Patented Dec. 14, 1937 2,102,539

UNITED STATES PATENT OFFICE

2,102,539

PROCESS OF TREATING METAL

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No Drawing. Application March 7, 1936, Serial No. 67,703

5 Claims. (Cl. 91—70.1)

This application is a continuation in part of our previously filed application Serial Number 606,907, filed April 22, 1932, issued as Patent No. 2,046,638.

This invention relates to the process of treating metal and particularly to a process which involves the treatment of a body of metal to form upon it or introduce within its mass another element which combines and alloys with the metal of the original mass.

It has for one object, therefore, to form upon a mass of metal a layer of an alloy in which the metal of the original mass and the added element are alloyed together.

It has for another object to introduce into the body of the original metal, to a greater or a less depth, another element which alloys with the original metal so that the original metal is alloyed throughout a part of or all of its mass.

The process involves the step of carrying one element into a mass of metal to become alloyed with it. It has been found that the halogen gases, such as bromine, chlorine, iodine and fluorine, will act as carriers for certain elements by combining at high temperatures with them to form gaseous compounds of them, and when such a gaseous compound of an element and a halogen gas is brought into contact with a body of metal at suitable temperatures and for suitable times, the gaseous compound will be carried into the metallic body and will produce an alloy in which the metal combines with the element which was introduced in the gaseous form.

One example of this process involves the use of manganese and chlorine with a ferrous metal to form an iron manganese alloy in the ferrous metal, or an iron manganese coating on the surface of the ferrous metal, or both. At sufficiently high temperatures manganese combines with chlorine to form a manganese-chlorine gas. In general, in the specification and the claims, where the expression "manganese-chlorine gaseous compound" is used, we mean any gaseous compound of manganese and chlorine. Iron or steel when subjected to this maganese-chlorine gas will take up the manganese and an iron-manganese alloy is formed, first at the surface of the mass of iron or steel, and upon continued subjection, the manganese penetrates increasingly into the iron or steel and thus the depth of the layer of the alloy is increased. If the process is continued sufficiently, the entire mass of metal may be alloyed with manganese.

In practice, for the sake of economy, it is usually advisable to use the most common and the most cheaply produced of the halogens; this is chlorine and it is readily produced from common salt. One practical application of our process involves the following steps: Iron castings are packed in ferro-manganese, manganese ore or manganese, and salt, and are then heated for approximately three hours at a temperature of 1600° F. to 2000° F. Upon cooling it is found that the castings have absorbed some of the manganese to form a layer of high manganese alloy.

Hard iron castings may be packed, as above described, and put through the normal annealing treatment which in usual practice, without the special packing, would malleableize them and it is found that after the usual annealing cycle, due to the ferro-manganese, manganese ore or manganese and salt packing, the resulting castings have a manganese alloy surface layer, and the usual soft malleable core. Thus the malleableizing of the hard iron castings has been effected during the same process in which the manganese alloy layer is produced. In either case, whether the process includes the malleableizing step or not, it is believed that the manganese was transferred to the iron by the manganese-chloride gas which is formed during the heating. Experiments in which manganese-chloride gas was passed over pieces of iron which were otherwise not in contact with the manganese, have shown that the manganese is carried over by the gas and alloyed with the iron by this method.

For certain purposes, and particularly for greater cheapness, any other suitable source of manganese may be used in a packing of common salt, sand and sometimes pulverized coal or charcoal. This packing, in addition to furnishing the manganese necessary, is arranged to take care of the oxygen which may be present from any source. This effect is accomplished by the breakdown of the sodium-chloride or common salt into chlorine which furnishes the gaseous halogen with which the manganese combines to make a manganese-chloride gas, and furnishes also the sodium which acts as a reducing agent.

Frequently it is desirable to carry out the alloying or coating above described as a part of an annealing or malleableizing treatment. A typical example of this is given below, in which the steps for making a manganese alloy in an annealing cycle are discussed.

If hard iron castings are submitted to the usual malleableizing cycle or treatment, in the presence of a packing including ferro-manganese, manganese ore or manganese, or some other source of manganese, and salt, or some other source of

a halogen gas, the usual malleableizing effect will be accomplished and at the same time and during the same process the manganese alloying will take place and as before, in the simple process above mentioned, the quantity or depth of alloy produced is dependent upon the time of heating. Such a malleableizing cycle is as follows:

The usual malleableizing cycle involves heating the iron to approximately 1600° F. to 2000° F. The casting is held at that temperature sufficiently to permit throwing of the carbon out of combination with the iron. While this will not take place completely, the major part of the iron carbide is thus removed. The casting is then cooled to a point somewhat above its critical temperature in the neighborhood of 1350° F., and during this cooling a further quantity of the carbon is thrown out of combination. In the usual method the carbon that still remains in combination is thrown out by controlling the final cooling, so that it occurs very slowly through the critical temperature range, the cooling being as slow as 5° F. per hour and the final cooling alone frequently requiring 48 hours. Where the malleableizing is thus carried out and the formation of the manganese alloy is to occur at the same time, the packing above indicated is used, in place of the usual packing for malleableizing, and the temperature may be as high as 1600° F. to 2000° F. to cause the formation of the manganese-chloride gas and to permit its penetration into the iron to the desired degree. Many modifications of this malleableizing cycle are used and generally in most of them the step of alloying may be included, provided only that the proper ingredients are introduced to produce the gaseous compound of manganese and a halogen and that the proper temperatures are attained for its production.

While we have mentioned a number of sources of manganese, we do not limit ourselves to these but they are mentioned only as being the most commonly present, and commercially and economically available. Any source of the alloying metal which is desirable may be used and the above examples are given merely as possible sources. Neither the invention nor the claims are to be limited to these particular sources.

While we have spoken of sodium-chloride or common salt as a source of the halogen, we do not limit ourselves to this particular source. It is a convenient and economical one but other sources of halogen are available and the use of any source of halogen is within the contemplation of the invention. Sodium-chloride has the advantage that it acts as a source both of the halogen and of sodium which is a reducing agent.

The effect of the salt and its use in our process may be summarized as follows:

(1) When a ferrous metal is heated in an uncontrolled atmosphere it probably forms an oxide at temperatures below 1475° F. and this oxide forming reaction may occur with increasing rapidity at the higher temperatures.

(2) The sodium chloride is heated to a temperature higher than 1475° F. and breaks down into chlorine and sodium in the presence of the other packing ingredients. This heating ordinarily occurs in the presence of the coating metal which is thus correspondingly heated.

(3) The sodium released, as mentioned in (2) above, being a stronger reducing agent, combines with the oxygen of the iron oxide, reducing it to iron and forming a sodium oxide. It also combines with the oxygen of the atmosphere of the container to make that a neutral atmosphere and to prevent further oxidation of the iron.

As a result, therefore, of the breakdown of the salt in the presence of the coating metal, the iron oxide is reduced to prepare the iron to receive the coating metal and the gaseous compound of the chlorine with the coating metal is formed directly and its penetration into and deposition upon the iron occurs.

Where a source of the coating metal is used which provides an excess of oxygen, it may be desirable to add a reducing agent in addition to that which is formed by the breakdown of the sodium chloride and our process therefore contemplates the addition of appropriate quantities of a further reducing agent should that be necessary. For many sources of the coating metal it is not necessary. Where such added reducing agent is necessary any one may be used. Carbon, because of its cheapness, is frequently satisfactory, but others may be used.

While in the specific examples above mentioned we have referred generally to the treatment of iron, it is to be understood that steel can equally well be treated and the processes described above can be applied to steel. Where steel is treated with the manganese the packing will again consist of a source of manganese and salt and may include sand.

In general, where steel is to be treated according to the process above outlined, the material is heated to the treating temperature, preferably for upwards of three hours, and is allowed to cool. No effort is ordinarily made to control the rate of cooling.

We claim:

1. The method of coating and alloying a ferrous metal, of the group consisting of iron and steel, with manganese, which includes the steps of placing the ferrous metal, together with common salt and a source of manganese, in a container, heating said container and contents to a point sufficient to break down the salt to chlorine and sodium and cause direct combination of the chlorine and manganese and free the sodium for action as a reducing agent on the ferrous metal, whereby the surface of the ferrous metal is alloyed and coated with manganese.

2. The method of coating and alloying a ferrous metal, of the group consisting of iron and steel, with manganese, which includes the steps of placing the ferrous metal, together with common salt and a source of manganese selected from the group of materials consisting of ferro-manganese, manganese ore and metallic manganese, in a container, heating said container and contents to a point sufficient to break down the salt to chlorine and sodium and cause direct combination of the chlorine and manganese and free the sodium for action as a reducing agent on the ferrous metal, whereby the surface of the ferrous metal is alloyed and coated with manganese.

3. The method of coating and alloying a ferrous metal, of the group consisting of iron and steel, with manganese, which includes the steps of placing the ferrous metal, together with common salt and ferro-manganese, in a container, heating said container and contents to a point sufficient to break down the salt to chlorine and sodium and cause direct combination of the chlorine and manganese and free the sodium for action as a reducing agent on the ferrous metal, whereby the surface of the ferrous metal is alloyed and coated with manganese.

4. The method of coating and alloying a ferrous metal, of the group consisting of iron and steel, with manganese, which includes the steps of placing the ferrous metal, together with common salt and manganese ore, in a container, heating said container and contents to a point sufficient to break down the salt to chlorine and sodium and cause direct combination of the chlorine and manganese and free the sodium for action as a reducing agent on the ferrous metal, whereby the surface of the ferrous metal is alloyed and coated with manganese.

5. The method of coating and alloying ferrous metal, of the group consisting of iron and steel, with manganese, which includes the steps of placing the ferrous metal, together with common salt and metallic manganese, in a container, heating said container and contents to a point sufficient to break down the salt to chlorine and sodium and cause direct combination of the chlorine and manganese and free the sodium for action as a reducing agent on the ferrous metal, whereby the surface of the ferrous metal is alloyed and coated with manganese.

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