April 16, 1929. H. W. TINKER 1,709,160

APPARATUS FOR TREATING STEEL

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Fig. 1.

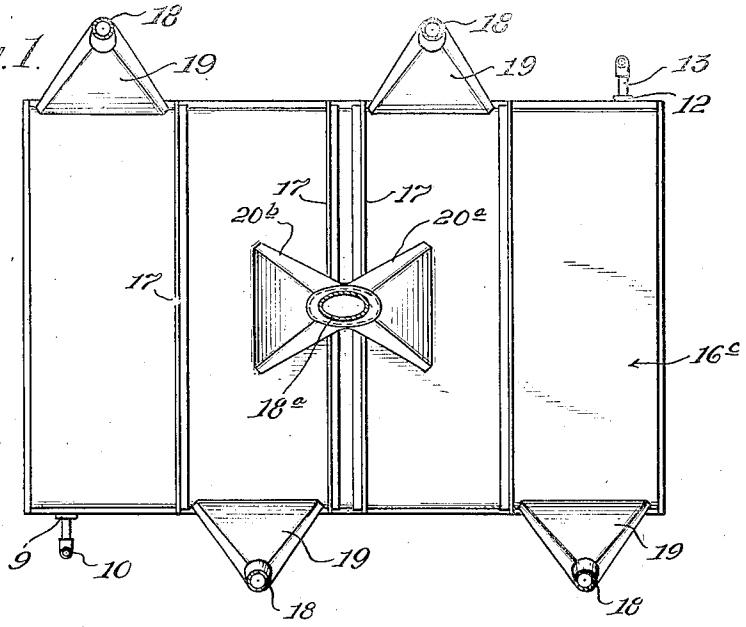
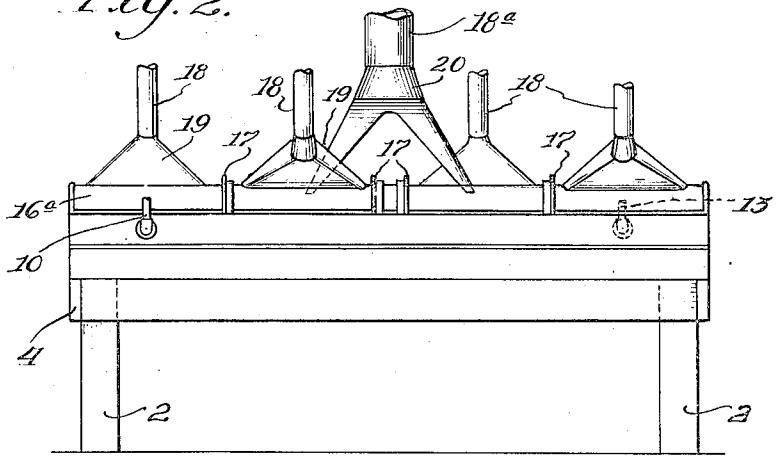


Fig. 2.



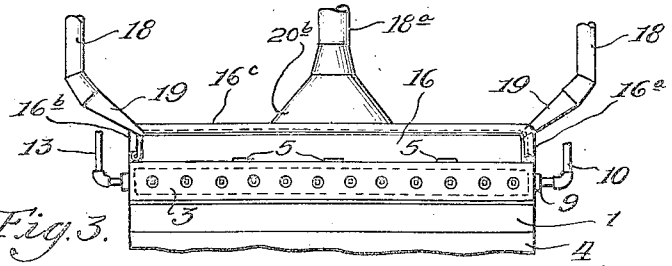


Fig. 3.

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Fig. 4

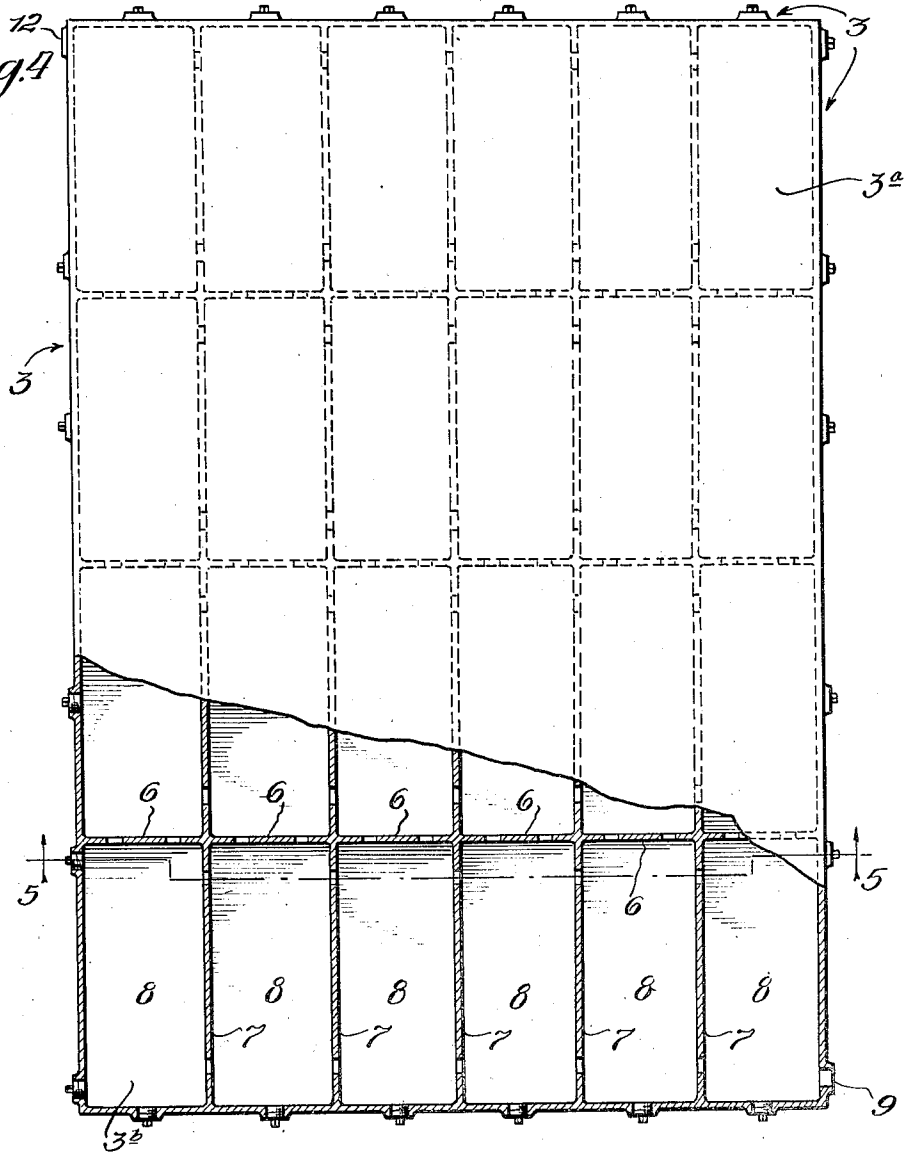
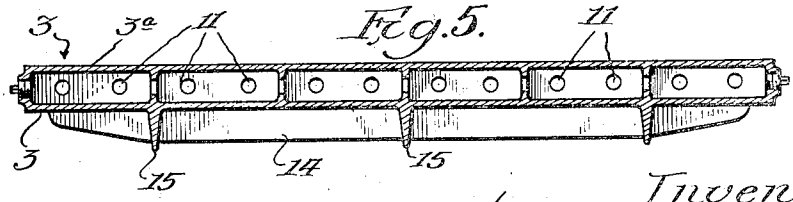


Fig. 5.



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APPARATUS FOR TREATING STEEL

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Fig. 6.

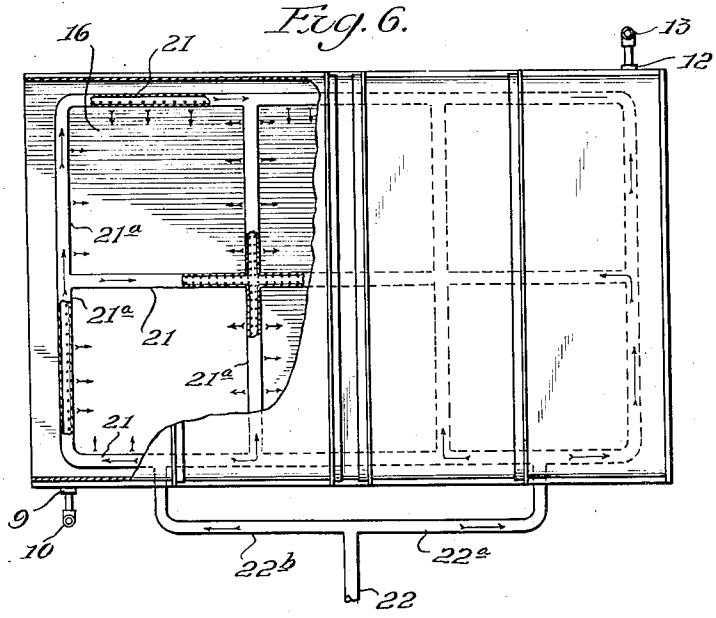


Fig. 7.

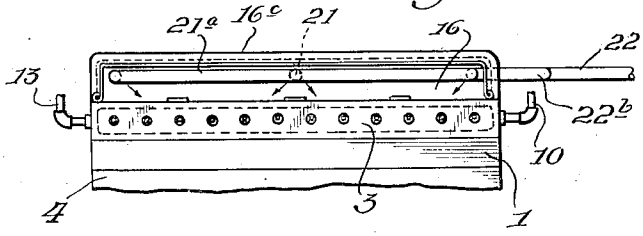
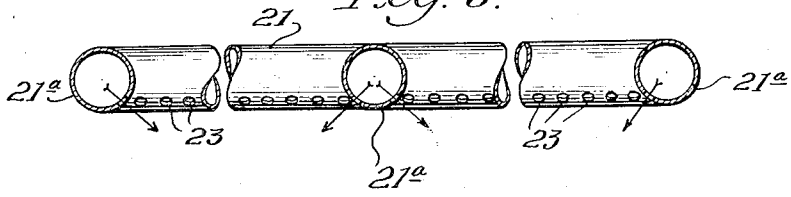


Fig. 8.



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Patented Apr. 16, 1929. 1,709,160

UNITED STATES PATENT OFFICE.

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APPARATUS FOR TREATING STEEL.

Application filed November 13, 1926. Serial No. 148,128.

My invention relates generally to apparatus for treating steel, and has to do particularly with air treatment of spring steel such, for example, as may be used for automobile bumpers and springs, and wherein the finished product is given the desired temper to produce the desired hardness and toughness to withstand ordinary impacts to which the same may be subjected without breakage or permanent distortion.

In the course of manufacture of many steel products, various heat treatments are employed to give the steel the proper metallurgical properties to condition the same for the particular use intended. In certain instances, for example, the manufacture of automobile bumpers and springs, it has been necessary to subject the steel which forms the same or certain of the parts of the same to a heat treatment for tempering the same so as to provide sufficient toughness and hardness in the finished steel parts, without brittleness, at the same time providing the desired tensile strength, elasticity and physical characteristics to render the same capable of receiving impact and load without breakage or permanent distortion.

The usual method employed in such instances for tempering the steel to the desired extent, is the well-known oil heat treating method. Generally speaking, in carrying out this customary oil heat treating method, as for example in the manufacture of automobile bumpers, or springs, the metal is first heated to the desired high heat sufficient to permit the same to be readily formed to the shape intended. This heating operation is then followed by the shaping of the bar by suitable tools. After the bar has thus been shaped, it is dipped in a cool oil bath where it is chilled and quickly cooled. In some cases the shaped bar may be heated to a desired high heat after the shaping operation and then, while at a desired high heat, dipped in the cool oil bath and rapidly cooled and chilled as stated. In either case, the rapid cooling makes the metal very hard and brittle and, so much so, that it would readily break when subjected to impact and ordinary stresses and would not be suitable for use until subjected to further treatment. This further treatment is generally termed "drawing" or "tempering." This drawing or tempering operation produces such a change in the molecular construction of the metal as to reduce its toughness and hardness to the desired point to withstand loads, stresses and impacts without breakage and permanent distortion, and it consists generally in reheating the steel under treatment to a heat lower than the original heat and then allowing the same to cool at a slower rate. This secondary heating or drawing operation is generally carried out by dipping the steel in a hot oil bath which is sufficiently hot to bring the steel only to the desired heat. The degree of temper or drawing depends, in part, on the degree of reheat, all of which requires skill and care in manipulation.

While the oil heat treating method may be employed to produce steel which satisfactorily meets the standard of practice that must be adhered to in each particular case and produces steel possessed of the necessary metallurgical properties, yet it is quite objectionable for various reasons. One objection is that it is a very expensive process involving a plural stage operation. It requires frequent handling of material; the operation and care of a plurality of furnaces, or the like; the care and changing of the oil in the treating tanks; and the upkeep of expensive equipment, etc. It also requires skilled labor, and even with the skilled labor aided by pyrometers, etc., uniformity in the product does not always exist due to variation in judgment and skill of the various workmen.

Still another objection to this former method is that the pieces of steel, and particularly bars for automobile bumpers and springs, become warped when dipped in the oil. This latter condition requires peening of the distorted metal to bring it to its intended shape, and this peening operation is objectionable because it tends to destroy the already established molecular arrangement and desired physical properties of the steel and tends toward brittleness which is highly undesirable. Furthermore, the oil treated steel must be thoroughly degreased or tumbled or sand blasted to clean it, all of which requires the use of costly apparatus and requires much time and operating expense.

An object of my invention is to provide a method of and apparatus for heat treating

spring steel wherein all of the foregoing disadvantages of the oil heat treating method are eliminated, thereby greatly increasing the rate of production with a like decrease in cost.

Another object is to provide for the treatment of steel to produce a desired temper condition as accomplished by air, wherein the tempering of the steel is effected by the continuous and uniform application of cool air to the same while in a heated condition. As the air is directed in contact with the heated metal and becomes heated by contact with the same it is immediately and continuously displaced and replaced by the constantly supplied cool air.

Still another object is to provide an inexpensive method of heat treating spring steel involving a minimum amount of inexpensive equipment and eliminating the necessity for the use of skilled labor. With my invention common labor may be employed, there being no pyrometers, furnaces, oil treating tanks, etc. to require the care of skilled workmen.

A further object of my invention is to simplify the heat treatment of steel by accomplishing the hardening, drawing and tempering of the metal all at one and the same operation, wherein the results of the plural-stage heat treating operation of the oil heat treating method is accomplished in a single-stage operation, and wherein the cooling of the metal is under a variable control (may be fast or slow) which is effective throughout the entire surface of the metal to cool the same uniformly so that the metallurgical properties will be uniform throughout.

A still further object of my invention is to prevent warping or distortion of the steel under treatment during its treatment thereby avoiding further treatment, such as peening, which destroys the already-established and desired metallurgical properties.

One highly desirable feature of my invention in addition to all the foregoing features and advantages is that I am able to produce a steel which can be readily cleaned for use by pickling in acid. This is a very simple and cheap way of cleaning. The steel thus produced has all of the desirable characteristics of that which is produced by the tedious and expensive plural-stage oil heat treating method.

Other and further objects and advantages will become apparent as this description progresses.

Although to facilitate the following description I refer to my invention as applied in the manufacture of automobile bumpers and springs, I do not desire to be limited to such use as it is obvious that it is capable of use in various instances where it is desired to harden and temper steel products or parts thereof.

In carrying out my method, say in the manufacture of bumper bars for automobile bumpers, a bar of spring steel of the proper dimensions is heated to a desired high heat suitable to permit ready shaping of the same and for carrying out the other operations to be described later. The heated bar is next subjected to a shaping operation, the desired shaping tools being employed to give the same the final intended shape. As soon as the bar has been given its intended shape, as stated, and while it is still at a high heat, it is placed upon a flat metal supporting surface in an air treating chamber. The surface upon which the bar is placed is cooled by water, or otherwise, to predetermined and variable extents to prevent warping of such surface, which, in turn, prevents any distortion of the heated bar placed thereon from that cause. If this were not done, the supporting surface may become heated by contact with the heated bars to such an extent that it would warp out of shape and prevent an uneven supporting surface and cause distortion of the heated bar carried thereby. In case the bar under treatment is a flat bar, it may be placed directly upon the supporting surface with its flat face contacting with the flat supporting surface, but in the event that the bar is of an irregular shape at any place throughout its length, it may be placed upon the cooled supporting surface on one of its side edges so that it will not become distorted and lose the already-given shape while in its heated state in the treating chamber.

After the bar has been so placed in the treating chamber, blasts of air are constantly applied to such heating chamber, such air being confined thereby and positively directed into contact with the metal bar under treatment. This air is fed in a cool state, and is so confined and directed by the treating chamber and associated parts and by its natural course of flow that it contacts uniformly with and throughout the surface of the bar. The temperature of the air admitted is under control as well as its rate of admission. The rate of cooling is thus under control and dependent upon the temperature and rate of admission of the air to the treating chamber. This action is also further aided due to the fact that the air which becomes heated by contact with the metal bar is rapidly displaced and replaced by the oncoming cool air so that the cooler air under treatment is constantly in contact with the bar. There is a constant circulation of the cool air throughout the treating chamber and in contact with the bar under treatment, the incoming air being directed to accomplish this. Thus, the cooling of the bar may take place rapidly or slowly and it is, at all times, sufficiently controlled to bring the steel down to the proper cool condition, in the proper time, to produce the desired metallurgical

properties in the same, that is, the proper temper condition. After the metal bar has been thus cooled, and to an extent such that the heat remaining in the bar will not draw the temper, and to the point where the molecular construction to the metal has adjusted itself to produce the proper metallurgical properties (the equivalent of those produced by the well-known oil heat treating method) it is removed from the oven and permitted to cool sufficiently to permit ordinary handling and final treatment of the same.

One form of apparatus which I may employ in carrying out my invention is shown in the drawings wherein Figure 1 is a top plan view of an air-treating oven.

Figure 2 is a side elevation of the treating oven of Figure 1.

Figure 3 is a partial end elevation of the structure of Figures 1 and 2.

Figure 4 is an enlarged top plan view of the cooled supporting plate of the treating oven, a portion thereof being shown in section.

Figure 5 is a vertical section taken on line 5—5 of Figure 4.

Figure 6 is a top plan view of another form of apparatus that may be employed for carrying out my invention, and showing a portion of the top cut away.

Figure 7 is a partial elevated view of the structure of Figure 6.

Figure 8 is an enlarged detail view, partially in section, showing the arrangement of the air delivery openings in the air pipes of the structure of Figures 6 and 7.

Referring to the drawings, the form of apparatus shown may comprise a rectangularly-shaped supporting frame 1 supported by a leg 2 at each corner. A surface or supporting plate member 3 is carried upon the frame 1 as shown in Figure 3, the member 3 being held in place by the frame in a suitable and desired manner. If desired the frame 1 and member 3 may be skirted by a sheet metal covering as indicated by the numeral 4 in Figure 2.

The supporting plate or member 3 is adapted to carry and support the heated steel bars 5 (Fig. 3) which, in this instance for the sake of illustration, are spring steel bars for use in connection with automobile bumpers. Obviously, if not otherwise taken care of, the supporting plate 3 would become excessively heated by the bars 5 and would tend to warp and thereby distort the heated bars carried thereby. One manner of taking care of this condition and preventing warping of the plate 3 is shown in Figure 4 wherein a preferred form of plate is shown.

As shown in Figures 4 and 5, the plate 3 is formed hollow with a plurality of spaced transverse partition members 6 and a plurality of longitudinal intersecting transverse partition members 7, all extending from the top 3^a to the bottom 3^b of such plate to divide its interior into a plurality of cooling chambers 8. The top 3^a and bottom 3^b may be integrally joined as shown or may be divided and assembled in any desired manner to produce the partition and chamber construction described. The top and bottom of such plate may be formed comparatively thin due to the web or honey-comb arrangement of its interior so that the top surface of such plate may be readily-cooled and maintained in a cool state.

I preferably cool the plate 3 and maintain it cooled to a predetermined extent regardless of the number of bars 5 placed thereon, and regardless of the rapidity of replacement by passing a cooling fluid, preferably water, into the interior of the plate at 9 through the pipe 10 by any suitable and desired flow-control means (not shown). Each of the intersecting partition members 6 and 7 are provided with a plurality of openings 11 so placed that each chamber 8 has a plurality of such openings leading into the adjacent chambers 8. The plate 3 is also provided with an exit opening 12 connected to a discharge pipe 13. Therefore, the cooling fluid which enters through pipe 10 and inlet opening circulates through the chambers 8, via the openings 11, and passes to a suitable drain (or if desired to a cooling station and is used over again) through the outlet 12 and pipe 13. The temperature of the water which is passed through the plate may be controlled in any desired manner, and the volume of cold water per minute or other unit of time may be controlled in any desired manner to cool the plate 3 to the preferred and variable extent so as to maintain it at all times at such a temperature that it will not warp. To still further assist in cooling the plate 3 and to further strengthen it I provide the bottom 3^b with a plurality of intersecting transverse and longitudinal ribs 14 and 15 which are arranged, preferably, alternately with the partitioning members 6 and 7, respectively. This construction permits the bottom 3^b to be formed comparatively thin to aid in the cooling effect. Also the rib effect shown permits the circulating air coming in contact with the thin portion and ribs to aid in cooling; and these 14 and 15 ribs also aid in conducting heat to the lower and cooler frame portions.

The supporting plate 3 is disposed within an air-treating chamber 16 and this plate 3 forms the bottom of such chamber. This chamber 16 is formed with, preferably, sectional sheet metal side walls 16^a and 16^b and a top 16^c. The sides and top of the chambers 16 are preferably formed sectional for facilitating construction and assembly, but may be formed of one continuous sheet or piece without departing from my invention. The wall sections may be supported by U-

shaped bar members 17 as shown in Figure 2, and any desired mode of attachment may be employed. The heating chamber is thus given a rectangular or other desired shape with depth, length and width to suit the conditions of use, the size and capacity of the chamber being variable as desired.

The ends of the chamber 16 are open (Figure 3) to permit ready egress of the heated air and scale, etc., as will be referred to more particularly hereinafter.

The chamber 16 is provided with air admission means which will now be described. Each of the wall sections of the chamber is provided with an air inlet of a width substantially equal to the width of the section. The air inlets of adjacent sections are arranged at opposite sides of the chamber and, preferably, at the upper outer edges thereof (Figs. 1 and 3). This construction provides for the admission of air to the chamber 16 in such a manner as to effect complete and uniform distribution of the same throughout the chamber, the adjacent air inlets or air currents being directed at close proximity in opposed directions to accomplish direct distribution to all points regardless of how remote from the inlets. The air inlets so far described direct parallel transverse currents of air; and at the center of the top 16^c I provide two opposite air inlets which direct air currents longitudinally of the chamber 16 in opposite directions and across and in the path of parallel currents. This further aids in the distribution of the parallel currents and provides additional air directly contacting with the material under treatment. The parallel air currents also carry air directly in contact with the material under treatment as well as to all other parts of the chamber 16.

Each of the side inlets are connected to a suitable source (not shown) of cool air by means of pipes 18. All of these pipes are, preferably, connected to a common source, but, if desired, may be connected to different sources, the air in each instance being varied as to temperature and rate of flow to suit the conditions of use. A fan blower (not shown) might well be employed for this purpose. The centrally disposed inlets in the top 3^b of the chamber are also connected to an inlet pipe 18^a similar to the pipes 18 but, preferably, of slightly greater capacity.

Each of the pipes 18 are provided with a V-shaped or flaring nozzle 19 which flares to a width equal to the width of the respective inlets to which they are connected (Figures 1 to 3). These nozzles are directed downwardly and inwardly at such an angle that the air passing therethrough and through the inlet will strike the material under treatment and will also be directed normally and by the bottom of the chamber to all portions of the chamber with rapidity and uniformity. This action is aided by the flaring nature of the nozzles 19. The pipe 18^a at the center is provided with a double nozzle 20 having nozzle extensions 20^a and 20^b similar to the nozzle 19 and arranged and directed in the same manner. The side nozzles 19 direct alternate parallel currents of air while the center nozzle 20^a and 20^b direct longitudinal cross currents of air thus positively insuring uniform distribution of the air to the material under treatment and throughout the chamber 16. It is obvious that the number of air inlets may be varied without departing from my invention.

The side air inlets and the central inlet may all be connected to a common air delivery source such as a fan blower (not shown) or each of these may be connected to an independent source as desired.

In operation cooling air at the desired temperature and at the desired rate is passed into the chamber 16 through the pipes 18 and 18^a and nozzles 19, 20^a and 20^b and as the same passes through the inlets into the chamber it expands and is directed to all parts of the chamber. During this time the cooling fluid for cooling the plate 3 is being circulated through the pipe 10, cooling chamber 8 and pipe 13. With the apparatus in operation in the manner stated, the steel to be treated, for example a bar 5 for a bumper, is first heated to the desired high heat and then shaped by suitable shaping tools and then placed in the chamber 16 in the manner and as indicated in Fig. 3. The bar 5 having been thus placed in the chamber 16, the air passing through the pipes 18 and 18^a and uniformly present throughout the chamber 16, contacts uniformly with all portions of the bar and cools the same. This cooling effect is aided and, uniformity is aided, by the cooling effect of the plate 3 upon the bar 5. The cooling of the bar 5 may be hastened or retarded by varying the amount and rate of flow of the cooling air through the cooling pipes, as well as varying the cooling of the plate 3. The ends of the chamber 16 being open permits ready access thereto and permits ready escape of the heated air and scale etc. carried by such air. The arrangement of the side air inlets at each end causes the air and scale etc. to tend to pass out at the side so that the operator may have ready access without interference by the heated air and objects carried thereby. Furthermore, this arrangement as a whole is such that as the air contacts with the heated bars and becomes heated it is rapidly displaced and ejected so that the cool air is constantly contacting with the material under treatment. The alternate and opposed arrangement of the air inlets provides for positive and direct application of the cooling fluid to all exposed parts of the bars 5 throughout their length.

As soon as the bar has been cooled to the desired point, this point being such that the

heat remaining in the same will not draw its temper, it is removed and allowed to cool thoroughly. Although one bar only has been referred to as that placed in the chamber, a great number of such bars may be placed therein, simultaneously, and receive the treatment just described simultaneously. As the result of the foregoing operations, the bars receive metallurgical properties, the equivalent of those received by the oil heat treating process, all being accomplished by a single stage operation, whereas in the oil treating process a plural stage operation is necessary. When the bars are removed from the treating chamber, they are properly tempered and possess such characteristics as to readily meet the requirements of the Society of Automotive Engineers.

Another form of apparatus for carrying out my invention is shown in Figures 6 to 8. This apparatus is practically the same as that of the preferred form except as to the manner of admitting air to and distributing it in the chamber 16. In this modified form, I may arrange a plurality of pipes 21 and 21ª in the top, or other suitable part, of the chamber 16 interiorly thereof as shown. These pipes are, preferably, all connected together and are, in turn, connected to a common source of supply (not shown), preferably, an air compressing device, by a pipe 22 having branches 22ª and 22ᵇ; or they may be individually connected to such a source. Each pipe is provided with a plurality of opposed openings 23 at each side, these openings being so arranged that they direct air currents or jets downwardly at an angle toward the plate 3 and the material under treatment and uniformly throughout the chamber 16. The connected pipes 21 and 21ª which may really be one continuously bent pipe with connecting branches, are connected as stated, to a high pressure air source such as a compressor (not shown) so that cold air at high velocity is directed into the chamber 16 through the openings 23 in the manner and directions indicated by the arrows in Figures 6 and 8. This high velocity cool air quickly cools the material under treatment, or at any desired rate, all of the effects and other operations being the same as in connection with the preferred form of apparatus.

Thus it is seen that I have provided a simple but efficient method for treating steel, particularly spring steel, for tempering the same and wherein all of the disadvantages of the commonly used oil heat treating method are eliminated, all of which is accomplished by a one-stage operation wherein controlled cooling air is employed for effecting the cooling of the metal to temper the same. A minimum amount of equipment is necessary, eliminating the necessity for the use of skilled labor. Production is increased with a decrease in cost of production. When the metal has once been shaped, this shape is maintained throughout the following operations without distortion.

While I have shown but two forms of apparatus for carrying out my invention, it is to be understood that various other forms and modifications may be resorted to without departing from the spirit and scope of my invention as set forth in the claims which follow.

I claim:

1. In an apparatus for hardening and tempering steel, a treating chamber including an artificially cooled bottom, side and top walls, a plurality of air inlets at the sides, adjacent inlets being at the opposite sides and directed downwardly and inwardly, and air inlets in the top directed in opposite directions and downwardly and inwardly.

2. An apparatus for treating steel comprising a chamber having an artificially cooled bottom, air delivery means at the sides of said chamber for directing air inwardly and downwardly toward said bottom, other air delivery means at the top of said chamber and arranged to direct air downwardly and inwardly toward said bottom and across the path of the air delivered by said first-mentioned delivery means.

3. An apparatus for treating steel comprising an open-ended chamber having an artificially cooled bottom, air delivery means at the sides of said chamber for directing parallel blasts of air from the opposite sides inwardly and downwardly toward said bottom, other air delivery means at the top of said chamber arranged to direct air downwardly and inwardly toward said bottom and in opposite directions across the path of the air delivered by said side air delivery means.

4. In an apparatus for hardening and tempering spring steel in a single-stage operation, a chamber having a bottom adapted to carry the steel under treatment, means for cooling said bottom and for maintaining the same cooled to a predetermined degree, air inlets at the sides of said chamber, the adjacent inlets being arranged at opposite sides of said chamber for conducting air in opposite directions into said chamber and in contact with said bottom, air conductors connected to said inlets other air inlets in the top of said chamber for conducting air into said chamber and in contact with said bottom and across the path of the air admitted through said side inlets, and air conducting means connected to said latter inlets.

5. In an apparatus for hardening and tempering spring steel in a single-stage operation, a chamber having a bottom adapted to carry the steel under treatment, means for cooling said bottom and for maintaining the same cooled to a predetermined degree including cooling fluid conduits leading to, through and from said bottom, air inlets at

the sides of said chamber, the adjacent inlets being arranged at opposite sides of said chamber for conducting air in opposite directions into said chamber and in contact with said bottom, air conductors having flared nozzles connected to said inlets, and other air inlets in the top of said chamber for conducting air into said chamber and in contact with said bottom and across the path of the air admitted through said side inlets, air conducting means having flared nozzles connected to said latter inlets.

6. In an apparatus for treating steel to harden and temper the same comprising a chamber having a bottom adapted to receive the steel in a heated condition, means for cooling said bottom and maintaining the same cooled, means for passing lateral and parallel blasts of air into said chamber in contact with the steel under treatment, the adjacent parallel blasts being directed in opposite directions, and means for passing longitudinal blasts of air into said chamber in opposite directions and in contact with said steel across the paths of said parallel blasts.

7. In an apparatus for treating spring steel, a supporting means for receiving and carrying the steel in its heated condition, comprising a hollow plate, transverse and longitudinal intersecting partition members carried by said plate dividing its hollow interior into chambers, connecting means between adjacent chambers, means for conducting a cooling fluid into one of said chambers, and discharge means connected to another of said chambers for carrying said cooling fluid away.

8. In an apparatus for treating spring steel, a supporting means for receiving and carrying the steel in its heated condition, comprising a hollow plate, having comparatively thin and connected top and bottom walls and having the space between said top and bottom walls divided into a plurality of connected compartments, connections between each of the adjacent compartments, a cooling fluid delivery conduit connected to one of said compartments, and a discharge conduit connected to another of said compartments, the arrangement being such that said cooling fluid is continuously passed through all of said compartments to maintain said plate walls cooled to a predetermined extent.

9. In an apparatus for hardening and tempering spring steel, a support for the steel in its heated condition during treatment comprising a plate having thin and spaced top and bottom walls connected by side and end walls, intersecting partitioning members between said top and bottom walls dividing said space into a plurality of compartments, means for connecting all of said compartments with each other, delivery conduit means connected to one of said compartments, discharge conduit means connected to another of said compartments, the arrangement being such that a cooling fluid is passed through said delivery conduit, each of said compartments and through said discharge conduit in the succession named to maintain said plate cool, and transverse and longitudinal intersecting ribs formed externally on said bottom wall.

10. In an apparatus for treating spring steel, a supporting means for receiving and carrying the steel in its heated condition, comprising a hollow plate, transverse and longitudinal intersecting partition members carried by said plate dividing its hollow interior into chambers, connecting means between adjacent chambers, means for conducting a cooling fluid into one of said chambers, discharge means connected to another of said chambers for carrying said cooling fluid away, and transverse and longitudinal ribs formed on the other bottom portion of said plate.

In testimony whereof, I have subscribed my name.

HERBERT W. TINKER.