PHILIPPINE PATENT [19]

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[54] Title: AN IMPROVED METHOD OF RECOVERING METALS AND METAL ALLOYS AND AN IMPROVED SYSTEM THEREFOR

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[57] ABSTRACT

In this method, metals or metal alloys, in particular ferro-alloys, are recovered by reduction of metal oxides in a reduction zone formed by a coal bed flowed through by a reducing gas.

To obtain metals that have a high affinity to oxygen, lumpy oxidic charging material is guided under the active bed layers, wherein a bottom layer of degassed coal covering a liquid sump of reduced metal and slag is provided. Furthermore, oxygen or an oxygen-containing gas is fed into a middle layer to form a hot reducing gas consisting essentially of CO, and into a top layer combustion gases of carbon particles and oxygen or oxygen-containing gas are fed.

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The invention relates to a method of recovering metals or metal alloys, in particular ferro-alloys, by reducing metal oxides in a reduction zone formed by a coal bed flowed through by a reducing gas, as well as a plant for carrying out the method.

In EP-A - 0 174 291 a method of melting metals, i.e. copper, lead, zinc, nickel, cobalt and tin, of oxidic fine-grain non-ferrous metal ores is described, wherein the charging material is charged into a reduction zone formed by a coal fluidized layer in a meltdown gasifier. When passing this reduction zone, the oxidic charging material is reduced to metal, which is collected in the lower part of the meltdown gasifier.

It has shown that the method according to EP-A 0 174 291 may advantageously be used for reducing oxides reacting with elementary carbon at temperatures below 1,000°C, yet that problems may occur when recovering metals and metal alloys, in particular ferro-alloys, such as ferro-manganese, ferro-chromium and ferrosilicon, which are recoverable from their oxides only at temperatures exceeding 1,000°C using elementary carbon as the reducing agent, since the period of contact of this oxidic charging material which reacts at higher temperatures, with the carbon particles forming the fluidized layer is relatively short.

The invention aims at avoiding these disadvantages and difficulties and has as its object to provide a method and a plant of the initially defined kind which make it possible to produce metals and metal alloys, in particular ferro-alloys, such as ferro-manganese, ferrochromium and ferrosilicon of lumpy oxidic charging material in a melt-down gasifier, wherein the metal has such a high affinity to oxygen that it reacts with elementary carbon at above 1,000°C only.

With a method of the initially defined kind this object is achieved according to the invention in that, under the action of gravity, lumpy oxidic charging material is guided through a static coal bed comprised of three layers, wherein

- a bottom layer of degassed coal is provided, which covers a liquid sump of reduced metal and slag,
- into a middle layer, oxygen or an oxygen-containing gas is introduced so as to form a hot reducing gas consisting essentially of CO, and
- into a top layer, combustion gases of carbon particles and oxygen or oxygen-containing gas are introduced.

Advantageously, lumpy oxidic charging material having a grain size of from 6 to 50 mm, preferably 10 to 30 mm, is used.

For forming the static bed layers, suitably coal having a grain size of from 5 to 100 mm, in particular 5 to 30 mm, is used.

According to a preferred embodiment, the thickness of the middle and top static bed layers is maintained between 1 and 4 m.

A further embodiment of the method according to the invention in characterised in that dust-like carbon particles are separated from the off-gas passing the static bed layers (reduction zones) and that these carbon particles, preferably in the hot state, together with oxygen or oxygen-containing gas are fed to burners directed into the top static bed layer.

As the coal, preferably coal maintaining its lumpy character after degassing is used, so that with a grain size range of from 5 to 100 mm, preferably 5 to 30 mm, utilized, at least 50 % of the degassed coal formed after degassing is present within the original grain size range of from 5 ro 100 mm or 5 to 30 mm, respectively, and the remainder is present as undersize grain.

The method according to the invention offers the advantage that all known advantages of the reduction processes in shaft furnaces heated with fossile energy are maintained, such as counterflow-heat exchange, metallurgical reaction with elementary carbon in the static bed, which is necessary for the reduction of oxides of non-

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precious metals, as well as a good separation of metal and slag. Coking or degassing of coal may be carried out without the formation of tar and other condensable compounds. The gas formed during the degassing of the coal acts as additional reducing agent to the reduction gases formed from the gasification of the degassed coal.

A particular advantage of the method consists in that the reduction of oxides of non-precious elements, such as, e.g., silicon, chromium, manganese, can be effected without using electric energy. In the method according to the invention, the energy required for degassing the coal is controlled in a simple manner, because the undersize grain (smaller than 5 mm) is discharged with the hot off-gases of the meltdown gasifier. separated, returned into the upper blowing-in zone of oxygen-containing gases and oxidized by means of the oxygen-containing gases, heat being released.

The grain decomposition behaviour is tested such that a grain fraction of from 16 to 20 mm is subjected to degassing for one hour in a chamber which has been preheated to 1,400°C. The volume of the chamber is 12 dm^3. After cooling by flushing with cold inert gas, the grain distribution is determined.

The invention furthermore comprises a plant for carrying out the method with a refractorily lined shaft-

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shaped meltdown gasifier, which has, in its upper part, charging openings for introducing coal and lumpy oxidic charging material, as well as a discharge duct for off-gas, the side wall of the meltdown gasifier being penetrated by supply ducts for coal and oxygen or oxygen-containing gas, respectively, and a lower section being provided for collecting molten metal and liquid slag. This plant is characterised in that, under formation of these superposed static bed layers A, B, C

- in the region between the bottom static bed layer A and the middle static bed layer B, a ring of blow-in pipes for oxygen or oxygen-containing gas is provided and
- at a distance thereabove, in the region between the middle static bed layer B and the top static bed layer C, a ring of burners charged with carbon particles and oxygen or oxygen-containing gas, respectively, is provided.

Advantageously, a hot cyclone for separating carbon particles from the off-gas is provided in the discharge duct for off-gas, and the discharge end of this hot cyclone is in flow connection with the ring of burners.

The method and the plant of the invention for carrying out the method are explained in more detail by way of the drawing, which shows a schematic illustration of the meltdown gasifier with additional means connected thereto.

A shaft-like meltdown gasifier denoted by 1 has a refractory lining 2. The bottom region of the meltdown gasifier serves for accommodating molten metal 3 and molten slag 4. A tap opening for metal is denoted by 5, and a tap opening for slag is denoted by 6. In the upper part of the meltdown gasifier, a charging opening 7 for supplying lumpy coal, as well as a charging opening 9 for lumpy oxidic charging material are provided. Above the liquid sump 3, 4, the static coal bed is formed, i.e. a bottom layer A of degassed coal which is not gas-passed, a middle layer B of degassed coal provided thereabove and passed by gas, and a top layer C of lumpy coal provided thereabove and passed by gas.

The side wall of the meltdown gasifier 1 is penetrated by blow-in-pipes, i.e. by a ring of blow-in pipes 8 for oxygen or oxygen-containing gases, respectively. These pipes are arranged in the border region between the non-gas-passed static bed layer A and the static bed layer B.

At a distance thereabove, i.e. in the border region between layer B and layer C, a ring of burners 10 penetrating the side wall of the meltdown gasifier 1 is provided, into which a mixture of dust-like carbon particles and oxygen or oxygen-containing gas is introduced and wherein the off-gas **possess** the static bed layers constituting reduction zone. From the upper part of the meltdown gasifier, a discharge duct 11 guides the off-gas formed to a hot cyclone 12.

Dust-like carbon particles suspended in the off-gas are separated in the hot cyclone 12 and fed from the discharge end of the hot cyclone 12, in which a dosing means 13 is provided, through a duct 14 to the burners 10 arranged in a ring. A duct for oxygen-containing gas leading to the burners 10 is denoted by 15. With the dosing means 13 the filling degree of the hot cyclone 12 can be regulated and the separating effect of the hot cyclone 12 can be influenced. From the upper part of the hot cyclone 12 off-gas is discharged through duct 16.

Advantageously, the method according to the invention is carried out such that coal and lumpy oxidic charging material are commonly introduced through the charging openings in the upper part of the meltdown gasifier 1. The coal is degassed in the static bed layer C. The heat required for degassing is provided, on the one hand, by the hot reducing gases rising from the static bed layer 6, and, on the other hand, by combustion heat from the carbon particles burned by means of oxygen-containing gases in the burners 10. The vertical extension of the layer C is selected such that the gas leaving layer C has a minimum temperature of 950^{o}C. Thereby it is ensured that tars and other condensable compounds are cracked. Thus an obstruction of the top static bed layer C becomes impossible. In practice, a layer thickness of from 1 to 4 m has proved to be advantageous for layer C. A vertical extension of from 1 to 4 m also proves to be advantageous for static bed layer B. Coal degassed in static bed layer C forms the static bed layer B when it sinks down.

The lumpy oxidic charging material is melted in static bed layer B and reduced by the elementary carbon. The heat required for melting and reducing is supplied by gassifying hot degassed coal by means of oxygen-containing gases introduced into the gasifier via the blow-in pipes 8. The molten metal forming in static bed layer B and the molten slag flow down and are collected and tapped below static bed layer A.

WHAT WE CLAIM IS:

1. In a method of recovering metals and metal alloys, by reducing metal oxides in a reduction zone formed by a coal bed flowed through by a reducing gas, the improvement comprising providing a three-layer static coal bed having a bottom static bed layer of degassed coal covering a liquid sump of reduced metal and slag, a middle static bed layer, and a top static bed layer,

guiding lumpy oxidic charging material under gravity action through said three-layer static coal bed,

introducing one of oxygen and an oxygen-containing gas into said middle static bed layer so as to form a hot reducing gas consisting essentially of CO, and

feeding combustion gases of carbon particles and one of oxygen- and oxygen-containing gas into said top static bed layer.

2. A method as set forth in Claim 1, wherein said lumpy oxidic charging material has a grain size of from 6 to 50 mm.

3. A method as set forth in Claim 2, wherein said lumpy oxidic charging material has a grain size of from

10 to 30 mm.

4. A method as set forth in Claim 1, wherein said static coal bed layers are formed by coal having a grain size of from 5 to 100 m.

5. A method as set forth in Claim 4, wherein said coal has a grain size of from 5 to 30 mm.

6. A method as set forth in Claim 1, wherein the thickness of said middle static bed layer and said top static bed layer is maintained between 1 and 4 mm.

7. A method as set forth in Claim 1, wherein off-gas passes the static bed layers constituting reduction zones, further comprising separating dust-like carbon particles from said off-gas and feeding said carbon particles together with one of oxygen and oxygen-containing gas to burners directed into said top static bed layer.

8. A method as set forth in Claim 7, wherein said separated carbon particles are fed in the hot state to said burners.

9. In a system for recovering metals and metal alloys, by reducing metal oxides in a reduction zone formed by a coal bed flowed through by a reducing gas

and of the type including a refractorily lined shaft-like meltdown gasifier having an upper part, a side wall and a lower part, the upper part including charging openings for charging coal and lumpy oxidic charging material as well as a discharge duct for off-gas, supply ducts for coal and one of oxygen and an oxygen-containing gas penetrating said side wall of said meltdown gasifier, and said lower part being provided for collecting molten metal and molten slag, the improvement wherein

- a bottom static coal-bed layer, covering a liquid sump of reduced metal and slag, a middle static coal-bed layer and a top static coal-bed layer are superposed,
- a ring of blow-in pipes for one of oxygen and oxygen-containing gas is provided in a region between the bottom static coal-bed layer and the middle static coal-bed layer and
- a ring of burners charged with carbon particles and one of oxygen or oxygen-containing gas is provided at a distance thereabove between said middle static coal-bed layer and said top static coal-bed layer.

10. A system as set forth in Claim 9, further comprising a hot cyclone for separating carbon particles

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from said off-gas and provided in said discharge duct for said off-gas, said hot cyclone having a discharge end, and means flow-connecting said hot cyclone discharge end with said ring of burners.

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ABSTRACT OF THE DISCLOSURE:

In this method, metals or metal alloys, in particular ferro-alloys, are recovered by reduction of metal oxides in a reduction zone formed by a coal bed flowed through by a reducing gas.

To obtain metals that have a high affinity to oxygen, lumpy oxidic charging material is guided under the action bed layers, wherein a bottom layer of degassed coal covering a liquid sump of reduced metal and slag is provided. Furthermore, oxygen or an oxygen-containing gas is fed into a middle layer to form a hot reducing gas consisting essentially of CO, and into a top layer combustion gases of carbon particles and oxygen or oxygen-containing gas are fed.

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FIG. 1

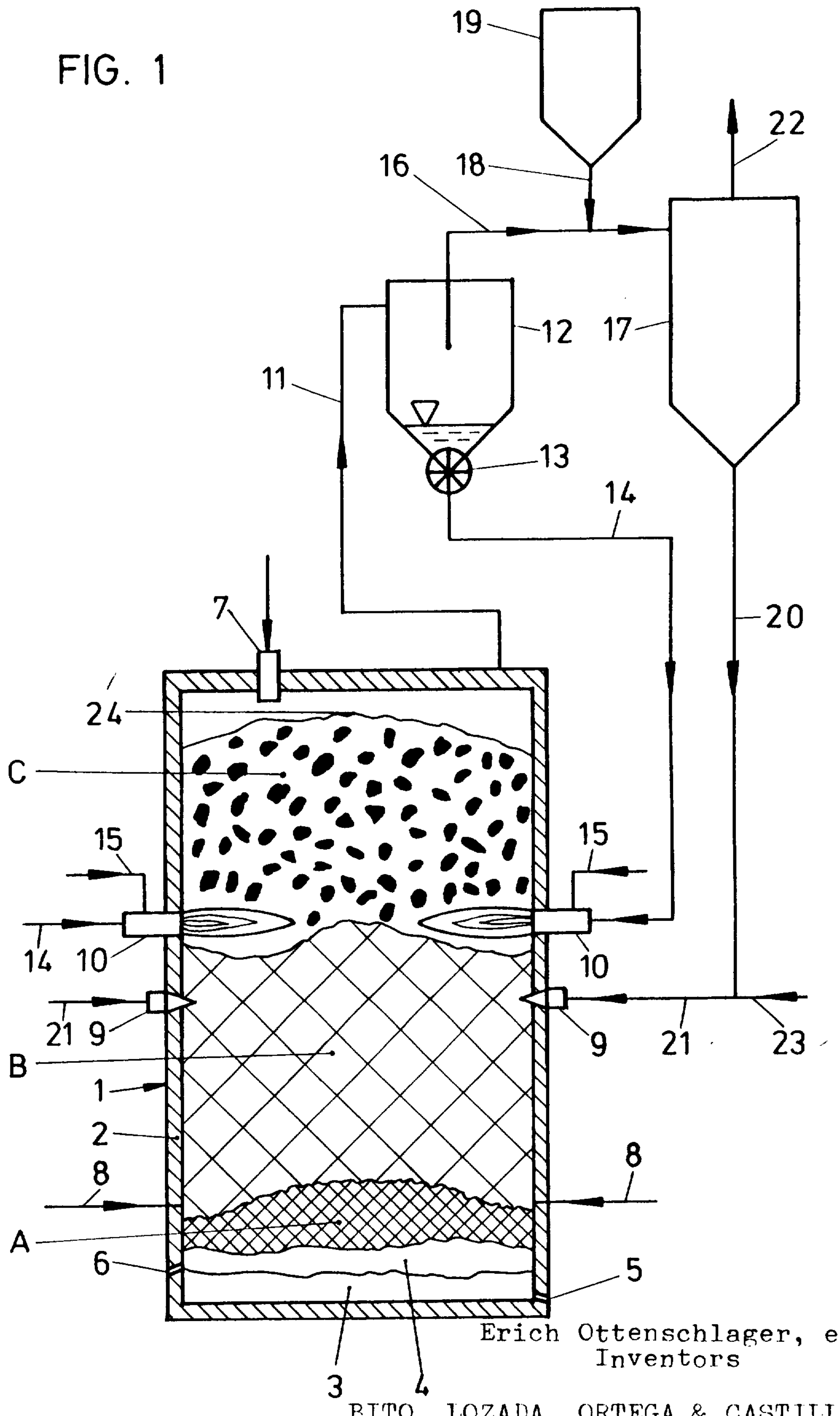

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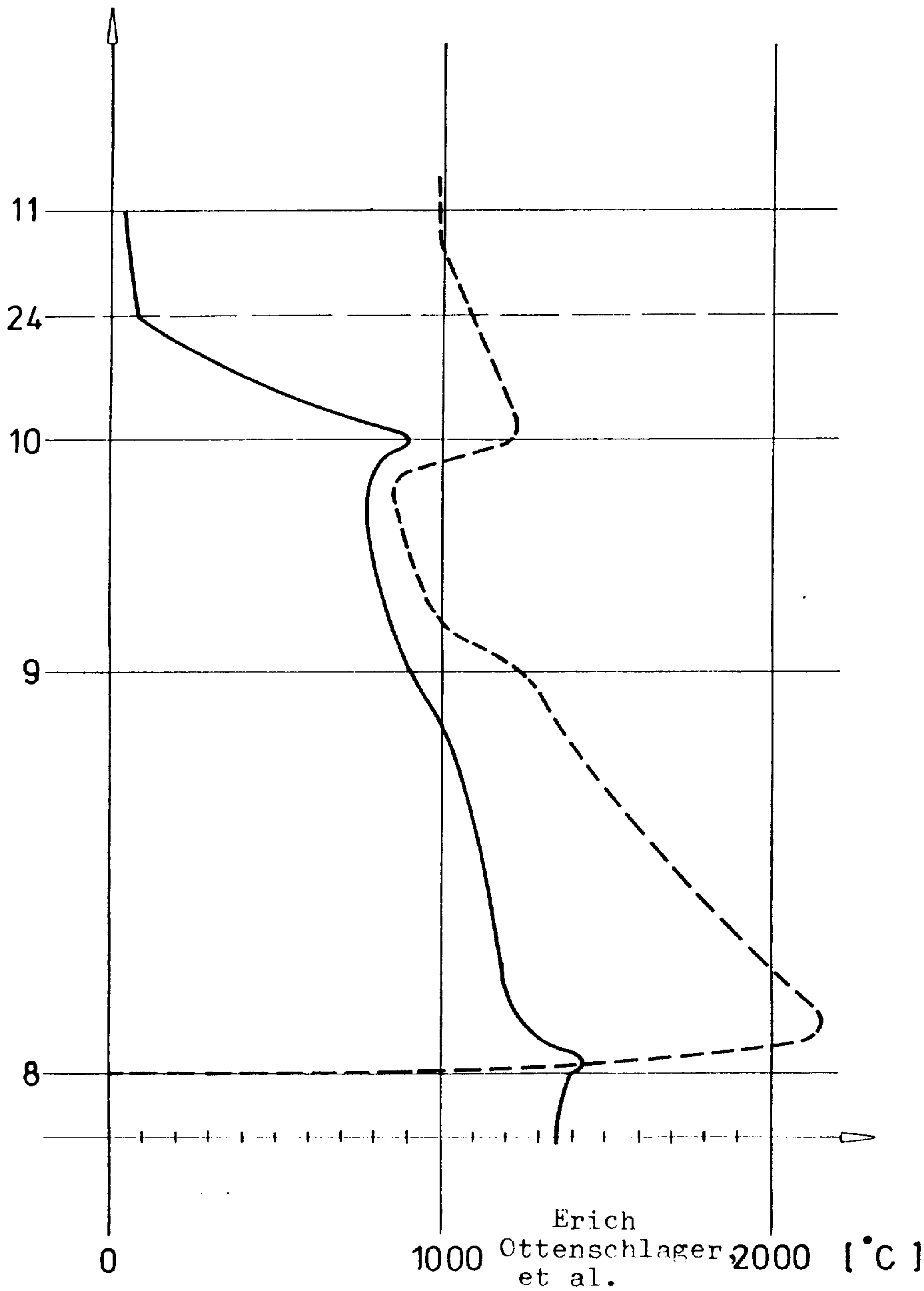
FIG. 2



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