July 1, 1924. 1,499,801

F. A. BOND

CASE HARDENING PROCESS

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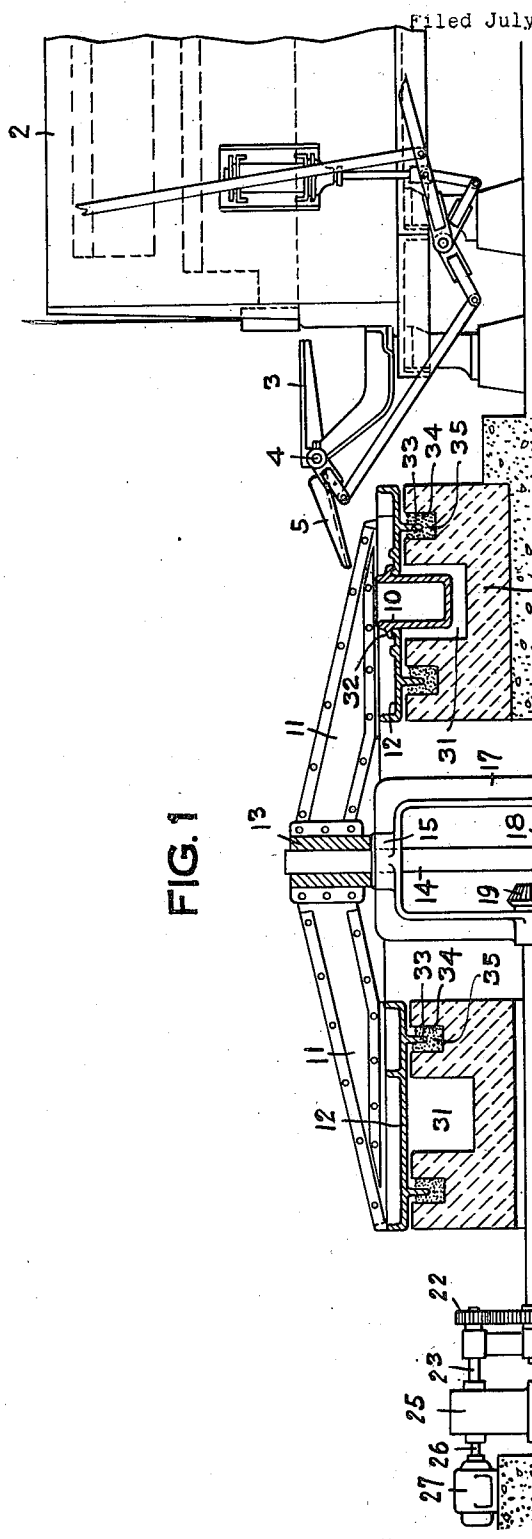


FIG. 1

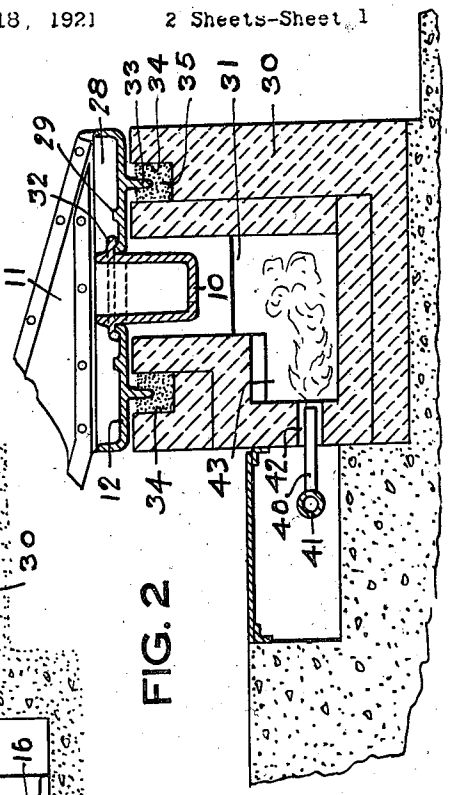


FIG. 2

INVENTOR

Frank A. Bond.

By Kay, Fuller & Brown

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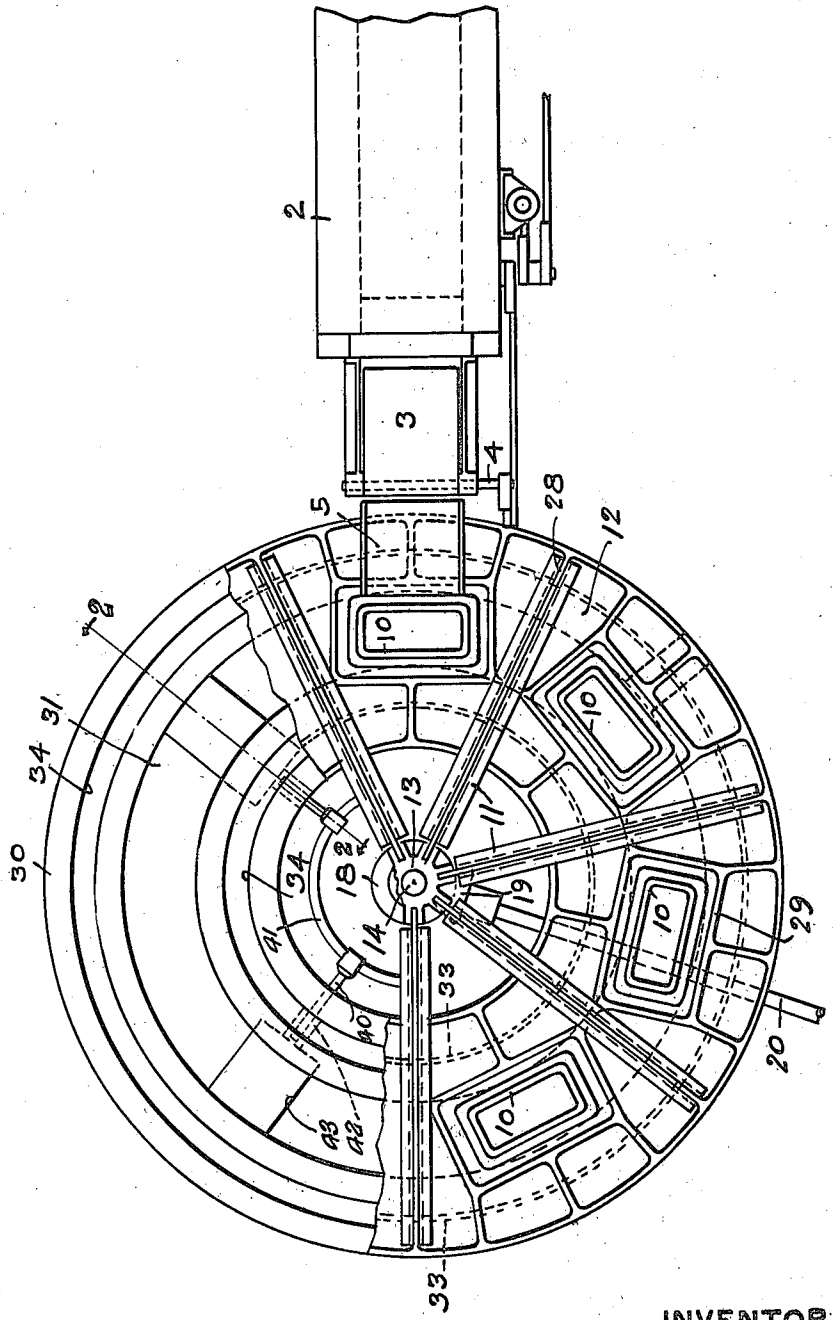
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FIG. 3



INVENTOR

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Patented July 1, 1924. 1,499,801

UNITED STATES PATENT OFFICE.

FRANK A. BOND, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO UNITED STATES CHAIN & FORGING COMPANY, A CORPORATION OF DELAWARE.

CASE-HARDENING PROCESS.

Application filed July 18, 1921. Serial No. 485,699.

To all whom it may concern:

Be it known that I, FRANK A. BOND, a citizen of the United States, and resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Case-Hardening Processes; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the hardening of metal to produce a hard and uniform surface layer of superior wear-resisting qualities, a tough, strong and unhardened core, and an intermediate layer of gradually varying hardness interposed between the hard outer layer and the soft, tough core.

A further object of my invention is to provide a process of producing case-hardened articles of the above indicated character, by which the depth to which the hardening effect penetrates may be closely controlled, and which shall produce uniformly hardened articles having uniform internal structure.

My process consists, in general, in providing a fused bath of case-hardening material containing a substantial portion of a cyanide, preparing the articles to be treated by preheating them at least to their upper point of decalescence and preferably to approximately the same temperature as the temperature of the fused bath, then introducing the preheated articles into the fused bath and keeping them there for a period of time which depends on the nature of the articles and the results to be produced. The temperature of the bath and of the preheated articles also depends upon the exact results to be produced, and may be varied within considerable limits, as will more fully appear below.

I am aware that potassium cyanide, sodium cyanide, and other cyanide materials have long been used for case-hardening. Usually the cyanide material is applied to the articles to be case-hardened by sprinkling the dry cyanide upon the articles, and then heating the articles to melt the cyanide. Other methods heretofore used involve melting the cyanide to form a fused bath, and introducing the articles to be case-hardened into the bath, but so far as I am aware it has never been proposed to prepare the articles before hardening by heating the articles to a temperature approximately that of the fused bath, nor has it ever been proposed to continue the treatment of the preheated articles in the fused bath for such a period of time as I have found to be necessary for the proper working of my process.

My present process was devised in connection with the hardening of anti-skid chains for automobiles and motor trucks. These chains must have the highest possible wear-resisting qualities, and I have found that the process described herein imparts to such chains a hardness and resistance to wear which is not possible in any other case-hardening methods heretofore used.

It will be understood that, although my process is of value as applied to the hardening of wheel chains, it is by no means limited to this use, but may be employed with equally good results for hardening a large number of other metal articles where hardness and resistance to wear are important, such as machine parts, driving chains for coal mining machines, and many other articles.

In the accompanying drawings, which show by way of example one form of apparatus suitable for carrying out my process, Fig. 1 is a vertical central sectional view through the apparatus for treating the articles with the fused bath, the preheating furnace being indicated diagrammatically; Fig. 2 is an enlarged vertical sectional view of a portion of the apparatus of Fig. 1, the section being taken substantially on the line 2—2, Fig. 3; and Fig. 3 is a somewhat diagrammatic plan view of the apparatus shown in Fig. 1.

Referring to the drawings the numeral 2 designates a preheating furnace which may be of any desired construction and which is therefore not illustrated in detail. This furnace is preferably of the type in which the articles to be heated are introduced at one end and are moved gradually through the furnace, being thereby heated to a definite final temperature. If relatively small articles are to be treated, such as cross-chains for use on vehicle wheels, they are preferably sent through the furnace in metal pans or other suitable containers.

At the discharge end of the furnace 2 is

a suitable transfer mechanism for conveying the preheated articles from the furnace to the case-hardening baths. As shown, this transfer mechanism comprises a set of arms 3 mounted upon a horizontal shaft 4 which may be rocked to allow the articles to slide into the case-hardening pots. An apron 5 or the like may be provided, as shown in Fig. 1, to guide the articles from the furnace to the treating pots 10 which are arranged circularly on a frame consisting of radial arms 11, and a circular horizontal plate 12 suspended from the arms 11. The radial arms 11 are all secured to a circular central casting 13 which is carried by a vertical central shaft 14 mounted in bearings 15 and 16 on a supporting frame 17. A bevel gear wheel 18 is secured to the vertical shaft 14 at its lower end and meshes with a bevel pinion 19 secured to one end of a horizontal counter-shaft 20 which also carries a spur gear 21 meshing with a driving pinion 22 on a shaft 23 which is connected through a set of reducing gears indicated diagrammatically at 25 to the armature shaft 26 of an electric motor 27. The power connections just described serve to rotate the vertical shaft 14, and with it the circular frame carrying the case-hardening pots 10. This rotation may be intermittent, the motor 27 being started and stopped to give the frame a partial rotation at suitable intervals, or the rotor may run continuously and rotate the frame at a slow speed, sufficient to present the treating pots 10 to the furnace 2 at the proper intervals. The same results can also be produced by means of various power connections, and it will therefore be understood that these particular arrangements of shafts and gearing are shown herein by way of example only.

The circular plate 12 is provided with radial flanges 28 for attachment to the under side of the radial arms 11, and with other flanges 29 forming rectangular seats for the pots 10. The plate 12 is suspended directly above a circular furnace 30, composed of brickwork or the like, and having an annular heating channel 31 into which the pots 10 extend. The pots 10 are supported from the circular plate 12 by means of flanges 32. Annular flanges 33 are formed on the underside of the circular plate 12 and extend into annular grooves 34 formed in the top of the furnace 30, the grooves 34 being filled with granular heat-insulating material 35. The plate 12 forms a cover for the furnace 30, and the flanges 33, being embedded in the granular material 35, substantially prevent the escape of heat around the upper edges of the furnace.

The furnace 30 is heated by means of any convenient number of burners which may be arranged, for example, as shown in Fig. 2, each burner consisting of a pipe 40 for admitting gas or fuel oil supplied from the pipe 41. The pipe 40 extends into an air inlet opening 42 of larger diameter than the pipe 40, and the combustion mixture passes into the channel 31 through an opening 43.

In operation, a quantity of fused cyanide-containing material, sufficient to cover the articles to be treated, is placed in each of the pots 10. The temperature of the fused bath is maintained constant by suitable regulation of the burners 40, and this temperature may vary from 1200° F. to 1750° or 1800° F. The composition of the bath may be varied considerably, so long as it contains a substantial proportion of cyanide material. One composition which I have found suitable for this purpose has the following percentage composition:

Sodium cyanide	35.09
Sodium carbonate	36.25
Sodium chloride	21.90
Calcium carbonate	.14
Combined water (water of crystallization)	6.68

The articles to be treated, having been preheated in the furnace 2 to approximately the temperature of the fused bath in the pots 10, are deposited by means of the transfer arms 4 in the pot 10 which, at the moment, is opposite to the transfer device. The circular framework carrying the pots 10 then moves to bring the next pot into position to receive a charge of preheated articles. The loading of the articles may take plate at intervals of about five minutes, and the treated articles are removed from the pots 10 when they come into the position next to the charging position, in which case each article remains in the cyanide bath for about a half hour, assuming the seven of the pots 10 are employed as shown in the drawing. A longer treatment in the cyanide bath is sometimes desirable, and this may be secured by moving the frame which carries the treating pots at intervals of ten minutes, for example, instead of at intervals of five minutes, or by providing a larger apparatus with a correspondingly larger number of treating pots. When the apparatus having seven boxes is moved at ten-minute intervals the furnace 2 may still operate to deliver articles at five minute intervals, two charges being placed in each of the pots 10.

After being removed from the cyanide bath the articles are quenched in oil or water, according to the usual case-hardening practice.

The preliminary heat treatment is employed for the purpose of completely removing any external strains that may have been set up in the articles during their manufacture, and thus rendering the metal capable of uniformly receiving the hardening material. This preheating should be sufficient

to bring the metal at least up to its upper critical point of decalescence, where internal strains disappear.

In the manufacture of vehicle wheel chains according to my process the metal of which the chains are composed is preferably a dead soft steel containing about .08 per cent of carbon, that is to say, a steel which is so low in carbon as to be nearly an iron. By treating this material at a temperature of approximately 1650° F. according to the process described above, and leaving the chains in the fused bath for about 1 hour and 5 minutes, the chains are found to have a clear and uniform penetration of carbon to about $\frac{1}{32}$ of an inch, the carbon content then varying toward the center of the metal and being reduced to the original carbon content of the steel before reaching the center. The depth of penetration of the carbon varies according to the time of treatment in the fused bath. This time should not be less than 30 or 45 minutes when treating cross-chains for vehicle wheels.

In the articles treated in this manner the structure of the metal at the center is not changed in any way, and the distribution of the carbon in the outer layers is remarkably uniform. In the ordinary pack-hardening systems the carbon enters the metal irregularly and may penetrate to the center of the article at one side, while stopping far short of the center on another side. Also, the ordinary case-hardening processes tend to weaken the central core of the article, thus reducing its ultimate strength below the strength of the original metal. The articles produced according to my process, on the contrary, are entirely uniform both as to the depth of penetration of the carbon and as to the nature of the hard layer produced on the surface, and are wholly unchanged as to the composition and strength of the central core. Also, the several articles of a given kind, such as chain links, are uniform with each other as to the depth of penetration of carbon and the nature of the surface layer. I attribute these results to the preliminary heating of the metal which gives it a uniform structure reassembling the structure of annealed metal, and to the time of treatment which enables the carbon to penetrate evenly. For the best results, the temperature to which the metal is heated, and the temperature of the fused bath, should be as high as practicable, but not above the point where the metal is harmed by excessive heat treatment. I have found that this upper limit of temperature is in the neighborhood of 1800° F.

The preheated articles are slightly cooled while being transferred from the furnace to the treating pots, and therefore they are preferably brought to a temperature correspondingly above the temperature of the fused bath, so that they enter the bath at approximately the same temperature as the fused material.

The details of structure, materials and manipulation described above are not to be understood as limiting my invention, which may be applied in various ways, within the scope of the appended claims.

I claim as my invention:

1. The process of hardening iron and steel that comprises preheating the metal to be hardened to at least its upper critical point and then immersing the preheated metal in a fused bath containing a cyanide.

2. The process of hardening iron and steel that comprises preheating the metal to be hardened to at least its upper critical point and then immersing the preheated metal in a fused bath containing a cyanide, the temperature of the metal being at least as high as the temperature of the fused bath.

3. The process of hardening iron and steel that comprises preheating the metal to be hardened to at least its upper critical point and immediately immersing the heated metal in a fused cyanide-containing bath of approximately the same temperature as the metal.

4. The process of hardening iron and steel that comprises preparing a fused bath containing a cyanide, heating the metal to be hardened to at least the same temperature as the bath, immersing the said metal in the said bath for a period of at least thirty minutes, and quenching the said metal.

5. The process of hardening iron and steel that comprises preparing a fused bath containing a cyanide and, in addition, at least one alkali-metal salt, heating the metal to be hardened to at least the same temperature as the bath, immersing the said metal in the said bath for a period of at least thirty minutes, and quenching the said metal.

6. The process of hardening iron and steel that comprises preparing a fused bath containing a cyanide, sodium chloride and sodium carbonate, heating the metal to be hardened to at least the same temperature as the bath, immersing the said metal in the said bath for a period of at least thirty minutes, and quenching the said metal.

7. The process of hardening iron and steel that comprises preparing a fused bath containing a cyanide, heating the said bath to a temperature between 1200° F. and 1800° F., heating the metal to be hardened to at least the same temperature as the said bath, immersing the said metal in the said bath for a period of at least thirty minutes, and quenching the said metal.

8. The process of hardening iron and steel that comprises preparing a fused bath containing a cyanide, heating the said bath

to at least 1650° F., heating the metal to be hardened to at least the same temperature as the bath, immersing the said metal in the said bath for a period of at least thirty minutes, and quenching the said metal.

9. The process of hardening iron and steel that comprises preparing a fused bath containing a cyanide, sodium chloride and sodium carbonate, heating the said bath to at least 1650° F., heating the metal to be hardened to at least the same temperature as the bath, immersing the said metal in the said bath for a period of at least thirty minutes, and then quenching the said metal in a cooling bath.

In testimony whereof, I the said FRANK A. BOND have hereunto set my hand.

FRANK A. BOND.

Witnesses:
R. W. BROWN,
JOHN F. WILL.