

UNITED STATES PATENT OFFICE.

TOYOKICHIRO TASHIRO, OF TOKYO, JAPAN.

PROCESS OF CARBURIZING STEEL AND IRON.

No Drawing.

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To all whom it may concern:

Be it known that I, TOYOKICHIRO TASHIRO, subject of the Emperor of Japan, residing at No. 450 Shirokane Sanko-Cho, Shiba Ku, Tokyo, Japan, have invented new and useful Improvements in a Process of Carburizing Steel and Iron (for which I have filed application in Japan August 13, 1918, application No. 40,345), of which the following is a specification.

This invention relates to improvements in the process of carburizing wrought iron, steel or steel alloy, or articles made thereof, and consists in causing carbon monoxide to form in a carburizing chamber which can be tightly closed and making it to act in its nascent state and under pressure on the material to be carburized. The object of this invention is to cause carbon by a simple means to impregnate deep and in a short time, utilizing reaction heat and pressure.

There are known several carburizing processes, but these may be classed into two.

In the first class, which is characterized by the use of solid carbon giving materials, material rich in carbon, such as charcoal or the like, or a cyanide, or charcoal mixed with an oxidizing agent, is used, and carbon monoxide is produced. However, in all these processes, although means are taken to prevent the combustion gases entering the carburizing chamber, no attempt has been made to intercept, at least with intention, gases generated in the carburizing chamber and retain them there, thus increasing pressure therein, such gases being rather made to escape rapidly therefrom.

In the second class, carbon containing gas such as a hydrocarbon, cyanogen, carbon monoxide or the like is forced into the carburizing chamber, and the iron or steel material is made to take carbon therefrom. Sometimes, charcoal or the like is put in the carburizing chamber and carburizing gas mentioned above is forced thereinto, but no oxidizing action takes place between the gas and the charcoal.

Again in processes of the first class, carbon monoxide is formed in the carburizing chamber, but it has not much tendency to penetrate into the material under treatment, and after remaining in contact therewith for a short time, it escapes therefrom. Thus

the waste of that gas is very great and the effect is very small. Moreover, in the carburizing chamber oxidizing action briskly takes place and consequently reaction heat is produced; but as the escaping gas carries out that heat, as much heat is lost as is produced, and the temperature of the chamber is never raised by such reaction heat. Thus, a large quantity of expensive carburizing agent is spent but the effect is very slight. According to experiments thus far known, iron was subjected for eight hours to a temperature of 2000° F., using as carbon giving material charcoal mixed with 40% of barium carbonate, and the result was that the material was carburized to a depth of 0.177 inches; and the result obtained by the same process using only charcoal powder without mixing barium carbonate therewith was impregnation of carbon to a depth of 0.138 inches. Notwithstanding the use of a large amount of barium carbonate, the result was that the iron was carburized 1.28 times deeper than when only carbon without any oxidizing agent is used. No wonder, therefore, that in large factories where armour plates are manufactured, there are still many which use only carbon powder for carburizing purpose.

In the second class process, a compound gas containing carbon is used for giving carbon to the iron. Or sometimes solid carbon is also kept in the carburizing chamber, but this is useful only for deoxidizing purpose, and no oxidizing action takes place between the same and the carbon giving gas, nor any useful gas is generated. Consequently, presence or non-presence of solid carbon has no direct effect on carburizing. Moreover, notwithstanding that it is a very difficult task to maintain a pressure of from two to four atmospheres in a high temperature of not less than 900° C., according to this process wrought iron 22 mm. thick must be subjected to such a heat under such a pressure for forty hours.

My invention is an improvement in the above described processes, and consists in filling a carburizing chamber, so constructed as to be tightly closed, with iron material and carbonaceous substances, and in causing carbon monoxide to form in the carburizing chamber, and to act in its nascent

state upon the iron material under a pressure higher than one atmosphere, by closing the carburizing chamber tightly and utilizing the reaction heat generated. The following are a few examples of carrying my invention into practice:—

The iron I use is Japanese knife iron, which is a kind of charcoal iron, refined into a kind with which Japanese swords are made. The constituents of knife iron are

Carbon, from 0.070 to 0.100.

Silicon, from 0.030 to 0.089.

Phosphorus, from 0.005 to 0.014.

Sulphur, from 0.009 to 0.040.

Manganese, trace.

Example 1.—Take iron pieces 1.2 inch thick of the kind mentioned above, and using as carbon giving material and oxidizing agent charcoal powder mixed with 25% of mixture of equal parts of iron oxide and manganese peroxide, subject the whole to heat at between 800° and 950° C. for two hours and a half, maintaining the pressure within the carburizing chamber higher than the atmospheric pressure by 0.153 pound per one square inch.

The result will be the carburization of the iron pieces to a depth of 0.5 inches or 13 mm. Even the central part will be found partially converted into steel, points having steel lustre being found interspersed there.

Example 2.—Take iron pieces one inch thick, and subject it to the treatment described in Example 1. Then embed the iron pieces thus treated in a mixture of equal parts of mixture of carbon giving material and oxidizing agent, once used in the first treatment, and of charcoal powder mingled with 20% of iron oxide, and subject the whole to heat at between 800° and 950° C. for another two hours and a half, maintaining the pressure within the carburizing chamber higher than the atmospheric pressure by 0.285 pound per square inch, thus the pieces being submitted in the two treatments to efficient heat for five hours.

As the result, the iron pieces will be found wholly converted into a high carbon steel, granulation in the interior part being very fine and compact.

Example 3.—Take iron pieces 1.2 inches, or 32 mm., thick of the kind above mentioned, and subject them first to the second treatment described in Example 2. Then, repeat the same treatment but subjecting the iron pieces to a heat above 950° C. and for a longer time, that is for three hours. Thus the time during which the iron pieces are subjected to efficient heat, is five hours and a half.

Then the iron pieces will be converted into a high carbon steel, small blisters being formed on the surface and a small part of the surface beginning to melt.

In this invention any low grade oxide, or ore, which frees oxygen at a high temperature and does not contain any injurious ingredient such as sulphur, phosphorus, or the like, may be used as oxidizing agent instead of iron oxide and manganese peroxide. Or, oxidizing agents such as air, oxygen or the like may be introduced from outside. Moreover, carburization may be accelerated by increasing the pressure and temperature, but in this case, a great care must be taken, as the material under treatment will be converted into high carbon steel, and begin to melt, and the treatment will go beyond the limit of carburization.

To give a few examples, iron pieces 1.2 inches thick, 1.4 inches broad and 1.6 inches long of the kind of knife steel above mentioned, together with a mixture of charcoal powder with 20% of manganese peroxide, were subjected to a heat not higher than 1200° C. for three hours at a pressure higher than the atmospheric pressure by 0.3 pound per square inch; and the pieces were found wholly converted into a high carbon steel and in a half melting condition, a part actually flowing and the pieces being found somewhat changed in its shape. Again, rods one inch square of the same kind of iron were subjected together with charcoal powder mixed with 10% of manganese peroxide to the same heat as in the above example for two hours and a half at a pressure higher than the atmospheric pressure by 1 pound per square inch and the iron rods melted and were converted to grey pig iron. Iron pieces 1.5 inches thick, 2 inches wide and 2.5 inches long, being heated in a high temperature furnace together with a mixture of 20 parts of manganese peroxide, and 80 parts of charcoal for one hour forty minutes at a pressure higher than the atmospheric pressure by 0.333 pound per square inch, were wholly converted into steel, and a small part melted and was converted into pig iron, grade from white to grey; and the part converted into pig iron could be perfectly broken off by hammering such treatment continued for only one hour did not cause the material under treatment to melt, and when repeated three times intermittently, the surface of the material was found intact. As to small rods of half an inch square, they were perfectly converted into steel after such treatment of one hour. In all the above experiments, cast iron pieces placed in contact with walls of the carburizing chamber for the purpose of adjusting pressure were never melted although they were used several times. This shows that notwithstanding the furnace temperature did not rise to 1220° C., the temperature at which grey cast iron melts, the temperature in the interior must have been raised by reaction to more than

1420° C., the temperature at which high carbon steel melts.

According to my invention, charcoal iron can be carburized in two hours and a half to a depth from 10 to 13 millimeters, and a piece 26 millimeters thick of the same iron can be wholly converted into steel in five hours, giving to the material the mild carburizing treatment. Using the mild and medium carburizing treatments consecutively on a piece of charcoal iron 26 millimeters thick, it can be wholly converted into high-carbon steel in five hours and a half, and if the high carburizing treatment be given to the same piece, the same result can be obtained in one-half or one-third of that time. Thus the time required to carburize iron using only charcoal powder as hitherto practiced, can be reduced to one hundredth or one-two hundredth, and the same result as obtained by the process explained above under class 2, can be secured in one tenth or one twentieth of the time required in that process.

The characteristics of the products obtained by my invention are, (1) material is carburized uniformly, carbon impregnating with comparatively greater uniformity even into the deepest part; (2) from the nature of the invention, the effective gas within the carburizing chamber acts upon the material to be carburized with equal tension all over its surfaces, and consequently the product is most suited as material for manufacturing crucible steel; and (3) as material can be carburized without producing any blister on the surface, my process is best suited for carburizing iron ware.

I claim:—

1. The process of carburizing iron, steel and the like, which consists in embedding the material to be carburized in a bed of a mixture of carboniferous substance and metallic peroxide in a carburizing chamber that can be tightly closed, and causing carbon monoxide to act in its nascent state under a pressure higher than the atmospheric pressure by heating, utilizing the reaction heat produced when the said carbon monoxide is formed.

2. The process of carburizing iron, steel and the like, which consists in placing the material in a carburizing chamber, mixing a carbon giving material with iron oxide and manganese peroxide, subjecting the wholes to a heat at a temperature between the approximate limits of 800° and 950° C. and maintaining the pressure within the carburizing chamber higher than the atmospheric pressure.

3. The process of carburizing iron, steel and the like, which consists in placing the material in a carburizing chamber, mixing a carbon giving material, iron oxide and manganese peroxide in proportions of ap-

proximately 75 per cent, 12½ per cent and 12½ per cent respectively, subjecting the whole to heat at a temperature between the approximate limits of 800° C. and 950° C. for a period of about 2½ hours, and maintaining the pressure within the carburizing chamber higher than the atmospheric pressure by approximately 0.153 pound per square inch.

4. The process of carburizing iron, steel and the like, which consists in placing the material in a carburizing chamber, mixing charcoal powder with iron oxide and manganese peroxide, subjecting the whole to heat at a temperature between the approximate limits of 800° and 950° C. and maintaining the pressure within the carburizing chamber higher than the atmospheric pressure.

5. The process of carburizing iron, steel and the like, which consists in placing the material in a carburizing chamber, mixing charcoal powder, iron oxide and manganese peroxide in proportions of approximately 75 per cent, 12½ per cent and 12½ per cent respectively, subjecting the whole to heat at a temperature between the approximate limits of 800° and 950° C. for a period of about 2½ hours, and maintaining the pressure within the carburizing chamber higher than the atmospheric pressure by approximately 0.153 pound per square inch.

6. The process of carburizing iron, steel and the like, which consists in placing the material in a carburizing chamber, mixing a carbon giving material, iron oxide and manganese peroxide in proportions of approximately 75 per cent, 12½ per cent and 12½ per cent respectively, subjecting the whole to heat at a temperature between the approximate limits of 800° and 950° C. for a period of about 2½ hours, and maintaining the pressure within the carburizing chamber higher than the atmospheric pressure by approximately 0.153 pound per square inch, then embedding the material in a mixture of equal parts of carbon giving material and oxidizing agent mixed with about 20 per cent of iron oxide, subjecting the whole to heat at a temperature between the approximate limits of 800° and 950° C. for a further period of approximately 2½ hours, and maintaining the pressure within the carburizing chamber higher than the atmospheric pressure by approximately 0.285 pounds per square inch.

7. The process of carburizing iron, steel and the like, which consists in placing the material in a carburizing chamber, embedding the material in a mixture of equal parts of carbon giving material and oxidizing agent mixed with about 20 per cent of iron oxide, then subjecting the whole to heat at a temperature between the approximate limits of 800° and 950° C. for a period of approximately 2½ hours, maintaining the

pressure within the carburizing chamber higher than the atmospheric pressure by approximately 0.285 pound per square inch, then embedding the material in a mixture of equal parts of carbon giving material and oxidizing agent mixed with about 20 per cent of iron oxide, again subjecting the

whole to heat at a temperature in excess of 950° C. for a further period of approximately 3 hours and maintaining the same pressure within the carburizing chamber.

In testimony whereof I have signed my name to this specification.

TOYOKICHIRO TASHIRO.