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PROCESS OF TREATING METAL

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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 chromium and chlorine with a ferrous metal to form an iron-chrome alloy in the ferrous metal. At sufficiently high temperatures chromium combines with chlorine to form a chromium-chloride gas, which may be chromic- or chromus-chloride. In general in the specification and in the claims, where we use the expression "chromic-chloride" or "chromous-chloride" we mean any gaseous combination of chromium and chlorine. Iron or steel when subjected to this chromic- or chromous-chloride gas will take up the chromium and an iron-chromium alloy is formed, first at the surface of the mass of iron and upon continued subjection of the iron to the chromic- or chromous-chloride gas, the chromium penetrates increasingly into the iron and thus the depth of the layer of alloy is increased. If the process is continued sufficiently, the entire mass of metal is alloyed with the chromium.

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-chromium and salt and are then heated for approximately three hours at a temperature of 1700° F.—1900° F. Upon cooling it is found that the castings have absorbed some of the chromium to form a layer of high chromium 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-chromium and salt packing, the resulting castings have a chromium 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 chromium alloy layer is produced. In either case, whether the process includes the malleableizing step or not, it is believed that the chromium was transferred to the iron by the chromic- or chromous-chloride gas which is formed during the heating. Experiments in which chromic- or chromous-chloride gas was passed over pieces of iron which were otherwise not in contact with the chromium, have shown that the chromium is carried over by the gas and alloyed with the iron by this method.

For certain purposes and particularly for the sake of greater cheapness, other chrouim bearing materials may be used in the packing. Thus chromite ore, which is the raw source of chromium, may be used in a packing of salt, sand and pulverized coal or charcoal. This packing, in addition to furnishing the chromium necessary, is arranged to take care of the oxygen which is present in the chromite ore.

The examples above mentioned refer specifically only to the use of chromium, but the invention is not limited to the use of that element alone and the particular steps in the method, the temperature and materials involved, are mentioned only as illustrating one application of the method. Many others may be made.

Frequently it is desirable to carry out the alloying as a part of an annealing or malleableizing treatment. A typical example of this is given below, in which the steps for making a chromium alloy during an annealing cycle are discussed. It will be understood that alloys of any of the elements or of several of them in combination may similarly be carried out during an annealing operation.

If hard iron castings are submitted to the usual malleableizing cycle or treatment, in the presence of a packing including ferro-chromium or some other source of chromium 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 chromizing 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 1650° F., or somewhat higher. 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 at 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 chromium alloy is to occur at the same time, the packing above indicated is used, in addition to the usual packing for malleableizing, and the temperature must be as high as 1700° F. to 1900° F. to cause the formation of the chromic- or chromous-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 chromium and a halogen and that the proper temperatures are attained for its production.

We claim:

1. The method of coating and alloying chromium with a ferrous metal of the group consisting of iron and steel which includes the steps of placing the ferrous metal together with common salt and a source of chromium selected from the group of materials consisting of metallic chromium, chromite ore and ferro-chromium 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 chromium, and free the sodium for action as a reducing agent on the ferrous metal, and alloying and coating the surface of the ferrous metal with said chromium.

2. The method of coating and alloying chromium with a ferrous metal of the group consisting of iron and steel which includes the steps of placing the ferrous metal together with common salt and ferro-chromium 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 chromium, and free the sodium for action as a reducing agent on the ferrous metal, and alloying and coating the surface of the ferrous metal with said chromium.

3. The method of coating and alloying chromium with a ferrous metal of the group consisting of iron and steel which includes the steps of placing the ferrous metal together with common salt and metallic chromium 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 chromium, and free the sodium for action as a reducing agent on the ferrous metal, and alloying and coating the surface of the ferrous metal with said chromium.

4. The method of coating and alloying chromium with a ferrous metal of the group consisting of iron and steel which includes the steps of placing the ferrous metal together with common salt and chromite ore and a reducing agent 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 chromium, and free the sodium for action as a reducing agent on the ferrous metal, and alloying and coating the surface of the ferrous metal with said chromium.

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