

UNITED STATES PATENT OFFICE.

FREDERICK K. VIAL, OF CHICAGO, ILLINOIS, ASSIGNOR TO GRIFFIN WHEEL COMPANY,
OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

METHOD OF MAKING LOCALLY-HARDENED CASTINGS.

1,004,115.

Specification of Letters Patent. Patented Sept. 26, 1911.

No Drawing.

Application filed December 8, 1910. Serial No. 596,177.

To all whom it may concern:

Be it known that I, FREDERICK K. VIAL, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Methods of Making Locally-Hardened Castings, of which the following is a specification.

The principal object of my invention is to provide a method for regulating the hardness of articles made of cast iron.

Another object of my invention is to provide a method for making locally hardened castings.

Another object of my invention is to provide a new and improved method of making car wheels by which any suitable or desired depth or degree of hardening may be obtained in the tread surfaces thereof.

Still another object of my invention is to provide a method of casting car wheels by which the degree or depth of chill at the tread surfaces may be regulated as may seem desirable and suitable.

All these objects and various others will be made apparent in the following specification and claims.

As is well known, carbon exists in iron in at least two forms: First, locally combined with the iron in the form of a white intensely hard substance having the composition Fe_3C , the chemical name of which is "iron carbid" or "cementite." Second, as pure graphite mixed through the iron, but not combined chemically therewith.

When the carbon is all combined, the iron is commonly spoken of as white iron or steel, but when the carbon is largely in the form of graphite the iron is called gray iron. The addition of carbon greatly hardens the iron, whereas pure iron is soft, ductile, and of comparatively low tensile strength. High carbon white iron, that is, iron having a considerable proportion of iron carbid, is extremely hard, while low carbon iron or steel is comparatively soft. The preparation of steel to be forged consists in properly treating it so as to remove the carbon by oxidation thereof.

In the case of certain articles of cast iron,

for example, car wheels, it is very desirable to have the surface or a particular portion thereof of very hard material, that is, in the case of car wheels it is exceedingly important to have the tread surface and flange of hard material to resist the intense abrasion of the brake shoes and the friction of the wheel on the rails. Such suitably hardened wheels can be made by using iron with a high proportion of carbon, but if the wheels were of the same composition and texture throughout, this would be very unsatisfactory because they would be brittle and entirely unsuited to withstand the severe shocks and strains to which they must necessarily be subjected.

It is well known in practice that car wheels may be made with a greater or less degree of local hardening at the tread surface by using iron containing three per cent. or four per cent. of carbon and employing a metal chiller to form the part of the mold adjacent to the tread surface of the wheel. Such a metal chiller rapidly abstracts the heat from the molten iron and this rapid cooling of the tread portion of the wheel has the effect that the solid form is taken with practically all of the carbon in the form of iron carbid or some modification thereof. The remainder of the wheel, that is, the portion thereof not close to the chiller, solidifies much more slowly and the effect of such slow solidification is that the carbon is present in the wheel as pure graphite finely mixed mechanically throughout the body of the wheel. Thus it results that the tread portion of the wheel is extremely hard, whereas the body portion of the wheel is not hard but is tough and adapted to resist breakage by shocks. In other words, the iron or steel adjacent to the tread surface of the wheel has three or four per cent. of chemically combined carbon, whereas the body of the wheel, all that portion not adjacent to the tread surface, has less than one per cent. of combined carbon, the excess carbon being distributed as graphite.

The extent to which the carbon in the molten iron will change into graphite in casting is regulated or determined to a cer-

tain degree by the different rates of cooling. Obviously, a small or light casting will cool much more readily and quickly than a large or heavy one. As is well known, commercial cast iron is far from being chemically pure and the presence of various other elements in addition to carbon, such as silicon and titanium, have a powerful influence to cause the change from combined carbon to graphite in cooling.

In some cases car wheels are ordered with the specification that a certain percentage of titanium shall be used in the casting composition. As high as one per cent. has been specified. The supposed effect of the titanium is to absorb or otherwise eliminate certain objectionable gases and perhaps other objectionable ingredients. Not all of the titanium is present in the finished casting. A considerable proportion of it apparently goes into the surface slag carrying the objectionable gases or other matter with it. This cleansing effect is considered desirable, but the titanium has a marked effect on the carbon and causes a large proportion of carbon to appear in the finished casting as graphite, that is, it causes the casting to be soft. Hence the use of as much titanium as may be desirable for cleansing purposes becomes impossible on account of this softening tendency on the finished casting. In other words, if enough titanium was put in to get all the cleansing effect desired then it would cause the carbon in the finished casting to appear almost wholly as graphite and would make the casting undesirably soft.

In view of the different rate of cooling for light castings and heavy castings it has been found necessary in the past to use different iron mixtures, so as to have in each case a mixture exactly suited for the particular casting. In casting light car wheels there must be a strong tendency for the combined carbon to turn into graphite, or the whole wheel will be so rapidly cooled that there will be no time for changing the combined carbon to graphite and the entire casting will be white, brittle and worthless. On the other hand, heavy castings require a considerable tendency for the carbon to remain in the combined form, for otherwise the carbon will all come to exist in the completed casting as graphite, on account of the greater slowness of cooling, and the wheel will be worthless because all parts, including its tread surface and flange will be soft. Hence one of the difficulties of casting car wheels of various sizes has been that different compositions were required to be made up in the cupola for different weights of wheels. Accordingly, it has been necessary to have a number of cupolas or different mixtures in the same cupola and draw different compositions for different sizes of wheels. Still another disadvantage of the prior art has been

that for the heaviest car wheels it has not been practicable with any ordinary composition of the iron to cast the wheel so that its tread surface would be of extreme hardness to a considerable depth, and yet the balance of the wheel would be tough and free from brittleness. This was because no chiller adjacent to the tread could abstract the heat sufficiently from the rim of the wheel, with the large body of molten metal lying in the tread and adjacent thereto.

In the art of casting iron it has been known prior to my invention that a composition of iron could readily be made which in cooling would rapidly change the combined carbon to graphite; this kind of a composition was obtained by adding a small quantity of silicon and such an addition of silicon is often called "softening the mixture." It has also been known that when there was too strong a tendency for the combined carbon to change to graphite in cooling, that is, when the mixture was too soft, a correction in some degree could be attained by adding a considerable amount of steel to the composition and this has been practically the only known method of correcting a composition which in cooling gives too large a proportion of graphitic carbon, that is, gives too soft a resultant product. But the action of steel in arresting a change of carbon from the combined form to the graphitic form in cooling is comparatively feeble and the addition of a large amount of cold metal to the molten metal is injurious and unsatisfactory.

My method, which forms the subject matter of this application for a patent, depends on the property which I have found attaches to the metal chromium of influencing the liberation of carbon. I have found that when a very small quantity of chromium is added to iron in the molten state containing three or four per cent. of carbon, then if the iron is cooled comparatively rapidly the presence of the chromium retards the liberation of the carbon. In other words, the chromium being present, the iron will solidify with a greater proportion of iron carbide for the same rate of cooling than if the chromium were not present. Stated still otherwise, the presence of a small quantity of chromium, with the condition of comparatively rapid cooling, results in the presence of a greater proportion of the carbon existing in the resulting solid in the combined state as carbide instead of the free state as graphite.

I have already in this specification mentioned the use of steel for counteracting a too great tendency to softness in a composition of cast iron. I have found that ferrochrome or some other composition of chromium has an effect somewhat similar to steel in neutralizing the effect of silicon, but is

much more positive in its action. If the silicon is present in the casting composition in such a proportion as to have the effect of changing the carbon from the combined
5 form to graphite in cooling, and thereby making the casting too soft, this tendency can be corrected by adding a small quantity of ferro-chrome or other chromium compound. Before pouring the composition
10 to make a desired casting, a small testing piece can be poured, rapidly cooled, and broken to show the character of the metal. If too soft, more chromium can be added. If too hard, silicon can be added, and thus
15 the exact desired adjustment may be attained.

It is very desirable to use titanium in wheel mixtures or other compositions of cast iron, on account of its action in cleansing
20 the iron from gases and other objectionable material. But titanium has a powerful influence similar to that of silicon in changing combined carbon to graphite and thus making a softer resulting casting than may be
25 desired. However, a little chromium may be added to the composition and it will counteract this objectionable effect of the titanium and thus allow the use of titanium in any desired proportion. In other words,
30 by adding chromium with the titanium the cleansing effect of the titanium is not counteracted, but the softening effect is counteracted and thus the use of chromium makes it possible to use as much titanium
35 as may be desirable. This makes it possible to use titanium in sufficient proportion to be decidedly effective and useful in the manufacture of car wheels. On the other hand it may be desirable, in
40 order to get an intense surface chill in the finished casting to employ a certain considerable proportion of the chromium in the casting, but this proportion of chromium may be so large that it will not only give the
45 desired surface chill, but will give an undesirable degree of chill throughout the body of the casting. In other words, if we use enough chromium to get the desired surface effect we get too much of this effect in the in-
50 terior of the casting. This can be corrected by using a little titanium. The addition of a little titanium does not detract from the effect of the chromium in giving the desired intense surface chill, but it does prevent the
55 chill in the interior of the casting which would otherwise be so objectionable. By my method, an ordinary or normal composition of molten iron may be used for casting all weights of car wheels whether ex-
60 tremely light or extremely heavy or having an intermediate weight, and according to this method any suitable desired depth of chill may be obtained in the treads of the wheels even for the largest sizes.

65 One specific application of the principles

heretofore stated is as follows: For casting a miscellaneous lot of wheels of various sizes I have a mixture suited for an average weight; then when I am about to cast a very heavy car wheel, weighing, say, one thousand
70 pounds, I take this ordinary composition of iron with, say, between three and four per cent. of carbon in the ladle, and just before putting it into the mold, I add a small quantity of chromium, say, one fifth of one per
75 cent. and then pour the composition into the mold, the mold having a chiller adjacent to the tread of the wheel. If the chromium were not added the chiller would not be able to abstract the heat from the large body of
80 metal rapidly enough to produce as great a degree or depth of chill in the tread as might be desired. But the addition of the chromium retards the liberation of the carbon in the chilled portion and by adding the right
85 proportion I can get such a degree of hardening or chill as may seem desirable. The body of the wheel, that is the part not adjacent to the chiller, will cool more slowly and the chromium will not only prevent the
90 liberation of carbon in the case of such slow cooling, but in addition it will make the body of the wheel tougher, due to the well known property of chromium which occasions its use in the toughest and strongest
95 tool steel. Before pouring a mixture drawn from the cupola I may pour a small test piece, cool it rapidly, and break to see whether it gives the desired depth of chill. This test enables me to determine how much
100 chromium, if any, should be added to the mixture. For a medium weight wheel I may add only a little chromium at the time of pouring the metal and for a light weight wheel I may add none at all. Of course it
105 will be understood that the exact proportion of chromium to be added is a matter like many others in the art of iron and steel working which depends upon observation and the exercise of individual judgment. The chromium may be added in any suitable
110 form such, for example, as ferro-chrome.

It will be appreciated that by my improved method as exemplified in casting car wheels the following advantages are secured: 115

(1) The preparation of the original composition for the cupola does not have to be made with as great care or exactness as formerly, because by my method a means is provided for regulating or modifying the
120 character of the composition so as to adapt it for the casting to be made therefrom. (2) Only one composition of iron is necessary for casting car wheels of various weights and sizes, and hence only one cupola need be employed and operations are decidedly simplified by having one composition to draw from instead of a plurality of different compositions. (3) In the case of all wheels the
125 depth of hardening can be regulated to a

nicety so that as much of the tread surface as desired may be made extremely hard, but the rest of the wheel can be made at the same time of extreme toughness so as to
 5 withstand shocks. (4) By virtue of the principles already explained I am enabled to use any quantity of titanium that may be desired in order to obtain the cleansing or
 10 other beneficial effect thereof and I can add chromium in sufficient proportion to counteract the softening tendency of the titanium without counteracting its cleansing effect.
 On the other hand, I may, when I desire to use a large proportion of chromium to get a
 15 desired degree of surface chill, add a little titanium in order to counteract the tendency for this chill to extend into the body of the cast article away from the surface.

Having described my invention and a specific sequence of operations thereunder, and having pointed out certain advantages thereof I now proceed to define the same in the following claims, the terms employed in these claims of course not being necessarily
 25 restricted in their significance, but intended to cover a reasonable range of equivalents.

I claim:

1. In the art of making an iron casting from a composition of iron and carbon in the molten state, the method of counteracting the tendency to softness in the casting due to silicon or titanium in the composition, which consists in adding a suitable quantity of chromium to the composition before pouring
 30 the same.

2. In the art of making an iron casting from a composition of iron and carbon in the molten state, the method of counteracting the tendency to softness in the casting made from the composition, which consists in adding a suitable quantity of chromium to the composition before pouring the same.
 40

3. The method of regulating the proportion in which the carbon of a casting poured from a composition of iron and carbon shall take the combined or graphitic form, which consists in adding silicon to cause the carbon to take the graphitic form or adding chromium to cause the carbon to take the combined form.
 50

4. The method of regulating the degree of surface chill of a casting made from a composition of iron and carbon and other ingredients such as silicon and titanium in the molten state, which consists in adding chromium in suitable proportion to the ingredients of the composition and then pouring the composition in a mold having a metal chiller.
 55

5. The method of adapting a composition of iron and carbon in the molten state so as to render it suitable for any desired size of casting to be made therefrom which consists in adding a definite quantity of chromium
 60 to the composition before pouring the same,

the proportion of chromium being greater the greater the size of the casting.

6. The method of making a car wheel which consists in preparing a composition of iron and carbon in the molten state, adding a suitable quantity of chromium thereto, and pouring the composition in a car wheel mold with a chiller adjacent to the car wheel tread, whereby there will be produced a car wheel having a suitable depth of chill in its tread.
 70
 75

7. The method of making car wheels of various sizes from the same ordinary composition of iron and carbon which consists in adding to said composition while in the ladle, a suitable quantity of chromium, then pouring the composition in a mold with a chiller adjacent to the car wheel tread, and thereby producing a car wheel having a suitable depth of chill in its tread.
 80
 85

8. The method of making a car wheel which consists in preparing a composition of iron and carbon in the molten state, adding a suitable quantity of chromium thereto, then pouring the composition in a car wheel mold with a chiller adjacent to the car wheel tread, and by means of the chromium retarding the change of combined carbon to graphite in the portion of the wheel adjacent to the chiller so as to produce a wheel having an intensely hard tread portion and a very tough body portion.
 90
 95

9. The method of making a car wheel having a very tough body portion and a hard tread portion which consists in adding chromium to the composition of iron and carbon of which the car wheel is to be made, and then pouring the composition into a car wheel mold which has a chiller adjacent to the tread of the car wheel.
 100
 105

10. The method of making a car wheel which consists in preparing a composition of iron and carbon in the molten state, adding a suitable quantity of chromium thereto, pouring the composition in a car wheel mold with a chiller adjacent to the car wheel tread, and thereby retarding the liberation of carbon in uncombined form in that part of the wheel adjacent to the chiller and permitting such liberation of carbon in the body of the wheel.
 110
 115

11. The method of making a car wheel which consists in preparing a composition of iron and carbon in the molten state, adding a suitable quantity of chromium thereto, pouring the composition in a car wheel mold with a chiller adjacent to the car wheel tread, and thereby retaining the carbon in the form of iron carbide in the tread portion of the wheel while permitting the liberation of the carbon as free graphite in the body portion of the wheel.
 120
 125

12. The method of making a car wheel which consists in preparing a composition of iron and carbon in the molten state, pouring
 130

a small test piece and cooling it quickly, then breaking it to observe the depth of chill, adding a suitable quantity of chromium to the composition in order to increase
5 the depth of chill to the desired extent, and pouring the composition in a car wheel mold with a chiller adjacent to the car wheel tread, whereby there will be produced a car

wheel having a suitable depth of chill in its tread.

In testimony whereof, I have subscribed
10 my name.

FREDERICK K. VIAL.

Witnesses:

H. J. MELLUM,

G. J. WEBER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents,
Washington, D. C."
