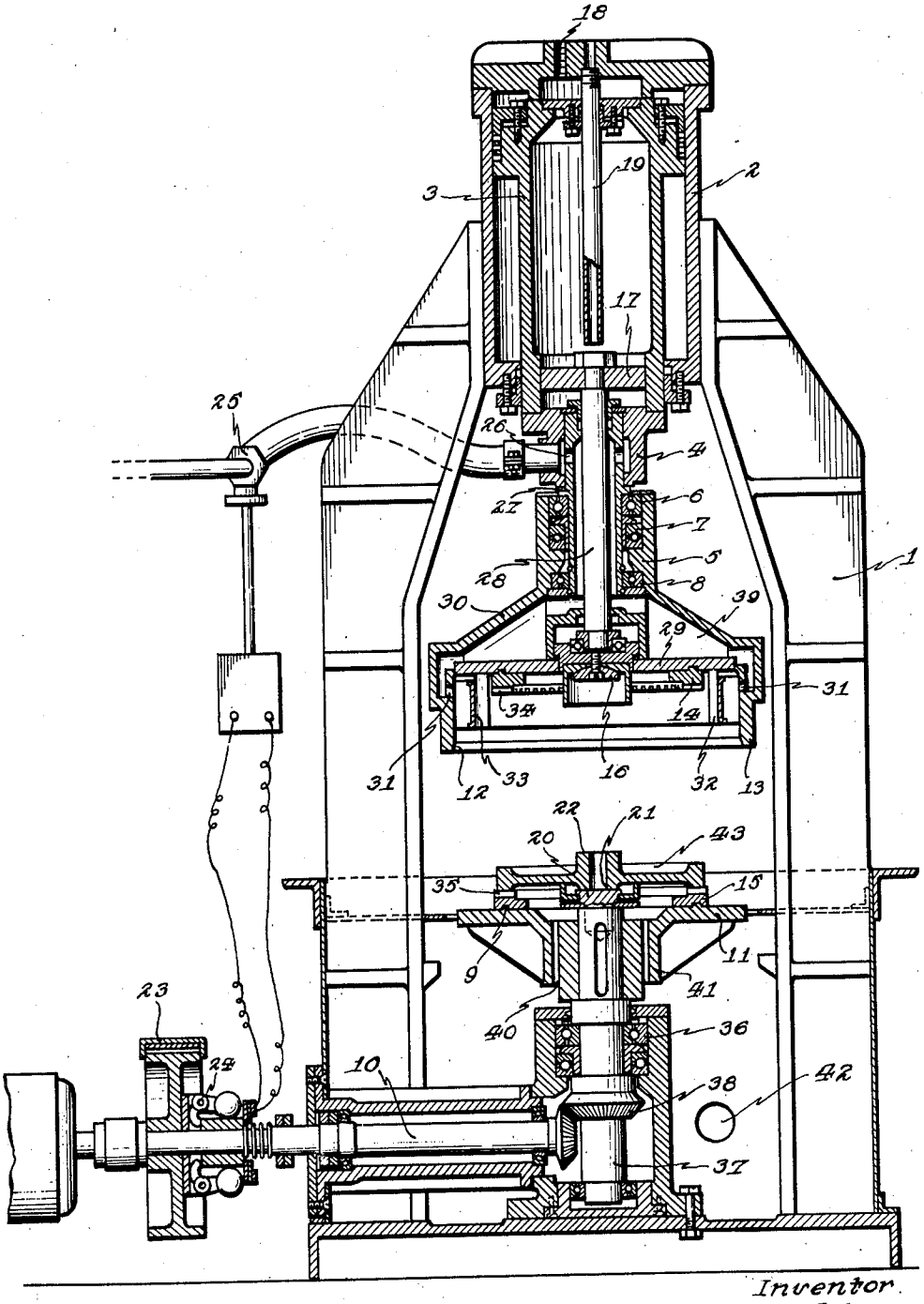
Jan. 26, 1937. H. J. GREGG 2,068,913

CENTRIFUGAL QUENCHING

Filed Dec. 2, 1935



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Patented Jan. 26, 1937 2,068,913

UNITED STATES PATENT OFFICE

2,068,913

CENTRIFUGAL QUENCHING

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Application December 2, 1935, Serial No. 52,563

9 Claims. (Cl. 148—21)

The method and machine herein disclosed are planned for bringing about a uniform quenching action from the periphery inwardly of circular metallic articles, such as gears.

In the manufacture of heat-treated steel gears, requiring an extraordinarily high degree of perfection in form, the customary methods of quenching result in a large percentage of scrap loss due to non-uniformity of application of the quenching fluid. The heated articles may be held in their original form by clamps under extremely high pressure; but, however great that pressure may be within practical limits, it is impossible to overcome the distortion strains set up in the metal by immersion.

It is now proposed to perform the quenching action by a uniform application of the quenching bath and the object of the invention is to attain such result through the use of centrifugal force, by building a ring of the quenching fluid around the heated article and forcing the enlargement of this ring inwardly to uniformly quench at a definite rate from the periphery to the center of the article; or to exhaust quench fluid at any given point between periphery and hub thereby resulting in sectionalized hardness.

It is also a purpose of the invention to provide mechanical improvements in machines for such work whereby a preliminary forming or correcting operation may be performed by the machine by the application of pneumatic or hydraulic pressure to the articles as received from heat treatment furnaces.

The machine provides for carrying out the method, which machine and method are planned for pressing and quenching disc-shaped, ring-shaped or cylindrical articles, is shown in the drawing in transverse vertical section.

Due to common faults in quenching processes, it is difficult to avoid unequal strains and resultant warpage in articles under treatment. In the case of expensive gears a barely measurable imperfection caused by the quench necessitates the articles being scrapped and reprocessed.

With a view to attaining during the quench a uniform molecular set from the periphery inwardly of cylindrical or disc-shaped articles such as gears or gear rings, in the improved process the quenching medium is caused to travel radially over the exposed surfaces of the articles. Such action is accomplished in a workable way by spinning the quenching fluid in a cylindrical container wherein the article to be quenched is firmly clamped in a central position and preferably spun with the quenching fluid as the latter is increased in volume by the pressure of incoming fluid.

The construction used for that purpose, as illustrated in the drawing, consists of an open frame 1, which supports a cylinder 2. Vertically movable within this cylinder is a piston 3 which carries at its lower end a bearing structure 4 for a rotating gear clamping head 5. Thrust and radial bearings for head 5 are indicated at 6, 7 and 8.

The head 5 is rotated with a coacting lower gear clamping member 9, which receives power from a drive shaft 10.

The circular flange 11 of clamping member 9 fits within the beveled edge 12 of the annular flange 13 of head 5, when the latter is in its lower position, clamping an article such as gear 43 between the gripping rings 14 and 15. A plunger 16 engages the gear at its hub, while these rings engage the periphery of the gear.

The plunger 16 is carried by a piston 17 fitting within the piston 3. Fluid pressure for operating piston 3 is admitted to cylinder 2 through conduit 18 and fluid under pressure for operating piston 17 is admitted to the interior of piston 3 by conduit 19. By this arrangement a like or differential pressure may be applied to the pistons. The gear 43 rests upon the ring 15 and also on a central support 20.

The product of some standard gear making machines is such that the lower face of the gear which rests upon ring 15 is in fixed relationship with the face of hub 21 but the hub 22 at the opposite side of the gear is slightly variable. Therefore plunger 16 is made adaptable to this variation by being capable of movement relatively to the clamping head 5.

When the clamping members are brought together to grip a gear, the gear is first engaged at the hub and then at the rim under a considerable hydraulic or pneumatic pressure such as is sufficient to correct warpage of the article during heat treatment. This forming operation is therefore distinct from and preliminary to the quenching operation. The latter occurs while the gear is still under the pressure of the press, and power has been applied to shaft 10 by operation of clutch 23.

A centrifugal contact maker 24 carried by shaft 10 controls the operation of solenoid valve 25, which in turn admits the quenching fluid through port 26 to the space between the bearing sleeve 27 and plunger rod 28. The fluid travels from there to the space between plate 29 and the housing 30 of clamping head 5. The outlet for

the fluid to the gear space, between plate 29 of the upper clamping member 5 and the flange 11 of the lower clamping member 9, occurs through the openings 31 which are spaced outwardly from the location of the gear under treatment.

The centrifugal force of the quenching fluid which rotates with the clamp largely because of radial fins 32 on baffles 33, first holds the fluid clear of the gear and against the outer wall of the clamp but the incoming flow of the fluid through the port 26, under a pressure exceeding in value the centrifugal action, forces an enlargement of the fluid ring against the centrifugal force which enlargement is in an inward direction toward the rim of the gear, all equally radially distant points of which will be contacted simultaneously by the fluid.

Thus, with a properly centered gear a highly perfected article is assured insofar as the quench is concerned, for this takes place radially inward and the shrinkage and stresses set up in the metal are so uniform as not to distort the article, such as the commonplace dished distortion occurring with old quenching methods wherein the fluid reaches one face of the gear before it does the other.

The clamping rings 14 and 15 have equally spaced gripping teeth 34 and 35, and head 5 is rotated by the clamping member 9 through the article which is placed between the clamps. Bearings for the clamping member 9 are indicated at 36 and the shaft 37 for this element of the clamp is geared to drive shaft 10 through the gears 38. Assuming that the gears treated by the particular machine illustrated are about 18 to 20 inches in pitch diameter, the horsepower required for drive shaft 10 is approximately 7½ when the speed thereof is 400 R. P. M.

The valves and fittings for controlling the operation of the hydraulic press are the same as is customary in that class of machinery, and therefore are not illustrated in detail.

In carrying out the improved process of quenching by use of the equipment illustrated, the articles to be quenched are handled singly, and when at the proper temperature, are removed from the heat treating furnace and placed upon ring 15, exactly true therewith, as determined by any desired centering means. Then the fluid pressure is admitted to cylinder 2 and piston 3, which results in the head 5 moving downwardly against the article, firmly gripping it at the rim and the hub with any desired pressure, or a differential pressure between these points.

The pressure applied at this time has a correcting effect on the article in case it has a tendency to dish equally or unequally. At the same time the flanges 13 and 11 come together and substantially seal the clamping members against outward flow of the quenching fluid. The clutch 23 is then operated to drive shaft 10 and thus rotate the clamping head with the article therein. When the desired speed has been attained, solenoid valve 25 opens and admits the quenching fluid to the space 39 in the rotating head. From this space the fluid enters the gear compartment through the openings 31. The centrifugal force causes the fluid to first form a peripheral ring against flange 13 without contacting gear 43, but this ring enlarges due to continued feed of the quenching fluid under pressure into the rotating head.

The fluid uniformly contacts the rim of the gear and travels inwardly toward the hub but may be permitted to flow out of the apparatus before reaching the hub through the openings 40 in the hub 41 of clamping member 9.

It is through this feature that it is possible to accomplish full hardness on the gear teeth and web, yet to retain a "hot hub" or "soft hub" which can later be easily finished machined, thus making possible savings in machining costs, not to mention other items such as flatness, roundness, improved "tooth action", which is attributed to the centrifugal quenching principle.

The lower part of the frame structure 1 forms a tank for receiving the used quenching fluid from which it is recirculated through drain 42.

Although but one specific embodiment of this invention is herein shown and described, it will be understood that details of the construction shown may be altered or omitted without departing from the spirit of this invention as defined by the following claims.

I claim:

1. The method of quenching heat treated circular articles which consists in surrounding such articles with a rotating ring of quenching fluid and enlarging the ring of fluid inwardly against centrifugal force and thereby quenching the article radially from the periphery toward the center.

2. The method of quenching a heat treated article which consists in rotating the article around a central axis and causing quenching fluid to rotate with the article and travel inward from the periphery thereof toward the center.

3. A method of treating articles of the class described consisting in first applying pressure to a heated article for the purpose of correcting distortion thereof under the action of heat, then rotating the article on a central axis and forcing a quenching fluid to flow inwardly over said article while exerting a counter centrifugal force on said fluid.

4. A centrifugal quenching machine comprising a hollow head having a gripping surface, a lower clamping member, means for rotating said head and lower clamping member and means for forcing a quenching fluid into the space enclosed by said head and lower clamping member and from the periphery thereof toward the center.

5. In a machine of the class described, a pair of gripping members mounted for rotation on a common axis, means for driving said members, hydraulic means for moving one of said members toward the other, said members being formed to carry a quenching fluid when in gripping relation, means for feeding a quenching fluid thereinto while said gripping members are under rotation.

6. In a machine of the class described, a clamping member mounted for rotation and means for driving said clamping member, a coacting clamping member movable toward and away from said driven clamping member and comprising a pair of relatively movable gripping elements, said clamping members being formed to receive a quenching fluid and feed said fluid from the periphery thereof inwardly against centrifugal action.

7. A centrifugal quenching machine comprising a hollow head for covering articles to be quenched, a lower clamping member, relatively movable gripping elements for retaining articles in a central position between said head and lower

clamping member, means for rotating said gripping elements, means for forcing a quenching fluid into the space enclosed by said head and lower clamping member from the periphery toward the center thereof, and a quenching fluid discharge port in said head and located between the periphery and the center thereof whereby quenching fluid does not reach the center portion of articles under treatment.

8. The method of quenching a heat treated article which consists in rotating the article around a central axis and causing quenching fluid to rotate with the article and travel inward from the periphery thereof toward the center and discharge away from said article at a point located between the periphery and the center thereof.

9. The method of treating articles of the class described consisting in first applying pressure to a heated article for the purpose of correcting distortion thereof under the action of heat, then rotating the article on a central axis and forcing a quenching fluid to flow around said article while exerting a counter centrifugal force on said fluid.

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