Feb. 6, 1923. 1,444,259.

M. T. LOTHROP.

PROCESS OF SIZING AND QUENCHING.

FILED FEB. 5, 1921. 2 SHEETS—SHEET 1.

Fig. 1.

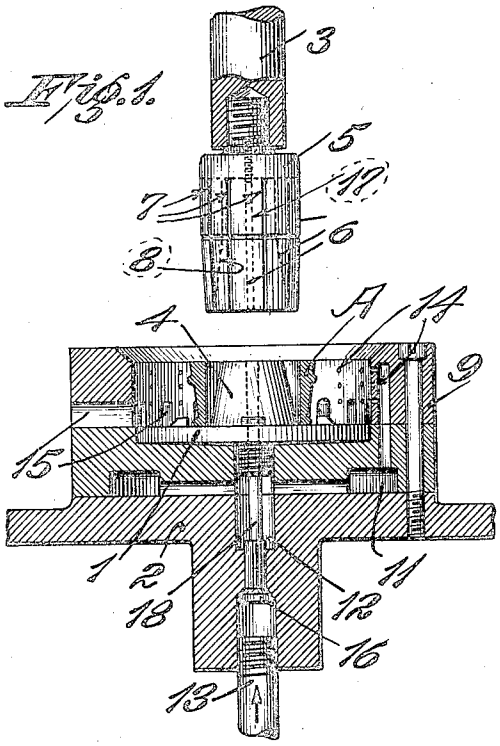


Fig. 2.

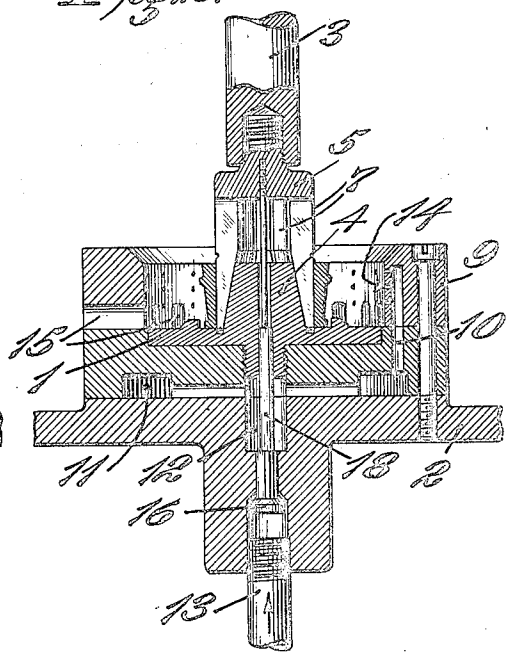


Fig. 3.

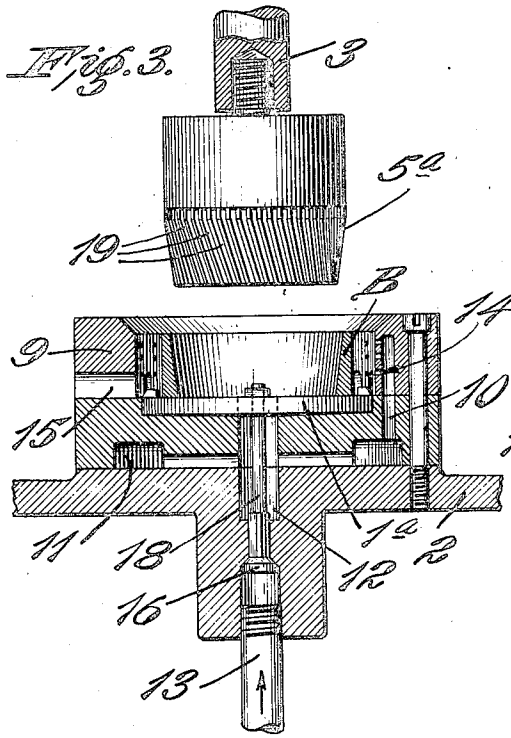
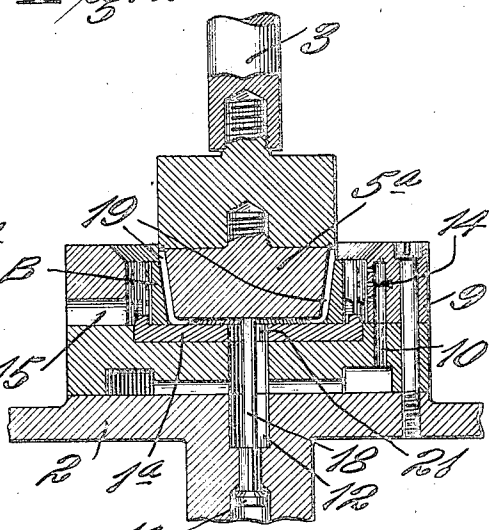


Fig. 4.



Inventor:
Magnus T. Lothrop,
by Carr & Carr
his Attorneys.

Feb. 6, 1923. 1,444,259.

M. T. LOTHROP.

PROCESS OF SIZING AND QUENCHING.

FILED FEB. 5, 1921. 2 SHEETS—SHEET 2.

Fig. 5.

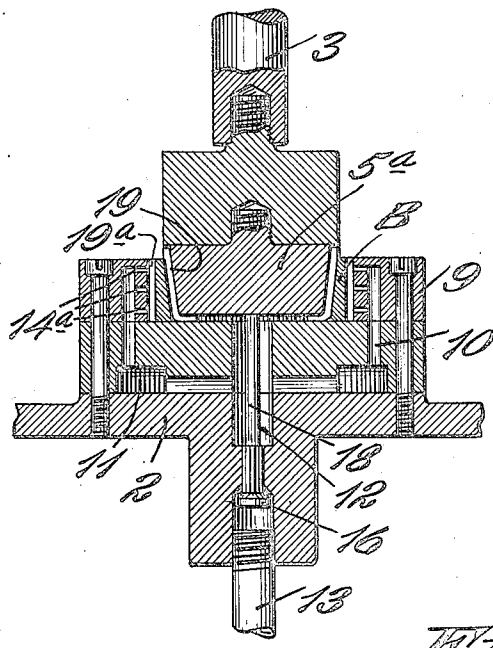


Fig. 6.

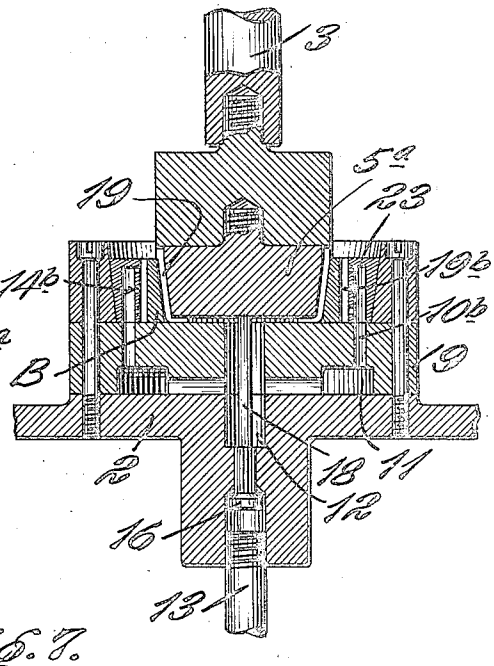
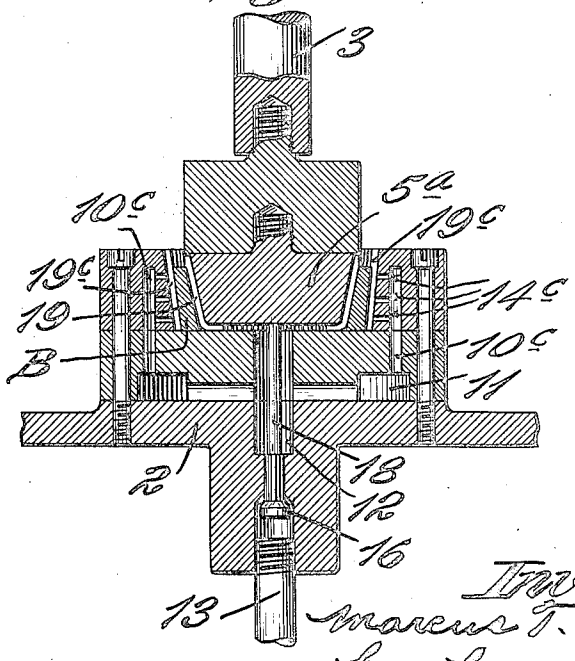


Fig. 7.



Inventor:
Marcus T. Lothrop,
by Carr & Carr,
his Attorneys.

Patented Feb. 6, 1923. 1,444,253

UNITED STATES PATENT OFFICE.

MARCUS T. LOTHROP, OF CANTON, OHIO, ASSIGNOR TO THE TIMKEN ROLLER BEARING COMPANY, OF CANTON, OHIO, A CORPORATION OF OHIO.

PROCESS OF SIZING AND QUENCHING.

Application filed February 5, 1921. Serial No. 442,737.

To all whom it may concern:

Be it known that I, MARCUS T. LOTHROP, a citizen of the United States, and a resident of the city of Canton, in the county of Stark and State of Ohio, have invented a new and useful Improvement in Processes of Sizing and Quenching, of which the following is a specification.

According to present practice, hardened metal articles of annular section, such for instance, as cups and cones for roller bearings, are first shaped and sized in any suitable way and afterwards heated and quenched for the purpose of hardening them; and distortion is so common an incident of the hardening operation that the hardened article usually requires to be ground to correct the distortion, notwithstanding that grinding is expensive and impairs the article. The principal objects of the present invention are to devise a cheap and simple method of sizing the article, to overcome the tendency of the hardening operation to distort the article, and to minimize or eliminate the need for grinding or like finishing operation. The invention consists principally in making the article of green or unhardened metal of approximately the shape and size required for the finished article but of slightly smaller bore, heating said article, expanding the bore thereof to a diameter slightly in excess of that required for the finished article and keeping the bore so expanded during the quenching operation. It also consists in mechanically stretching the heated article and quenching the same without appreciable time interval after such stretching. It also consists in mechanically creating circumferential tension in the hot article and quenching the same without relieving such tension. It also consists in the operations hereinafter described and claimed.

In the accompanying drawing, wherein like numerals refer to like parts wherever they occur,

Fig. 1 illustrates portions of apparatus suitable for practicing my process in connection with the sizing and quenching of cones for roller bearings, such a cone being shown in position to be operated on by the expanding member which is in its uppermost position, said expanding member being shown in elevation and the cone and other portions of the apparatus being shown in section;

Fig. 2 is a vertical section of the parts of apparatus illustrated in Fig. 1, with the expanding member at the downward limit of its stroke;

Fig. 3 is a view similar to Fig. 1 and Fig. 4 is a view similar to Fig. 2, but with the expansion member shown in the form of a tapering plug adapted for use in the manufacture of a roller bearing cup; and

Figs. 5, 6 and 7 illustrate modifications of such apparatus suitable for restraining the cup both interiorly and exteriorly during the quenching operation.

While my invention is applicable to the manufacture of other articles, I will first describe it in connection with the manufacture of cones for roller bearings.

The stock, which is preferably steel is first worked by ordinary metal cutting or forging operations into a green article of substantially the size and shape required for the final product, but with its bore of slightly smaller diameter. This green article is then heat treated in conformity with current practice or in other suitable manner; but instead of being quenched as it comes from the furnace, it is submitted to an operation that quickly stretches the metal circumferentially to enlarge its bore slightly in excess of that required for the finished product, and it is then immediately quenched without releasing the circumferential tension or stretching force.

Referring to Figs. 1 and 2 of the accompanying drawing, A represents a green cone for roller bearings made in any suitable way but with its bore of slightly less diameter than required for the finished article. This green cone is heat treated, in accordance with common or other suitable practice; and, immediately upon its removal from the hardening furnace, is set on a suitable seat 1 provided therefor on the bed plate 2 of a press whose plunger 3 works up and down in alinement with said seat. The bed plate 2 is provided with an elongated wedge block 4 in axial alinement with the plunger and preferably in the form of an upwardly ta-

pering cone. The head of the plunger is provided with an expansion plug 5 comprising a plurality of elongated segmental portions 6 which are illustrated as being integral with the base of said plug and being separated from one another by longitudinally extending slots, 7. The outer surfaces of said segments are concentric and of the curvature required to produce the desired expansion of the bore of the heated article; that is, the surfaces of the segments, when fully expanded radially, are concentric with the axis of the wedge block 4 and of the plunger 3 and have a radius slightly in excess of that desired for the finished article. The inner surfaces of said segments are tapered as illustrated at 8, and shaped to cooperate with the tapered wedge block 4; and the parts are so related that the downward movement of the plunger will cause the inner surfaces of said segments to bear against and be spread radially outward by the wedging action of the wedge block. By this arrangement, the hot bearing cone that surrounds the wedge block 4 and rests on the seat 1 provided therefor on the bed plate is in position to permit the expanding segments to enter a considerable distance into the bore of the hot cone, before any expanding action occurs; while the further downward movement of the plunger causes the segments to spread outwardly against the inner wall of the cone and enlarge the bore thereof. As stated above, the parts should be so adjusted that, when the segments are fully spread, the bore of the hot cone will be slightly greater than that required for the finished article.

This operation of expanding the bore sets up a circumferential tension in the metal of the cone; and it is very advantageous to quench the cone without any appreciable interval of time after such enlargement of the bore and without relieving the cone from the force that expanded it. For this reason, the quenching system is so disposed and timed with relation to the expanding segments that the quenching fluid is brought into operation simultaneously with completion of the expanding operation.

For the purpose of quenching, the seat for the hot cone is surrounded by an annular wall 9 which forms with said seat a quenching well or chamber. This wall has a multiplicity of passageways 10 extending longitudinally through the bottom thereof and communicating through an annular channel 11 and a bore 12 and a pipe 13 with a source of quenching fluid. Each of said passageways 10 in the wall of the quenching well communicates with the interior of said well through jet openings 14 in the inner face of said wall; and the bottom portion of said wall is provided with a multiplicity of holes 15 for draining the quenching fluid from said well. The supply of quenching fluid is controlled by a valve 16 mounted in said bore 12 in axial alinement with the plunger of the press. This valve 16, which is adapted to move up and down, is normally seated in its uppermost position, and it is adapted to be actuated to open position by a downwardly extending rod 17 mounted on or movable with the head of the press plunger in position to bear against the stem 18 of the valve and thereby open the valve and effect the flooding of the quenching well when the plunger approaches the downward limit of its stroke.

As the plunger moves with the usual speed of a power press plunger, the operations of expanding and quenching the cone are accomplished very rapidly and without any appreciable time interval between them; and as the jets spray the entire circumference simultaneously and while the cone is still on the expansion segments, the resulting product is free from distortion. As the metal is under circumferential tension prior to quenching, and is quenched without releasing such tension, its bore will contract slightly when the quenched cone is stripped from the expansion segments. It is on account of this slight contraction on stripping that the expansion segments are set so as to expand the bore of the hot cone slightly beyond what is wanted for the finished article.

In the case of a roller bearing cone with an axial cylindrical bore, the shrinkage in diameter is uneven on account of the variation in the thickness of the wall; and if the wall of such cone is proportionately much thicker at the large end than at the small end, such uneven shrinkage will produce a distinct taper of the bore from the narrow end of the cone towards the large end. While this taper due to shrinkage of a wall of uneven thickness is slight, due allowance should be made for it in determining the taper of the sizing plug on which a roller bearing cone is sized and quenched; that is, the taper of such sizing plug should be very slightly less than that desired for the bore of the finished cone. A similar allowance should be made also for uneven shrinkage in the case of roller bearing cups and other articles wherein the bore is conical and the outer surface is approximately cylindrical or of considerably less taper than the inner surface. The effect of such allowance is to produce a greater enlargement of the bore at the thick end of the article, where the shrinkage is greatest, than at the thin end, where the shrinkage is least. In the case of alloys that shrink very little, no allowance need be made.

The effect of such expansion followed by quenching under the conditions stated above is to produce great accuracy of size and

shape of section and great smoothness and integrity of surface. Distortion is eliminated, grinding of the hardened article is made unnecessary in most instances, the full depth of the hardened case portion is preserved and the surface is sound and ready for use for bearing purposes.

It is an important advantage of my process that the grinding of cups and cones for roller bearings and the like can be effected in their green or unhardened condition, as the subsequent hardening operations are effected under conditions which tend to improve rather than impair the accuracy and soundness of the bearing surfaces. It is noted that the process described not only sets up a plastic flow which causes the metal to conform accurately to the shape of the plug or segments by which it is expanded and on which it is quenched but that the withdrawal of such plug axially tends to planish or polish the surface thereof without impairing its soundness.

Figs. 3 and 4 illustrate an apparatus like that of Figs. 1 and 2, but adapted for practicing my process in connection with the sizing and quenching of cups for roller bearings. For this purpose, the expansion member on the press plunger is not made of segmental form but is made in the form of a continuous plug 5^a of the taper desired for the inner surface of the finished cup of slightly larger size than required for such finished cup. For the sake of quenching, the outer surface of said plug is provided with a multiplicity of longitudinally extending grooves 19 that are slightly oblique or helical and extend to the bottom of said plug whereby said grooves communicate with the space 20 in the quenching well below said plug and thence, through a passageway 21 in the seat 1^a, with the supply system for the quenching fluid. The operation of this apparatus is similar to that of the apparatus illustrated in Figs. 1 and 2; but it is noted that the quenching liquid is directed against both the inner and the outer surfaces of said cup B simultaneously.

Fig. 5 illustrates an apparatus adapted to restrain the cup both exteriorly and interiorly during the quenching operation. Said apparatus is provided with a circular depression adapted to receive the hot cup. The annular wall of said depression is provided with a series of helical grooves 19^a which communicate with the passageways 10^a through a series of jet openings 14^a. The operation of the apparatus is similar to the operation of the apparatus shown in Figs. 3 and 4; but it is noted that the cup is restrained both exteriorly and interiorly during the quenching operation.

The apparatus illustrated in Fig. 6 is provided with a segmental holder 23, whose outer surface is tapered to fit the tapered seat provided therefor in the wall 9. The inner surface of the holder 23 is provided with a series of helical grooves 19^b which communicate through jet openings 14^b and passageways 10^b with the annular channel 11. The operation of this apparatus is similar to the operation of the apparatus shown in Fig. 5.

The apparatus illustrated in Fig. 7 is adapted for use in sizing and quenching cups whose inner and outer surfaces are tapered. Said apparatus is provided with a conical depression whose wall is provided with a series of helical grooves 19^c which communicate through jet openings 14^c and passageways 10^c with the annular chamber 11.

It is noted that the apparatus hereinbefore described is simply typical and that many changes may be made such as using solid plugs or different forms of expanding plugs from that shown and I do not, therefore, wish to be limited to any particular form of apparatus. It is further noted that by changing the form of the plug, my process may be made applicable to hollow articles whose bore is not circular.

What I claim is:

1. The process of treating articles of annular section which consists in forming them in the green, heating them and then circumferentially stretching the hot articles and quenching them while in stretched condition the operations of stretching and quenching being substantially instantaneous and performed soon enough after heating to prevent appreciable cooling of the article.

2. The process of treating articles of annular section which consists in forming such articles in the green, heating them and then mechanically creating a circumferential tension in the hot articles and quenching the hot articles while still under circumferential tension the operations of stretching and quenching being substantially instantaneous and performed soon enough after heating to prevent appreciable cooling of the article.

3. The process of treating articles of annular section which consists in forming them in the green, heating them and then mechanically creating a circumferential tension in the hot articles and immediately quenching them without releasing such tension the operations of stretching and quenching being substantially instantaneous and performed soon enough after heating to prevent appreciable cooling of the article.

4. The process of treating articles of annular section, which consists in forming the article in the green, heating the same, mechanically circumferentially stretching the same and quenching the same while so mechanically stretched and without appreciable time interval after stretching the operations of stretching and quenching being per-

formed so soon after heating and so rapidly as to accomplish substantially instantaneous quenching and prevent appreciable cooling of the article prior to quenching.

5. The process of sizing and quenching articles of annular section which comprises the formation of the article in the green with a slightly smaller bore than desired for the finished article, heating the same, circumferentially stretching the heated article to enlarge its bore slightly in excess of the bore desired for the finished article, and immediately quenching the same without releasing the circumferential tension the operations of stretching and quenching being performed so soon after heating and so rapidly as to accomplish substantially instantaneous quenching and prevent appreciable cooling of the article prior to quenching.

6. The process of sizing and quenching articles of annular section which comprises the formation of the article in the green, heating the same, circumferentially stretching the heated article to enlarge its bore slightly in excess of the bore desired for the finished article, and immediately quenching the same without releasing such circumferential stretching the operations of stretching and quenching being substantially instantaneous and performed soon enough after heating to prevent appreciable cooling of the article.

7. The process of sizing and quenching articles of annular section which comprises the formation of the article in the green with a slightly smaller bore than desired for the finished article, heating the same, circumferentially stretching the heated article by forcing an expansion member into the bore thereof to enlarge said bore slightly, and immediately quenching the same while still stretched on said expansion member the operations of stretching and quenching being substantially instantaneous and performed soon enough after heating to prevent appreciable cooling of the article.

8. The improvement in the manufacture of conical bearing cups and the like which consists in forming the same with a diameter slightly less than desired for the product, heat treating the same, and while still hot forcing axially into the same a plug that has a portion of the diameter and taper desired for said product, the movement of said plug being continued after said portion engages said cup to enlarge its bore slightly beyond that desired for said product.

9. The improvement in the manufacture of conical bearing cups and the like which consists in forming the same with a diameter slightly less than desired for the product, heat treating the same, and while still hot forcing axially into the same a plug that has a portion of the diameter and taper desired for said product until said portion partially passes its point of engagement with said cup and cooling said cup while it is still in engagement with said portion of the plug.

10. The process of sizing and quenching cups for conical roller bearings which consists in forcing a tapered plug a predetermined distance axially into a heated cup and then quenching said cup while in the predetermined position on said plug, the outer surface of the portion of the plug in contact with said cup in said predetermined position being of the taper desired for said cup but of slightly larger size.

11. The process of quenching cups for conical roller bearings which consists in heating said cups, restraining the same exteriorly and interiorly in grooved conical members that fit the inner and outer surfaces thereof and submitting the same while so restrained to the action of the quenching liquid introduced through the grooves, the restraining and quenching operations being so soon after heating and so rapid as to be substantially instantaneous.

12. The process of sizing and quenching articles of annular section, one of whose surfaces is nearly cylindrical and the other conical, which comprises the formation of the article in the green with a slightly smaller bore than desired for the finished article, heating the same, circumferentially stretching the heated article to enlarge its bore slightly in excess of the bore desired for the finished article but more at the thick end than at the thin end thereof, and immediately quenching the same without releasing the circumferential tension.

13. The improvement in the manufacture of conical bearing cups and the like which consists in forming the same with a diameter slightly less than desired for the product, heat treating the same, and while still hot forcing axially into the same a plug that has a portion of the diameter desired for said product but of slightly less taper, the movement of said plug being continued after said portion engages said cup to enlarge its bore slightly beyond that desired for said product.

14. The process of making roller bearing cups and cones and the like which comprises the making of a green article grinding the bearing surface thereof to approximately the size and shape of the finished article, and with a smaller bore than the finished article, heat treating said article, expanding the heated article mechanically and quenching the same while mechanically restrained, the operations of expanding and quenching being substantially instantaneous and performed soon enough after heating to prevent appreciable cooling of the article.

15. The improvement in the manufacture of conical bearing cups and the like which

consists in forming the same with a diameter slightly less than desired for the product, heat treating the same, and while still hot forcing axially into the same a plug that has a portion of the diameter and taper desired for said product.

16. The process of sizing and quenching cups for conical roller bearings which consists in forcing a tapered plug a predetermined distance axially into a heated cup and then quenching said cup while in the predetermined position on said plug, the outer surface of the portion of the plug in contact with said cup in said predetermined position being of the taper desired for said cup.

17. The process of quenching cups for conical roller bearings which consists in heating said cups, restraining the same interiorly on a grooved conical member that fits the inner surface thereof and submitting the same while so restrained to the action of the quenching liquid introduced through the grooves, the restraining and quenching operations being so soon after heating and so rapid as to be substantially instantaneous.

18. The process of sizing and quenching articles of annular section, one of whose surfaces is nearly cylindrical and the other conical, which comprises the formation of the article in the green with a slightly smaller bore than desired for the finished article, heating the same to enlarge its bore slightly in excess of the bore desired for the finished article but more at the thick end than at the thin end thereof, and immediately quenching the same without releasing the circumferential tension.

Signed at Canton, Ohio, this 27th day of January, 1921.

MARCUS T. LOTHROP.