Nov. 7, 1939. A. C. DAMES 2,179,073

APPARATUS FOR HEAT TREATING

Original Filed June 10, 1935 2 Sheets-Sheet 1

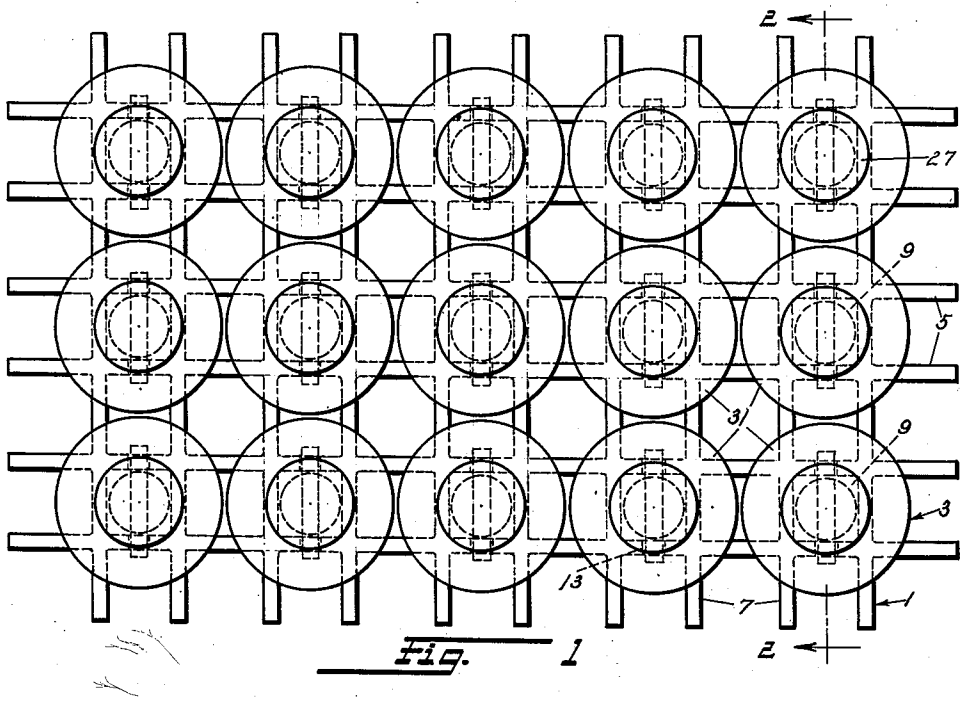


Fig. 1

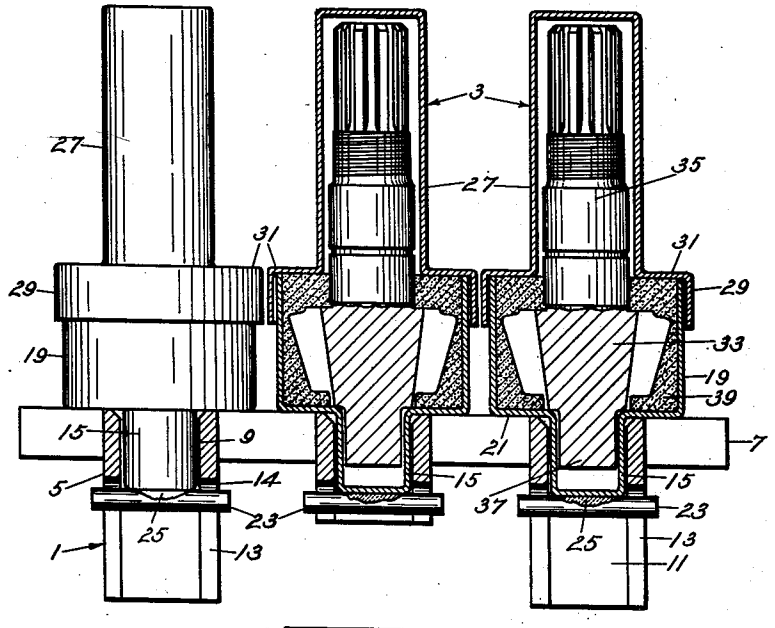


Fig. 2

INVENTOR.
Albert C. Dames

BY

Strauch & Hoffman
ATTORNEYS

Nov. 7, 1939. A. C. DAMES 2,179,073

APPARATUS FOR HEAT TREATING

Original Filed June 10, 1935 2 Sheets-Sheet 2

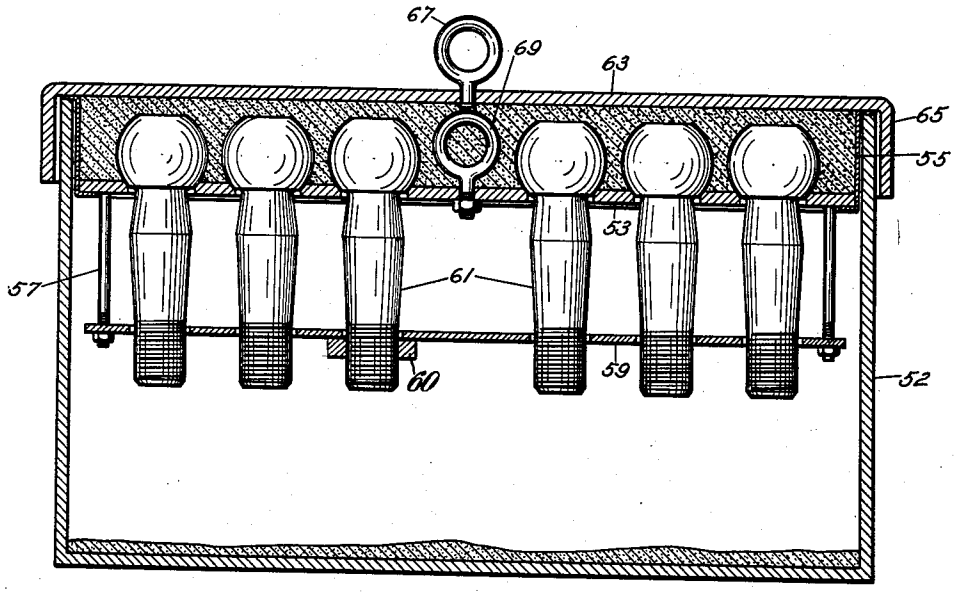


Fig. 4

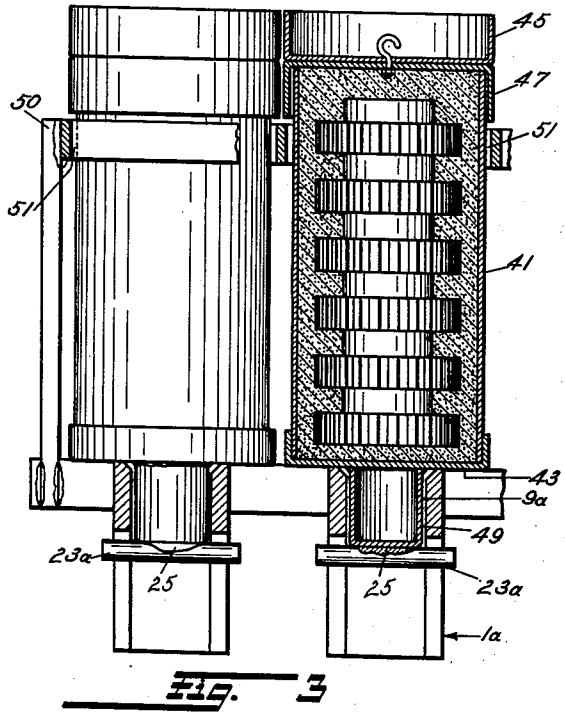


Fig. 3

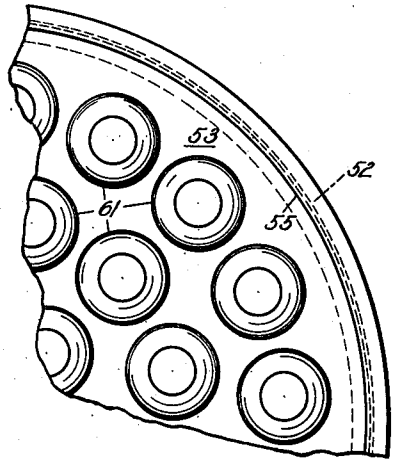


Fig. 5

INVENTOR.
Albert C. Dames

BY

Strauch & Hoffman
ATTORNEYS

Patented Nov. 7, 1939

2,179,073

UNITED STATES PATENT OFFICE

2,179,073

APPARATUS FOR HEAT TREATING

Albert C. Dames, Detroit, Mich., assignor to The Timken-Detroit Axle Company, Detroit, Mich., a corporation of Ohio

Application June 10, 1935, Serial No. 25,921
Renewed April 6, 1939

12 Claims. (Cl. 263—47)

This invention relates to apparatus for the heat treatment of articles of manufacture, and more particularly, to containers for carburizing metallic articles of manufacture.

In all lines of manufacture in metals, and especially in the automotive field, there are many parts which are required to be extremely hard at one portion and comparatively soft at others. Such parts are, for example, gears wherein only the gear teeth need be hard, camshafts wherein only the cams need be hard, and steering balls wherein only the ball portions need be hard. The usual method of obtaining the requisite hardness is by carburization, or as it is sometimes called—case hardening.

When a combination of hardnesses is sought in a single piece as in a gear or a steering ball, either of two methods have heretofore been used.

The first is to copper or tin plate the portions which are to remain soft, place the entire article in a carburizing pot, and place the pot in a heat-treating furnace for a period of hours. Carburization will not take place where the part has been copper-plated. This process requires that after carburization the copper-plating must be removed from the soft portions, as by grinding, and then the soft portions annealed, or further heat-treated in case a medium hardness is required at such portions.

The second method is to carburize the entire piece and then, after carburization, draw, as by immersing only the portions to be softened in a pot of heated lead, and quench in air. This reduces the extreme hardness gained by carburization to an intermediate value. It is necessary, after the lead pot draw to perform a wire-brushing operation in order to remove particles of lead which may adhere to the article.

Either of the above two methods is necessarily costly as they entail a material amount of direct labor which is an item to be avoided wherever possible under present mass production policies. In removing the necessity for such labor and in accordingly effecting economies, a primary object of my invention is to provide novel apparatus for selectively carburizing articles of manufacture without plating whereby only such portions of said articles are carburized as require carburizing, and the remainder thereof are left comparatively soft.

A further object is to provide novel apparatus for selectively carburizing articles of manufacture wherein substantial variations of hardness may be imparted to different portions of a single article simultaneously, thereby eliminating operations hitherto considered necessary, such as copper or tin-plating, or lead pot drawing and wire-brushing, or in fact, all subsequent heat treatment.

A further object is to provide novel carburizing apparatus wherein only those portions of the article to be heat treated as by carburizing, are encased within carburizing compound and the remainder thereof is free of compound, but protected from an oxidizing atmosphere.

Still a further object is the provision of novel heat treating apparatus wherein only selected portions of an article to be heat treated are placed in contact with carburizing compound and wherein compound-free portions are hardened to a degree different from that of the compound encased portion.

A further object of my invention is to provide novel carburizing apparatus wherein means is provided for individual handling of the articles to be carburized, the means conforming in contour substantially to the shape of the articles.

Due to the high temperatures required for carburizing, the life of the containers employed is relatively short in spite of the development of special materials for this purpose. The old type of container, namely, a large box in which a number of pieces are packed with carburizing compound separating them, has perhaps as long a life as any container since made. However, these containers are very inefficient, as there is a large loss of compound per individual heat, due to the fact that the box must be dumped—at least in part—before the articles may be removed. Also, individual handling of the carburized articles is impossible with the result that such containers have a high percentage rejection, and a great deal of straightening, grinding and other reconditioning operations are necessary upon the carburized pieces.

An improvement on this form of apparatus is the invention disclosed in the copending application of Harry W. McQuaid, Serial No. 692,329, filed October 5, 1933. In this type of apparatus individual handling of the parts is obtained and the loss of compound and the percentage rejection is reduced. The results from the use of the present invention are even better than those resulting from a practice of the McQuaid invention in that the containers employed have been found to be characterized by a longer life and a tendency not to warp or lose their alignment in spite of the heat to which they are repeatedly subjected. It is therefore a major object of my invention to provide novel carburizing apparatus wherein individual containers may be employed with a life far

in excess of the life of containers used in former practice.

Still a further object of my invention is to provide novel carburizing apparatus comprising a plurality of containers full-floatingly affixed to a single base member whereby warpage and misalignment due to the repeated subjections to heat are eliminated.

A further object is to provide novel carburizing apparatus which reduces the cost of actual carburizing operations and eliminates any necessity for further heat treatment or reconditioning by way of machining.

Still a further object of my invention resides in the provision of a novel container for containing an article to be carburized, the container being designed to cooperate with the article whereby carburizing compound introduced into contact with a selected portion of the article is prevented from contacting other portions of the article.

A further object of my invention resides in the provision of a novel carburizing container for an individual article wherein a selected portion of the article may be encased in a carburizing compound, another portion of the article being free from the compound but subject to the gases therefrom whereby the latter portion may be increased in hardness to a degree differing from that of the encased portion.

Still a further object of my invention is the provision of a novel carburizing container wherein selected portions of an article may be encased in carburizing compound, the container being formed of a material less resistant to carburizing than the remaining portion of said article whereby gases escaping from said carburizing compound to the other sections of the container will act upon the container walls rather than upon the adjacent portions of the article.

A further object is the provision of a novel carburizing apparatus whereby selected portions of an article may be carburized without effect on other portions of the article in the absence of plating or other protective means.

Still a further object of my invention is to provide a novel carburizing apparatus whereby varying degrees of hardness may simultaneously be imparted to a single article by contacting a selected portion or portions of the article with carburizing compound and subjecting other portions of the article to the gases emanating from the compound.

The above and further objects will be more apparent from a study of the following description when taken in connection with the accompanying drawings wherein:

Figure 1 is a top plan of a battery of carburizing containers embodying a preferred embodiment of my invention,

Figure 2 is a side elevation taken partially in section substantially along the line 2—2 of Figure 1,

Figure 3 is a side elevation partially in section similar to Figure 2, but illustrating a further preferred embodiment of my invention,

Figure 4 is an elevation of a section along a diameter of a further preferred embodiment of my invention, and

Figure 5 is a partial plan view of Figure 4 with the cover and carburizing compound removed.

A preferred embodiment of my invention will be described in connection with the carburizing of automobile rear axle drive pinion gears, but it will be understood that I do not wish to be limited to this use. Other shapes and configurations are contemplated for differently formed articles of manufacture and are intended to come within the scope of the appended claims.

Referring now to the drawings wherein like reference characters refer to like parts wherever they occur, and with particular reference to Figure 1, the apparatus in this embodiment comprises two features—a base plate 1 and carburizing containers 3. Base plate 1 is preferably an open grill section and may be cast or built up from strip stock and welded or otherwise secured. Care must be taken that the members forming the grill are of substantially uniform section in order that uniform heating and cooling will occur.

The grill work, as shown, has longitudinal and lateral members, 5 and 7, respectively, which cooperate to form square apertures 9. If desired, members 5 and 7 may be of such shape as to cause apertures 9 to be of circular configuration. The portions of said members 5 and 7 which form alternate apertures 9 extend downwardly a substantial distance to form feet or supports 11, whereas the portions of members 5 and 7 which form the remaining apertures 9 extend downwardly a lesser distance. Each of the feet 11 has vertical slots 13 arranged in lateral alignment, which extend upwardly of said feet and terminate in half-round slots, and the lower portions of the alternate depending portion have half-round slots 14 in similar lateral alignment, said slots 14 preferably terminating in vertical alignment with slots 13. These slots are for a purpose which will be evident hereinafter.

It is to be noted from the description of base 1 that it is of rigid construction and yet weighs very little. It is also to be noted that because of the substantially uniform section thereof that there will be little tendency toward warping.

Extending into the apertures 9 are lower cylindrical portions 15 of containers 3. Referring to one container as an example, the outside diameter of cylindrical portion 15 is slightly less than the width of the apertures 9. This insures that even under high temperatures there will be no binding of the containers in base member 1. Above the portion 15 is a cylindrical portion 19 of larger diameter than portion 15, the upper end thereof being open and the lower end being joined to portion 15 by a circular wall or flange 21 which is adapted to rest upon the upper surface of base plate 1.

The lower portion of the container is loosely affixed to base plate 1 by means of short rods or pins 23, which are inserted into slots 13 of feet 11 and slots 14, above described, and welded, or otherwise secured to the closed end portion of cylindrical portion 15, as indicated at 25. Pins 23 are of slightly greater length than the outside width of feet 11, thereby insuring that the lower portion of container 3 cannot part company with the base. It is also to be noted that a slight amount of clearance is allowed between pin 23 and the upper portion of slots 13 to provide for a full-floating relation.

The upper portion of container 3 comprises a cover having a long upstanding cylindrical portion 27 closed at its upper end and joined at its lower end to a larger cylindrical portion 29 by means of a horizontal circular wall or flange 31. The inside diameter of the large cylindrical portion 29 is slightly larger than the outside diameter of the large cylindrical portion 19 of the lower portion of said container. Thus, as seen in Figure 2, cylindrical portion 29 overlaps cylindrical portion 19.

This overlapping is extremely important since it forms a seal which prevents the articles within the containers from being subjected to an oxidizing atmosphere at carburizing temperatures. Such an atmosphere would cause the formation of scale on the articles and would turn the compound to ash. The formation of scale would destroy the close limit machining previously given the articles and the formation of ash would destroy the effectiveness of the compound. During carburization, gas is generated by the compound and the overlapping relationship, above noted, prevents the generated gas from being displaced by the oxidizing gases in the furnace.

A number of these containers may be mounted on a single base. As illustrated in the drawings, there are fifteen containers on the one base.

As above noted, the containers just described are particularly adapted for heat treating automotive rear axle bevel pinion gears. Such gears are of the type generally shown in Figure 2 having an enlarged gear portion **33**, a long shank or end portion **35** and in some cases a small bearing piloting section **37** adjacent the gear portion and on the opposite side thereof from the shank **35**. In such articles of manufacture it is necessary that the teeth of the gear be extremely hard and that the shank of the gear be comparatively soft. In practice, a Rockwell C scale hardness of 58–65 is required on the gear teeth, and a hardness of 33–43 is required upon the shank portion. The reason for this is that after carburizing a finishing die must be run over any threads on the shank and in some instances splines or keyways cut in the end thereof. If this portion is harder than the above-noted 33–43, then extreme difficulty is encountered in performing these operations.

Referring now to Figure 2, it will be noted that the piloting portion **37** is dropped into the cylindrical portion **15** so that the shoulder between said piloting portion **37** and the gear portion **33** cooperates with the upper side of the circular flange **21** to form a seal therewith. Carburizing compound **39** is then packed around the gear portion **33** up to the top of the lower portion **19** of the container. The cover of the container is then put in place. This procedure is repeated for all of the containers of the battery. The battery is then placed into a heat-treating furnace where it is left for a period of hours until the required depth of carbon penetration is obtained.

Upon removal from the furnace each cover is individually removed and the gear in said container is removed and quenched in oil before the next container cover is removed and the next piece removed and quenched. This insures that the handling of each piece is individual and that the handlers will be careful and avoid any nicking or scratching of the articles. This is important since metal at a temperature of about 1700° F. may easily be scuffed. Since the teeth of the gear portion **33** of the pinion gears are finish ground before carburizing, if any scuffing or nicking does take place during heat treat, it is necessary that the gear be returned to the gear grinder for further finishing.

It is to be noted that after carburization and when the gears are removed from their individual containers, only a very small portion of the compound will be removed after they are exposed to the air. When the compound is at the carburizing temperature and is exposed to the air, it turns to ash. However, if it is not exposed to the air and is allowed to cool back to room or normal temperatures, then it may be used over again. By reason of the small amount of lost compound, the cost of carburizing articles in this type of containers is accordingly reduced.

A further point to be noted is the very small amount of compound needed per pinion gear. The economy effected thereby is striking when it is considered that in the old single box construction, the weight of compound per pinion gear was 1¾ lbs. whereas in my invention only ½ lb. is required per gear. This results in a savings of approximately 75 percent without consideration of the fact that a major amount of the compound may be re-used.

This small amount of compound is conducive to a faster carburizing cycle for the filled containers are brought up to temperature faster. Whereas approximately eighteen hours was required heretofore for a given treatment of a certain article, the present invention has enabled a reduction to ten hours. Also, with this design of apparatus the percentage rejection is reduced to ½ percent and less as compared to 4 percent for the single box type. In considering the factors hitherto noted and other items of cost, it has been determined that by employing the present invention, the cost of heat treating the gears is reduced 21 percent over the prior single box type.

It is to be noted that the shank portion **35** of the gears, while not in contact with the carburizing compound, during the heating operation, is exposed to the gases emitted by the compound. While the effect of the gases is not very great due to the formation of a gas pocket in the cylindrical portion **27** of the containers, and a corresponding restriction of circulation of the carburizing gases, the small amount of gas that does circulate, plus the oil quench which is given the parts after being heated, imparts to the shank portion just the degree of hardness required for the transmission of torque. This hardness, as above noted, for the particular gears described, is the Rockwell C scale hardness of 33–43.

In the event a greater hardness differential is required the covers or upper portions of the containers **3** may be of a simple low carbon steel rather than the special carburizing resistant steel which is at present used. In this case any gases which may circulate within cylindrical portion **27** will act upon the container rather than the article therein. While the life of such covers would not be as long as those made from special container material, as excessive carburization would make them extremely brittle, their cost is materially less, so that even though more covers are necessary, the cost per article carburized is not increased.

It is also to be noted that the portion **37** of said gears which extends into the lower cylindrical portion **15** of said containers is substantially sealed from the carburizing gases by reason of the engagement of the shoulder intermediate the gear tooth portion **33** and the bearing pilot portion **37** with the upper portion of circular flange **21**. Any gases that may leak into said chamber will only have an effect similar to that described for the cylindrical portion **27**.

Referring now to the preferred embodiment illustrated in Figure 3, the containers bear some resemblance to those illustrated in the above-noted McQuaid application, having a long cylindrical body portion **41** with a closed bottom **43**.

Reversible covers 45 are provided for the open tops of the cylindrical portions and have overlapping cylindrical portions 47 thereon. This overlapping arrangement has the same function as previously described in connection with the overlapping arrangement of Figure 2.

Centrally attached to the lower portion or base 43 of said container is a cylindrical portion 49 which is adapted to project into apertures 9a of the base 1a much in the same manner as the cylindrical portion 15 of the containers 17 of Figure 2 projects into the apertures 9. In like manner, rods or pins 23a are welded to the lower portion of cylindrical portions 49, thus retaining the containers loosely within the base 1a.

As a stabilizing measure, in the event that the containers are inclined to be top-heavy, an upper structure is provided for the base 1a, which comprises a lateral and longitudinal grill work 50 which may be cast integral with base 1a, or may be of a built-up welded section and composed of strips of steel. The upper structure forms apertures 51, the width of which is greater than the outside diameter of the cylindrical portion 41 of said containers which are thereby loosely confined in upright position.

The containers illustrated in Figure 3 are extremely satisfactory and as economical as those of Figure 2 for substantially cylindrical parts of nearly the same size as the containers, or for small parts which may be stacked one on top of the other (as shown), and thus form substantially a cylinder.

Referring now to Figures 4 and 5, there are some automotive parts which require that only a portion have a hard surface, but which it would be highly impractical to give individual handling. Such parts are steering arm balls, as used in conjunction with steering axles. These parts require that only the head or spherically rounded portion shall be hard. As it is inherent in the design of these parts that a comparatively deep undercut portion be adjacent the spherical or head portion, it is highly important that no carburization take place in this undercut portion. Failure to take this precaution usually results in breakage of the part at the undercut. The present practice of carburizing these parts is to finish the parts all over and copper-plate all but the portion of the head or spherical portion which is to be hardened. The entire part is placed in a carburizing pot and carburized and after carburization the copper-plate is removed. Then the shank of the ball must be properly tempered.

I have illustrated in Figures 4 and 5 a further preferred embodiment of my invention in the way of an improved apparatus for carburizing such parts as steering balls whereby carburization will only take place at that portion where it is required and wherein operations of copper-plating and removing copper plate and tempering are eliminated.

This apparatus comprises a preferably circular box structure 52 having an open top. Inserted therein is an apertured plate 53 which is suspended part way down and on the inside of the box by means of support 55. Support 55 comprises in effect a cylindrical member terminating at its lower portion in an inwardly turned lip upon which plate 53 rests and at its upper portion in an outwardly turned lip whereby the support 55 and plate 53 are supported upon the upper edge of box 52. Suspended from plate 53 by means of long bolts 57 is a second plate 59 which is apertured in alignment with the apertures in plate 53.

The steering balls 61 are inserted vertically through the apertures in plates 53 and 59. The apertures in plate 53 are of such size that the portion of the heads of said balls which are to be hardened are prevented from passing therethrough. The apertures in plate 59 are for the purpose of preventing said steering balls from being displaced too far out of vertical alignment. If desired, nuts may be threaded onto the threaded ends of said balls and secured against the lower side of plate 59 to insure such alignment as shown at 60.

Carburizing compound is packed around the spherical end portions which project above plate 53 and is leveled off with the top of support 55. A cover 63 is then placed upon the top of the box, the cover having a depending lip portion 65 which overhangs on the outside of box 52. Suitable eyes 67 and 69 may be provided in cover 65 and plate 53 respectively for convenient handling. A small amount of carburizing compound may be sprinkled in the bottom of box 51 to insure that an oxidizing atmosphere will not be present in the vicinity of the shank ends of balls 61 during caburizing.

It is thus seen that only a predetermined portion of the spherical ends of the steering balls will be carburized, as the lower portion of the box is effectively sealed from the bulk of the carburizing gases. Such gases as may leak into the lower chamber will have the effect before described in connection with the shank 35 of the gear of Figure 2. Since it has heretofore been necessary to temper the end portions of the balls, the above described effect is very desirable in giving the end portions an intermediate hardness and thus eliminating the tempering operation.

From the above and foregoing description, it is evident that my invention comprises carburizing apparatus which effectively overcome the disadvantages of prior practices and have distinct advantages thereover, including the following:

1. Carburization of only those portions which require carburizing.
2. Automatic heat treatment of portions not carburized.
3. Use of extremely small amounts of carburizing compound and small loss thereof.
4. Absence of oxidizing atmosphere within the containers.
5. Comparatively small time in the furnace.
6. Guarantee of individual handling.
7. Low percentage of rejection.
8. Parts are in upright position, thereby substantially eliminating warpage.
9. Elimination of costly operations subsequent to carburization.
10. Reduction in cost per article carburized.
11. Full floating containers in battery arrangement.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictuve, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meanning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A heat-treatment container for supporting a manufactured article having an enlarged portion, said container being formed to substantially conform to the shape of said article and enlarged adjacent said enlarged portion of said article to provide for the use of a heat treating compound and formed with a section to directly engage and co-operate with said enlarged portion of said article to substantially protect other portions of said article from the action of said heat treating compound.

2. In a heat treating apparatus for manufactured articles, a plurality of individual containers arranged to support said articles, a base member associated with said containers and means to secure said containers directly to said base member in full floating relation therewith.

3. In a heat treating apparatus for manufactured articles, a base member comprising a series of members arranged in angular relation to one another to form a series of pockets, containers arranged to fit within said pockets, and means to loosely secure said containers within said pockets.

4. In a heat treating apparatus for manufactured articles, a base member comprising a series of members arranged in angular relation to one another to form a series of pockets with slots in the lower portions thereof, containers arranged to fit within said pockets, and means to engage said slots and said containers to loosely secure said containers within said pockets.

5. In an apparatus for heat treating a manufactured article having an enlarged portion and projecting end portions, a container comprising a section generally conforming to said article, a shoulder between the ends of said section arranged to be engaged by said enlarged portion of said article to define a zone for the reception of heat treating compound and a zone for receiving one of said projecting end portions substantially sealed from said compound, and an additional section arranged to engage an end of said first section in sealing relation and of a shape to conform to the other said projecting end portion of said article.

6. In an apparatus for heat treating a manufactured article having an enlarged portion and a projecting end portion, a container comprising a section generally conforming to said article, said section being enlarged adjacent said enlarged portion of said article for the reception of a heat treating compound, and an additional section arranged to engage said first section in sealing relation thereto and of a shape to conform to the projecting portion of said article, said second section being arranged to receive gases from a heat treating compound in said first section.

7. In a heat treating apparatus for manufactured articles, a base member comprising a series of members arranged in angular relation to one another to form a series of pockets, containers with ends thereof arranged to fit within said pockets, means to loosely secure said ends of said containers within said pockets, and means secured to said base and arranged to support the opposite ends of said containers.

8. A container for heat treating manufactured articles comprising a relatively deep section open at the top thereof, and a tray engaging the sides of said section to support articles to be heat treated and to confine the heat treating compounds adjacent selected portions of said articles, said tray being formed to cooperate with portions of said articles to substantially seal the remaining portion of said articles from said heat treating compound.

9. A container for heat treating manufactured articles comprising a relatively deep open ended box section, a tray mounted adjacent the upper end of said section and arranged to seal the edges thereof, said tray being formed with apertures in the bottom thereof of a size to receive articles to be heat treated and maintain said articles in suspended relation, and heat treating compound in said tray, and means to seal said section and said tray to prevent the access of an oxidizing gas thereto.

10. A container for enclosing and supporting an article for selective heat treatment, said container comprising means providing adjacent chambers, a wall member intermediate of said chambers having an article supporting surface thereon, said surface being adapted to engage a portion of an article to be treated and to individually support said article with portions thereof in each of said chambers, said surface and said portion cooperating to isolate said chambers, and a cover for said container.

11. A heat-treating container for enclosing and individually supporting an article to be selectively treated and characterized by having an enlarged portion to be treated by carburizing compound and another portion to be isolated from said compound during treatment; said container comprising, means forming a first chamber for holding carburizing compound and for receiving the enlarged portion of an article to be treated and a second chamber for receiving another portion of the article, a supporting means associated with said first named means for supporting the article, said last named means being arranged to directly contact the enlarged portion of the article to isolate the other portion thereof from carburizing compound in said first mentioned chamber, and a cover for said container for sealing said chambers from furnace gases.

12. A heat-treating device comprising a container, said container being formed to provide adjacent chambers, one of said chambers being arranged above the other and adapted to receive carburizing compound and to enclose an enlarged portion of an article to be treated, the other of said chambers being adapted to enclose another portion of the article, means on said container adjacent said chambers for directly engaging the enlarged portion of the article to individually support the article in said container, said last named means being arranged to cooperate with the enlarged portion of the article to seal said second chamber from said first chamber whereby the other portion of the article will be isolated from carburizing compound in said first chamber during treatment, and means for closing said container.

ALBERT C. DAMES.