along said rack, means for energizing the inductor element and said inductor element being supported to be shiftable from operative position.

7. An apparatus for induction heating and hardening of the character described comprising in combination with a tank and a quenching medium therein, a longitudinally extending inductor element supported above the quenching medium and in close proximity thereto and formed for spaced registration with the surfaces to be treated, a traveling support for the work piece movable in a horizontal direction within the tank, means for supporting a work piece detachably on the support for rotative movement about a horizontal axis and means to effect rotation of

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the work piece as it is progressed in a horizontal direction perpendicular to said axis in the tank consisting of a rack supported within the tank and a pinion journaled in the movable support in mesh with the rack and connected to rotate the work piece, and means for energizing the inductor element with a high frequency current.

8. In an apparatus for progressive induction heating of work pieces of the character described comprising a longitudinally extending inductor element having active portions formed for close spaced registration with the surfaces to be treated, a traveling support for the work movable to pass beneath the inductor, means for journalling a work piece for rotative movement on the support and means to effect simultaneous rotation and progression of the work piece along the inductor element in register with the active portions thereof.

9. In an apparatus for induction heating of toothed wheels and the like comprising a longitudinally extending inductor element having active portions formed for close-spaced registration with the re-entrant portions of the toothed wheel, a traveling support for the toothed wheel movable to pass beneath the inductor element, means for journalling a toothed wheel for rotative movement on the support about an axis and means to effect rotation of the toothed wheel as it is progressed in a direction perpendicular to said axis consisting of a longitudinally extending rack supported parallel to the longitudinal extension of said inductor element and a pinion journaled in the movable support in mesh with the rack and connected to rotate the toothed wheel.

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