Jan. 4, 1938. G. E. SEIL 2,104,530

ELECTRIC FURNACE PROCESS

Filed Nov. 28, 1936

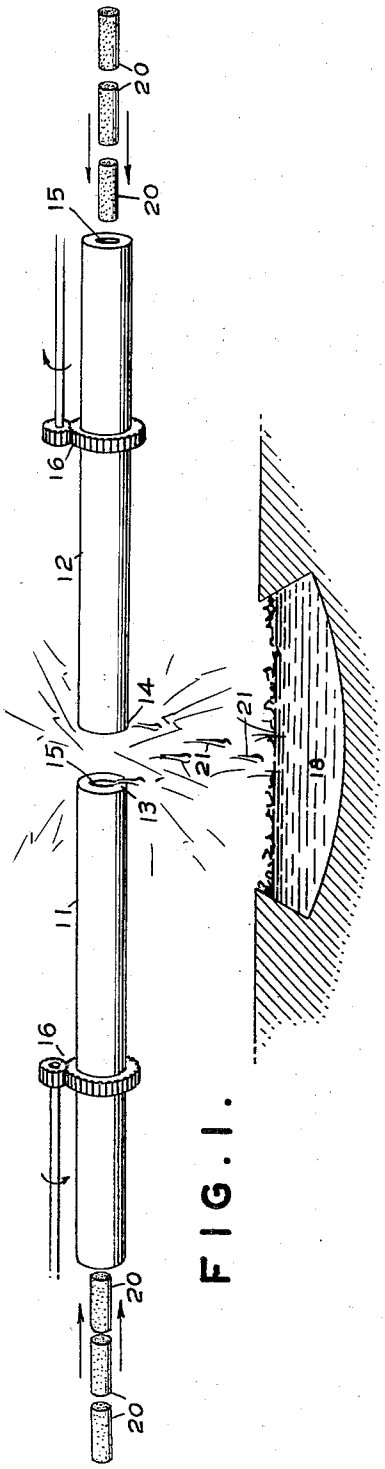


FIG. 1.

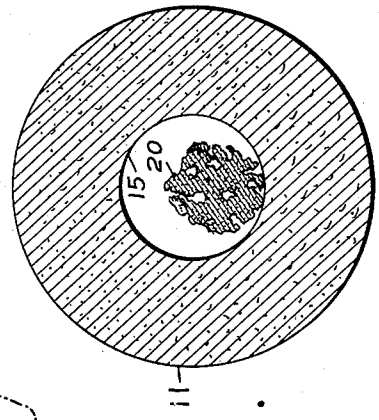


FIG. 3.

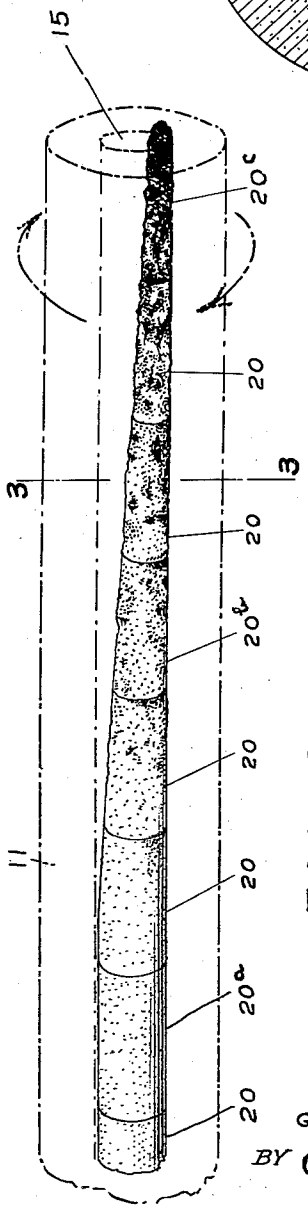


FIG. 2.

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ELECTRIC FURNACE PROCESS

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5 Claims. (Cl. 75—10)

This invention revolves about smelting operations, such as the refining of alloys and relates more particularly to ferro-alloys including chromium.

Heretofore, I have proposed for this purpose a process, the essence of which is the production within a hollow electrode of a highly oxidizing reagent for use subsequently in admixture in liquid phase with a bath of molten metal to be refined, by virtue of which the oxidizing reagent oxidizes in that bath oxidizable impurities present therein, coupled with increments to the bath of desirable metal released from the reagent when it gives up its oxygen to the impurity.

This reagent is produced by supplying to the bore of an energized hollow substantially horizontal electrode of an electric furnace having an atmosphere of carbon monoxide, cores containing comminuted materials capable of yielding under the influence of the heated zone of the electrode, molten metal having a metal oxide dispersed therein, detaining the core materials in the heated zone long enough for the molten metal to attain a temperature substantially above its melting point, to increase the solubility function of the metal for the metal oxide.

When attempt was made to practice this process, disadvantages were experienced under certain conditions in uninterruptedly passing the cores into the bore of the electrode and through the heated zone thereof. So to overcome this is an object of this invention to the end that the functioning of the furnace shall progress smoothly and dependably. This object is attained by rotating the hollow electrode while the production of the refining reagent proceeds therein.

A furnace with these advantages has been devised by me. It forms the subject-matter of my patent application Ser. No. 22,963, filed May 23, 1935. That case is drawn to describe a multiplicity of details of a complete electric furnace including features of construction of electrode carriage, electrode cooling, core feeding mechanism, and so on. That case has its emphasis directed to apparatus even though it describes a mechanism in which the process of this invention may be carried out. So this case has its emphasis directed toward the process irrespective of the specific apparatus that may be used in its carrying out. Nevertheless, since everything disclosed in that case is contemplated herein, the priority date of that case will be claimed for this one, on the principle that this is a continuation-in-part of my said earlier application.

Rather than reuse, in reiteration, all of the many pages of description and drawings of that case, only that portion thereof is used herein which has direct reference to the novel process steps to be claimed in this patent.

The invention hereof is diagrammatically illustrated in the accompanying drawing in which,

Figure 1 shows in skeleton form the essential parts and elements of an electric furnace suitable for carrying out this invention. Such a furnace is shown in greater detail in my said copending patent application Ser. No. 22,963.

Fig. 2 illustrates the novel effects attained by the rotation of the hollow electrodes showing particularly the behavior of the cores due to that rotation; and

Fig. 3 is a transverse cross sectional view taken along the lines 3—3 in Fig. 2.

In Fig. 1 of the drawing, 11 and 12 indicate substantially horizontal hollow energizable electrodes having adjacent ends 13 and 14 respectively for supporting an arc therebetween of sufficient intensity to heat the region of the arc ends of the electrodes to a requisite temperature. 15 indicates a bore of each electrode, and 16 any suitable mechanism for rotating the electrodes while energized. The electrodes, of course, are to be housed in an operable electric furnace with usual boundary walls and top and provided with a hearth 17 adapted to hold a bath of molten metal material 18 having an oxidizable impurity to be refined therefrom and having on the bath a slag 19 containing oxide material. To the bores of the electrodes are forcibly supplied cores 20, and from the arc ends of the electrodes there fall drops 21 of the refining reagent. The reagent is highly oxidizing and includes a metal desirable in the refined metal to be recovered from the bath saturated with a metal oxide dispersed or dissolved therein whose metal also is desirable in the refined metal. The oxide is reduced to metal by the transference of the oxygen thereof to combine with the oxidizable impurity of the bath (such as carbon). The impurity in the form of an oxide departs from the bath of metal being refined as a gas if gaseous, or into the slag if a solid. As the usual impurity is carbon, when oxidized it forms carbon monoxide and this, in being continually evolved, forms the atmosphere of the furnace. The reduced metal forms an addition to the metal content of the bath.

The cores 20 are composed of comminuted materials comprising those that are translatable under the conditions of temperature obtaining in the heated zone of the electrode, into a metal refining reagent. More particularly those ma-

terials can be a metal oxide preferably as an ore; a reducing agent such as carbon in quantity insufficient to reduce all of the metal oxide so that the end product of the reactions in the electrode will be reduced metal and unreduced metal oxide; and a corrective for controlling the passage of the reactive materials through the heated zone of the electrode whereby the reduced metal yielded therein is retained therein long enough to become superheated high enough above its melting point to become a solvent for the unreduced oxide but below the melting point of the oxide. A satisfactory degree of superheat is of the order of 600° F. above the melting point of the metal. The result is the emission from the electrode of an oxidizing metal refining reagent. These reactions and the manner of attaining these results form the subject-matter of my patent application Ser. No. 59,690, filed January 18, 1936, (now Patent No. 2,070,186) and of its predecessor patent applications referred to therein, on which it depends for priority.

As the metal oxide is reduced to metal which first appears in the form of drops thereof, the reduced metal occupies less volume than the constituents which yield it. This causes the cores to become pitted or possessed of pores. The outer surface sections of the cores disintegrate slowly under the influence of the heat, although they hold the metal in place long enough to attain its desired superheat. As long as the cores are in core form, they exhibit a sponge-like function. Nevertheless, as the drops of metal form, they should be kept away from the carbon of the electrode and this is done to some extent by the sponge-like action of the core provided however, the drop is not allowed to remain in too long contact with the carbon. Otherwise the metal will stick to the carbon and freeze the core against further forward progress thereof through the bore of the electrode. Such a prolonged contact of the core with one spot in the electrode tends to cause the oxide present in the core to give up some of its oxygen to the carbon of the electrode. Again, as the metal oxide usually used in this process is chromium oxide, or an ore containing it such as chromite, the reduced chromium being the heaviest constituent of the mass in the electrode tends to settle out and stratify therein whereas it is highly desirable to keep the molten or fluid constituents in the electrode in well dispersed or mingled condition. And further, if the reduced metal such as chromium should stick to the electrode, the carbon thereof being hotter than the metal, will result in a detrimental pick-up of carbon by the metal.

For overcoming or at least discouraging the encountering of these disadvantages, it is proposed herein to rotate the hollow electrodes. Rotation thereof results in an action illustrated in Figs. 2 and 3. Herein is illustrated what happens to the cores as they are forced through the heated zone of the electrode so **20***a* represents a core **20** in one condition, **20***b* a core in a condition of partial disintegration, **20***c* a core in an advanced state of disintegration, and so on. The bore of the electrode is shown in dotted lines in order to show the decreased diameter and conical shape assumed by cores during their advance through the heated zone as a result of the joint causes of the reduction of some of the metal oxide of the core to metal and of the rotation of the electrode. The reaction between the reducing agent in the core and some of the metal oxide therein takes place under the influence of the temperature encountered by the cores in the heated zone of the electrode with the result that pores appear in the core and their size diminishes. Rotation of the electrode keeps the core and its contents free from the bore of the electrode because the core is caused to roll at a different rate than the speed of the inner wall of the electrode because the diameter of the core is less than that of the bore. The steady wear on the core and steady translation of its constituents discourages the core from breaking into fragments which would in turn cause jamming thereof in the bore. The space **22** existing between the core and the bore, that increases toward the arc end of the electrode, is useful and advantageous because it provides a ready escape for the carbon monoxide of the furnace that is constantly produced due to the oxidation of the carbon impurity of the metal being refined by the oxygen of the oxidizing refining reagent.

Satisfactory results have been attained by rotating the electrodes at a peripheral speed of three inches per minute, that is, one revolution of a ten inch diameter electrode in ten and a half minutes.

Thus, the step of rotating the electrode serves the several purposes of preventing the reduced metal and its oxide from remaining in fixed relationship with any particular spot in the bore of the electrode; of maintaining the fluid constituents of the mass in the electrode in intermixed and intermingled condition; and of causing the cores to disintegrate gradually without breaking and thus avoid jamming thereof in the electrode. At the same time it assures the disintegration of the cores with the translation of their reactant materials to progress uniformly, dependably and in an orderly manner.

I claim:

1. The steps in a process of refining metal material comprising passing into a substantially horizontal hollow electrode of an electric furnace cores of a mixture capable of yielding metal and a metal oxide, meanwhile rotating the electrode.

2. The steps in a process of refining metal material comprising passing into an energized substantially horizontal hollow electrode of an electric furnace cores containing reactive materials capable of yielding in the heated zone of the electrode a superheated molten metal having a metal oxide dispersed therein, meanwhile rotating the electrode.

3. The steps in a process of refining metal material comprising supplying to the bore of an energized substantially horizontal hollow electrode of an electric furnace cores containing materials capable of being translated under the influence of heat into molten metal having a metal oxide dispersed therein, detaining the core materials in the heated zone of the electrode long enough for the molten metal to attain a temperature substantially above its melting point, meanwhile rotating the electrode whereby the cores disintegrate gradually into conical shapes as the core material thereof is translated.

4. The process of refining metal material comprising forming a molten bath of metal having an oxidizable impurity therein and an oxide containing slag thereon; passing into an energized substantially horizontal hollow electrode of an electric furnace cores containing materials capable of yielding in the heated zone of the electrode a molten metal having a metal oxide dispersed therein, meanwhile rotating the electrode, supplying the metal and oxide to the molten bath

of metal in an atmosphere of carbon monoxide whereby there is effected an oxidation of the impurity of the bath with an increase of the metal content thereof and there is a departing of the resulting oxide from the molten metal, and then recovering the refined metal from the bath.

5. In the refining of a metal bearing material made up of a plurality of constituents including at least one metal as a desirable constituent thereof and at least one oxidizable undesirable constituent thereof, the process for modifying the proportion of certain constituents thereof which comprises forming a molten bath of the material to be refined and an oxidizing slag thereon in a carbon monoxide atmosphere, forming an oxidizing reagent composed essentially of metallic oxide and a reduced metal at a temperature in excess of the melting point of the reduced metal while confined in a substantially horizontal hollow electrode, meanwhile rotating the electrode, supplying a quantity of reagent to the bath for liquid admixture therewith under conditions for inducing an oxidizing action of the reagent upon the oxidizable undesirable constituent of the molten bath by virtue of which the proportion thereof is decreased through conversion into an oxide, and then recovering refined metallic material from the bath.

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