

# UNITED STATES PATENT OFFICE.

ARTUR KRUPP, OF BERNDORF, AUSTRIA-HUNGARY.

## PROCESS OF SMELTING NICKEL AND COBALT ORES.

SPECIFICATION forming part of Letters Patent No. 308,175, dated November 18, 1884.

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*To all whom it may concern:*

Be it known that I, ARTUR KRUPP, of Essen, in the German Empire, Prussia, subject of the Emperor of the German Empire, residing at Berndorf, in the Province of Nether Austria, in the Empire of Austria-Hungary, have invented certain new and useful Improvements in Process of Smelting Nickel and Cobalt Ores; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a novel process of treating nickel or cobalt in order to obtain a homogeneous malleable or ductile metal. The affinity of nickel and cobalt for or their tendency to absorb or assimilate carbon as well as oxygen or both within certain limits has heretofore been the cause of failure to obtain a homogeneous and malleable cast metal. When smelted in a graphite crucible, these metals will combine with more or less carbon and oxygen, and the cast metal on cooling will give up the greater portion of oxygen, while the carbon is retained. The brittleness of the metal as well as the degree of ductility or malleability thereof will depend upon the amount of carbon combined therewith. It is, however, very easy to eliminate the oxygen during the process of smelting by keeping the metal in fusion for some time, and especially by smelting under a layer or strata of charcoal. This will, however, tend to increase its brittleness. The longer the metal is kept in fusion under these conditions the greater will be its brittleness, the grayer its color, and the nearer it will approach in texture to that of cast-iron, as the amount of carbon assimilated increases with the time the metal is kept in fusion, and such metal will be unfit for use for most purposes. In general I may say that when nickel or cobalt is smelted in presence of carbon, as in graphite crucibles, and I am not aware that crucibles free from carbon have ever been produced for this purpose, the absorption or assimilation of the carbon is so rapid that unless prevented or counteracted the metal is always brittle or cast-iron like

and unfit for general use, owing to the carbon in the metal.

My improved process hereinafter described is based upon the properties of nickel and cobalt to assimilate or absorb both oxygen and carbon, and I obtain a thoroughly homogeneous malleable or ductile product adapted for general use in the arts and manufactures. In order to obtain such homogeneous malleable nickel or cobalt, it is necessary to employ means to prevent the absorption or assimilation of carbon. This I have found can be attained by effecting the smelting of the metals in the ordinary graphite crucibles in presence of an oxidizing agent in such manner that the latter will gradually give up its oxygen as the smelting progresses. Various oxidizing agents may be employed. I have, however, obtained the best results with a manganate or permanganate salt, preferably permanganate of potash and permanganate of soda, and in practice after the smelting is completed I preferably employ a deoxidizing agent to counteract the effect of the oxygen on these metals.

In carrying out my invention I take the oxide of nickel or cobalt in as pure a state as possible, and either in the form of cubes or small pieces of other form, and reduce them at a moderate heat to avoid fusing, and also to avoid their assimilating or absorbing carbon. The somewhat porous material thus obtained is then impregnated or saturated with a solution of permanganate, either of soda or of potash, containing about four per cent. of the salt. The saturated material is then dried and smelted (preferably in a crucible) in a blast-furnace at a high temperature, the permanganate counteracting the deleterious effect of the carbon of the gases evolved, and is itself partially reduced, while the metal becomes homogeneous and malleable.

It is evident that by treating the reduced oxides as described, the oxidizing agent is intimately incorporated therein, and in a finely-subdivided condition, and will, as the smelting proceeds, be gradually given up, acting constantly to counteract the carbon and prevent it being absorbed by the metal. The effect of the oxidizing agent is due more to the ab-



sorption of the liberated oxygen by the carbon than to the fact that the deleterious action on the metal of the small quantity of carbon absorbed thereby, notwithstanding any precaution that may be taken to prevent this is counteracted.

The metal may be completely deoxidized by any suitable agent—as, for instance, by the addition of black flux and charcoal. The former can be obtained by carefully heating tartar (bitartrate of potassia) in a closed vessel, or by the addition of small quantities of aluminium, calcium, or calcium-zinc, which latter can be readily obtained by the Caron process, or by a mixture of any two or more of the latter metals.

In deoxidizing by means of black flux and charcoal these are introduced in small quantities either as soon as the metal has become fluid or immediately after, and the combined action of the carbon and the potassium vapors evolved by the black flux will in a short time remove any oxygen combined with the metal.

In deoxidizing by means of the metals above referred to I proceed as follows: I place on the fluid nickel or cobalt sufficient charcoal until it appears covered thereby, then through the charcoal I add the aluminium, or calcium, or calcium-zinc, or any two or more of these in the proportion of about four parts of the latter to every one hundred parts of the molten metal. In this manner I obtain nickel or cobalt in a perfectly homogeneous and ductile or malleable form.

I am aware that permanganate of soda has

heretofore been used in the treatment of metals, and I do not wish to claim such use, broadly.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. The process of obtaining nickel and cobalt in a homogeneous and malleable form, which consists in impregnating the reduced oxides of the metals with a manganate or permanganate salt, and then smelting the impregnated oxide, as described, for the purpose specified.

2. The process of obtaining nickel and cobalt in a homogeneous and malleable form, which consists in impregnating the reduced oxides of the metals with a manganate or permanganate salt smelting the same, and covering the molten metal with black flux at the termination of the smelting process, substantially as described, and for the purpose specified.

3. The process of obtaining nickel and cobalt in a homogeneous and malleable form, which consists in first impregnating the reduced oxides of the metals with a manganate or permanganate salt, smelting the impregnated oxide, covering the molten metal with charcoal, and adding at or after the termination of the smelting process aluminium, or calcium, or calcium-zinc, or mixtures of these, substantially as and for the purpose specified.

In testimony whereof I affix my signature in presence of two witnesses.

ARTUR KRUPP.

Witnesses:

JAMES RILEY WEAVER,  
CLARENCE M. HYDE.