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(54) **SYSTEM FOR THE TREATMENT OF PELLET FINES AND/OR LUMP ORE AND/OR INDURATED PELLETS**

SYSTEM ZUR BEHANDLUNG VON PELLET-FEINPARTIKELN UND/ODER STÜCKIGEM ERZ UND/ODER VERHÄRTETEN PELLETS

SYSTÈME DE TRAITEMENT DE FINES DE GRANULÉS ET/OU DE MINERAI EN MORCEAUX ET/OU DE GRANULÉS INDURÉS

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Description

[0001] The present invention is directed to the treatment of pellet fines and/or lump ore and/or indurated pellets, wherein lump ore and/or indurated pellets and/or green pellets are fed onto a traveling grate for drying, preheating and hardening (in the case of green pellets) and then transferred into a reactor for further treatment, such as reduction or smelting.

[0002] The world crude steel production in 2011 amounted to about 1.500 million tons with a share of electric steelmaking of about 30%. Electric steelmaking is mainly based on scrap and DRI (direct reduced iron). The total DRI production in 2011 amounted to about 70 million tons. Direct reduction processes use either coal or gas as reducing agent and fuel. The iron-containing material is introduced into the reduction reactor in the form of lump ore and/or pellets in the case of the gas-based shaft furnace processes, such as the Midrex process or the Energiron process, accounting for about 75% of world DRI production, or the coal-based rotary kiln processes, such as the SL/RN process, accounting for about 23% of world DRI production. Only a few fluidized bed or rotary hearth furnace based plants, accounting for less than 2% of world DRI production, are able to treat fine-grained concentrates.

[0003] As described in "Sponge Iron Production in Rotary Kiln" by Arabinda Sarangi and Bidyapati Sarabi, PHI Learning Private Limited, New Delhi, 2011, the most widely used coal based process for the production of DRI is the SL/RN process. In this process, material consisting of lump ore or indurated pellets is charged into a rotary kiln together with coal and recycle char as reducing agents, and limestone or dolomite needed to absorb the sulfur from the coal. The iron oxides are reduced in the rotary kiln at a temperature of 900 to 1.100 °C. To prevent reoxidation the kiln discharge is cooled indirectly in a rotary cooler and thereafter separated into DRI, DRI fines and nonmagnetics by screening, magnetic separation or other suitable process steps.

[0004] The traditional rotary reduction kilns have been designed to treat 100% lump ore and/or indurated pellets. Only in exceptional cases, such as Falconbridge Nickel Mines, Canada, treating calcined pyrite fines, and Nippon Kokkan K.K., Japan, treating steelworks dust, a combination of prehardening grate and rotary kiln was applied, enabling feeding of 100% green pellets. The fine grained material was pelletized and the green pellets were charged on the prehardening grate, where they were hardened by using rotary kiln offgas. The feed of a mixture of lump ore and green pellets onto the standard prehardening grate is not possible, as the lumps would destroy the green pellets. Parallel feeding of prehardened pellets from the grate and cold lump ore and/or indurated pellets directly into the downstream rotary kiln is only possible with a high amount of additional equipment and a decreased kiln capacity. To change the feed material from lump ore and/or indurated pellets to green pellets requires the adaptation of the process parameters and a different operation of the plant. It is, therefore, cumbersome, time consuming and thus costly.

[0005] Document EP 0 207 654 A1 describes a process for sintering iron ore according to the preamble of claim 1. In a first step, green pellets with a thickness of from 300 to 1,500 mm are fed onto a hearth layer ore on an endless travelling grate. On the endless travelling grate they are transported sequentially through the drying zone, the ignition zone and the firing zone. In the drying zone situated in the drying oven, drying gas with a temperature of from 150 to 350 °C is blown downwardly into the drying zone to dry the green pellets in this zone. Afterwards, a high-temperature combustion waste gas is produced for example by a combustion of a fuel, and is blown as an ignition gas downwardly through an oven into the ignition zone to ignite a powdery solid fuel on the surfaces of the green pellets. Finally, the solid fuel is sucked by blowers and is combusted in the firing zone. During firing the pellets are heated to a temperature about 1350 °C. Thereby, the fired pellets are formed into a large slab-shaped mass. The slab-shaped mass is crushed in a crusher for any further operation

[0006] Document WO 2005/085481 A1 teaches a method for the production of a raw sintering mixture. The green pellets (having the optimum grain size of 8 mm) are coated with fine grained fuel, preferably coke fines. After coating, the pellets are transported via a conveyor onto the travelling grate of the sinter machine and are sintered after being ignited by means of an ignition hood. The sintered material leaving the sinter machine will be pre-crushed in a crusher before being cooled and further crushed and screened.

[0007] It is the object of the present invention to provide for more flexibility in producing DRI by allowing to choose the most economical feed material available.

[0008] According to the present invention this problem is solved by a system comprising the features of claim 1.

[0009] Preferred embodiments of the present invention are evident from the dependent claims.

[0010] According to the present invention, a first feeder is provided to feed lump ore and/or indurated pellets, and a second feeder is provided to feed green pellets onto the traveling grate, wherein the first feeder for feeding the lump ore and/or the indurated pellets is provided upstream of the second feeder for feeding the green pellets. Thereby, the lump ore and/or the indurated pellets are fed onto the traveling grate before the green pellets are introduced such that the lump ore and/or the indurated pellets form a layer on the traveling grate for receiving the green pellets. The destruction of the green pellets by the iron ore lumps, as it would happen upon the simultaneous supply of both feed streams onto the traveling grate, is securely avoided. According to the present invention belt conveyors, roller feeders or other suitable devices may be used to feed the lump ore or the indurated pellets or the green pellets.

[0011] Preferably, the lump ore and/or the indurated pellets form a hearth layer on the traveling grate for holding the green pellets. The height of the layer of lump ore and/or indurated pellets on the traveling grate is preferably controlled by a segment gate arrangement in order to provide a uniform hearth layer receiving the green pellets.

[0012] In a preferred embodiment of the invention a pelletizing unit is provided upstream the second feeder for pelletizing fine grained iron ore concentrate that then can be easily fed onto the layer of lump ore and/or indurated pellets on the traveling grate.

[0013] In a preferred embodiment of the invention the traveling grate is equipped with a hood that is divided into several process zones in particular for drying, preheating and hardening the green pellets, resting on the layer of lump ore and/or indurated pellets, in order to release moisture and other components that dissociate at elevated temperatures, preheat and harden them. Thereby, the green pellets finally achieve the required pellet strength at the grate discharge.

[0014] The different process zones, such as drying, preheating and hardening, comprise wind boxes sealed towards the traveling grate for sucking hot gas through the ore and pellet layers resulting in the thermal treatment of the ore and pellets.

[0015] Below the wind boxes preferably a duct is provided comprising a valve arrangement for controlling the gas flow through the traveling grate. Thereby, the desired temperatures can be easily adjusted.

[0016] The reactor located downstream the traveling grate is a rotary kiln and preferably comprises an after burning chamber, wherein an offgas conduit of the after burning chamber is connected to the hood of the traveling grate to provide the hot gas for the thermal treatment of the feed materials.

[0017] Between the traveling grate and the reactor preferably a refractory lined chute is provided to introduce the material into the reactor.

[0018] The invention is also directed to a method for operating a system as described above in accordance with the features of claim 11. The lump ore and/or indurated pellets are fed onto the traveling grate by the first feeder at a position upstream of the second feeder such that the lump ore and/or the indurated pellets form a hearth layer on the traveling grate for receiving green pellets from the second feeder. "Upstream the second feeder" in the sense of the present invention means a position located before the second feeder so that the material will travel to the second feeder after it has passed the position.

[0019] Preferably, lump ore, indurated pellets and green pellets form a bed on the traveling grate, wherein the bed height on the traveling grate is controlled by varying the velocity of the traveling grate.

[0020] The invention will subsequently be explained in detail with reference to the accompanying drawing and an exemplary embodiment. All features described and/or illustrated form the subject matter of the present invention *per se* or in any combination, independent of their inclusion in the claims or their back reference.

Fig. 1 is a flow sheet of a plant comprising the system according to the present invention.

[0021] According to the present invention and as shown in Fig. 1, lump iron ore and/or indurated pellets are fed from a first feeder 1 comprising a feed bin 2 and a segment gate 3 onto a traveling grate 4, on which it forms a hearth layer 5.

[0022] A second feeder 6 is provided for feeding green pellets produced from iron ore concentrate in the upstream pelletizing unit 9. The grain size of the concentrate is preferably 100% below 100μ. The iron ore concentrate is fed via a weigh feeder 7 and a belt conveyor 8 onto a pelletizing unit 9 for forming the green pellets. From the pelletizing unit 9 the green pellets are fed onto the traveling grate 4 via a belt conveyor 10 and a roller feeder 11, where the green pellets form a second layer on top of the hearth layer 5 formed by the lump ore and/or indurated pellets. If no lump ore or indurated pellets are fed from the first feeder 1, the green pellets will rest directly on the traveling grate 4. The bed height on the traveling grate 4 is preferably measured online and can be easily controlled by varying the velocity of the traveling grate 4. Additionally, the height of the lump ore/indurated pellets layer is controlled by a standard segment gate arrangement. Thereby, a constant bed height is achieved and steady process conditions can be realized.

[0023] The traveling grate 4 is equipped with a refractory lined hood 12 extending over at least a part of the traveling grate 4 in its longitudinal direction and divided into several process zones. Wind boxes 13 sealed towards the traveling grate 4 are provided for the respective process zones. The material on the traveling grate 4, i.e. (a) green pellets resting on the lump ore/indurated pellets layer, (b) only green pellets or (c) only lump ore/indurated pellets, is conveyed through the process zones for drying, preheating and, in the case of green pellets, hardening at a temperature of about 900 to 1.100 °C, preferably 1.000 to 1.050 °C, in order to release moisture and other components that dissociate at elevated temperature and finally achieve the required pellet strength at the grate discharge 14. The hot gas flow sucked through the traveling grate 4 and the wind boxes 13 is preferably controlled by a valve arrangement in the duct below the wind boxes 13 (not shown) and temperature measurements. The temperature can vary depending on the materials used in the process.

[0024] From the grate discharge 14 the heated and treated material is supplied to the reactor, in particular a rotary kiln 15, via a refractory lined chute 16. In the case of feeding a rotary reduction kiln ,reducing agents, in particular coal and char, and if necessary a further suitable fuel are added to and combusted in the rotary kiln 15 to heat and reduce the iron material at a reduction temperature of about 800 to 1.200 °C, preferably 900 to 1100

°C. Here as well, the temperature can vary depending on the materials used in the process. Limestone or dolomite is added as desulfurizing agent.

[0025] The reduced material then proceeds into a rotary cooler 17 where it preferably is indirectly cooled using water. Thereafter the resulting DRI and nonmagnetics are discharged for product separation into DRI, DRI fines, char and wastes by a system usually comprising screening and magnetic separation steps.

[0026] Part of the hot offgas from the kiln's after burning chamber 18 is directed to the hardening zone of the traveling grate 4 in order to apply the highest possible temperature to achieve sufficient pellet strength at the grate discharge 14. Part of the hot offgas obtained in the after burning chamber 18 is mixed with part of the recycled offgas coming from the hardening zone of the grate 4 after passing the cyclone separator 22 and the recuperation fan 23. This hot gas mixture is introduced into the preheating zone of the traveling grate 4 to heat up the iron containing material. The remaining part of the offgas leaving the after burning chamber 18 may be forwarded to a waste heat boiler 19, where steam is produced for power generation. The offgas is cleaned in an electrostatic precipitator 20 and discharged through stack 21. The separated dust may be further treated before it is finally discharged.

[0027] Part of the recycled offgas coming from the hardening zone of the grate 4 after passing the cyclone separator 22 and the recuperation fan 23 mixed with some cold air is introduced into the drying zone. The hot offgas leaving the drying and preheating zones of the traveling grate 4 via the wind boxes is separated from dust in an electrostatic precipitator 24 before it is discharged through stack 25.

[0028] As it is evident from the above description, the invention is based on the application of a conventional traveling grate 4 extended in length to facilitate the incorporation of independent lump ore or indurated pellet feeding facilities in addition to the conventional green pellet feeding facilities. Thereby, the system enables the plant operator to react without long delay to changing market conditions and choose the most economical feed material available. In particular, it is possible to operate the system with

- a mixture of lump ore and green pellets produced from iron ore fines, wherein the lump ore forms a hearth layer holding the green pellets;
- 100% green pellets produced from iron ore fines;
- 100% lump ore feed, wherein the traveling grate 4 primarily is used as a preheating unit for the subsequent rotary kiln 15.
- Instead of lump ore also indurated pellets could be used as feed material.

[0029] In case of operating interruptions of the pelletizing facilities lump ore/indurated pellet feeding could automatically replace the feeding of green pellets.

[0030] As the lump ore layer acts as a protective hearth layer against overheating of the traveling grate, higher operating temperatures and a higher energy flow for hardening the green pellets is possible. This results in higher compression strength of the prehardened pellets. In particular for the lower level pellets the exposure to higher temperatures is advisable to improve pellet strength.

[0031] In case of operating the system as a preheating unit with lump ore or indurated pellets only, the production capacity of the downstream reactor could be substantially increased (in the case of a rotary kiln 15 by about 30%), compared to feeding cold material. In this case more heat could be recovered in the waste heat boiler 19, compared to feeding green pellets, leading to increased steam production and power generation. This is due to the fact that more heat and therefore more hot gas is required for heating up green pellets because of their higher moisture content.

[0032] In case of DRI production, the product quality can be improved by blending lower grade lump ore with green pellets produced from high grade iron ore concentrates.

[0033] The present invention has been described on the basis of a reduction reactor for reducing iron ore material. It goes without saying that the invention is also suitable with other types of reactors requiring the preheating or thermal treatment of various types of lumpy material, such as a smelter.

List of reference numbers:

[0034]

1	First feeder
2	Feed bin
3	Segment gate
4	Traveling grate
5	Hearth layer
6	Second feeder
7	Weigh feeder
8	Belt conveyor for concentrate
9	Pelletizing unit
10	Belt conveyor for green pellets
11	Roller feeder for green pellets
12	Hood
13	Wind box
14	Grate discharge
15	Rotary kiln
16	Chute
17	Rotary cooler
18	After burning chamber
19	Waste heat boiler
20	Electrostatic precipitator
21	Stack
22	Cyclone separator
23	Recuperation fan
24	Electrostatic precipitator

25 Stack

Claims

1. System for the treatment of pellet fines, and/or lump ore, and/or indurated pellets, comprising a first feeder (1) for feeding lump ore and/or indurated pellets, and a second feeder (6) for feeding green pellets produced from iron ore concentrate in a pelletizing unit (9), a traveling grate (4) and a reactor for further treatment of the feed material,
wherein the first feeder (1) is provided to feed the lump ore and/or indurated pellets, and the second feeder (6) is provided to feed green pellets onto the traveling grate (4), and wherein the first feeder (1) for feeding the lump ore and/or indurated pellets is provided upstream of the second feeder (6) for feeding green pellets,
characterized in that the reactor is a rotary kiln (15) wherein the material in the reactor is heated to a temperature of about 800 to 1200 °C.

2. System according to claim 1, **characterized in that** the lump ore forms a hearth layer (5) on the traveling grate (4) for holding the green pellets.

3. System according to claim 1 or 2, **characterized in that** the first feeder (1) comprises a feed bin (2).

4. System according to any of the preceding claims, **characterized in that** a segment gate (3) arrangement is provided above the travelling grate (4).

5. System according to any of the preceding claims, **characterized in that** a pelletizing unit (9) is provided upstream the second feeder (6).

6. System according to any of the preceding claims, **characterized in that** the traveling grate (4) is equipped with a hood (12) that is divided into several process zones.

7. System according to claim 6, **characterized in that** the process zones comprise wind boxes (13) sealed towards the traveling grate (4).

8. System according to claim 7, **characterized in that** below the wind boxes (13) a duct is provided comprising a valve arrangement for controlling the gas flow through the traveling grate (4).

9. System according to any of claims 6 to 8, **characterized in that** the reactor comprises an after burning chamber (18) and that an offgas conduit of the after burning chamber (18) is connected to the hood (12) of the traveling grate (4).

10. System according to any of the preceding claims, **characterized in that** between the traveling grate (4) and the reactor a refractory lined chute (16) is provided.

11. Method for operating a system according to any of the preceding claims, wherein the lump ore and/or indurated pellets are fed onto the traveling grate (4) by the first feeder (1) at a position upstream of the second feeder (6) such that the lump ore and/or indurated pellets form a hearth layer (5) on the traveling grate (4) for receiving green pellets from the second feeder (6), **characterized in that** the reactor is a rotary kiln (15) for heating the material to a temperature of about 800 to 1200 °C.

12. Method according to claim 11, wherein lump ore and/or indurated pellets and/or green pellets form a bed on the traveling grate (4) and wherein the bed height on said traveling grate (4) is controlled by varying the velocity of the traveling grate (4).

Patentansprüche

1. System zur Behandlung von Pellet-Feinpartikeln und/oder stückigem Erz und/oder verhärteten Pellets, mit einer ersten Zufuhreinrichtung (1) zum Zuführen von stückigem Erz und/oder verhärteten Pellets, und einer zweiten Zufuhreinrichtung (6) zum Zuführen von Grünpellets, die aus Eisenerzkonzentrat in einer Pelletiereinheit (9) hergestellt sind, einem Wanderrost (4) und einem Reaktor zur Weiterbehandlung des Zuführmaterials, wobei die erste Zufuhreinrichtung (1) dazu vorgesehen ist, das stückige Erz und/oder die verhärteten Pellets zuzuführen, und wobei die zweite Zufuhreinrichtung (6) dazu vorgesehen ist, Grünpellets auf den Wanderrost (4) aufzugeben, und wobei die erste Zufuhreinrichtung (1) zum Zuführen des stückigen Erzes und/oder der verhärteten Pellets stromaufwärts der zweiten Zufuhreinrichtung (6) für die Zufuhr von Grünpellets vorgesehen ist, **dadurch gekennzeichnet, dass** der Reaktor ein Drehrohrofen (15) ist, wobei das Material in dem Reaktor auf eine Temperatur von etwa 800 bis 1200 °C erhitzt wird.

2. System nach Anspruch 1, **dadurch gekennzeichnet, dass** das stückige Erz auf dem Wanderrost (4) eine Herdschicht (5) zum Halten der Grünpellets ausbildet.

3. System nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die erste Zufuhreinrichtung (1) einen ersten Zufuhrbehälter (2) aufweist.

4. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** oberhalb des

Wanderrostes (4) eine Segmenttoranordnung (3) vorgesehen ist.

5. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** stromaufwärts der zweiten Zufuhreinrichtung (6) eine Pelletiereinheit (9) vorgesehen ist.

6. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Wanderrost (4) eine Haube (12) aufweist, die in mehrere Prozesszonen unterteilt ist.

7. System nach Anspruch 6, **dadurch gekennzeichnet, dass** die Prozesszonen Windkästen (13) aufweisen, welche in Richtung des Wanderrostes (4) abgedichtet sind.

8. System nach Anspruch 7, **dadurch gekennzeichnet, dass** unterhalb der Windkästen (13) ein Kanal mit einer Ventilanordnung zur Steuerung der Gasströmung durch den Wanderrost (4) vorgesehen ist.

9. System nach einem der Ansprüche 6 bis 8, **dadurch gekennzeichnet, dass** der Reaktor eine Nachbrennkammer (18) aufweist und dass eine Abgasleitung der Nachbrennkammer (18) mit der Haube (12) des Wanderrostes (4) verbunden ist.

10. System nach einem vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** zwischen dem Wanderrost (4) und dem Reaktor eine feuerfest ausgekleidete Rutsche (16) vorgesehen ist.

11. Verfahren zum Betreiben eines Systems nach einem der vorhergehenden Ansprüche, wobei das stückige Erz und/oder die verhärteten Pellets durch die erste Zufuhreinrichtung (1) an einer Position stromaufwärts der zweiten Zufuhreinrichtung (6) auf den Wanderrost (4) gefördert werden, so dass das stückige Erz und/oder die verhärteten Pellets auf dem Wanderrost (4) eine Herdschicht (5) zur Aufnahme von Grünpellets von der zweiten Zufuhreinrichtung (6) bilden, **dadurch gekennzeichnet, dass** der Reaktor ein Drehrohrofen (15) zum Aufheizen des Materials auf eine Temperatur von etwa 800 bis 1200 °C ist.

12. Verfahren nach Anspruch 11, wobei stückiges Erz und/oder verhärtete Pellets und/oder Grünpellets ein Bett auf dem Wanderrost (4) bilden und wobei die Betthöhe auf dem Wanderrost (4) durch Variation der Geschwindigkeit des Wanderrostes (4) gesteuert wird.

Revendications

1. Système pour le traitement de fines de granulés et/ou de minerai en morceaux et/ou de granulés indurés, comprenant un premier dispositif d'alimentation (1) pour distribuer du minerai en morceaux et/ou des granulé indurés, et un deuxième dispositif d'alimentation (6) pour distribuer des granulés verts produits à partir d'un concentré de minerai de fer dans une unité de granulation (9), une grille de déplacement (4) et un réacteur pour le traitement ultérieur du matériau distribué,
dans lequel le premier dispositif d'alimentation (1) est fourni pour distribuer le minerai en morceaux et/ou les granulés indurés, et le deuxième dispositif d'alimentation (6) étant fourni pour distribuer des granulés verts sur la grille de déplacement (4), et dans lequel le premier dispositif d'alimentation (1) pour distribuer le minerai en morceaux et/ou les granulés indurés est fourni en amont du deuxième dispositif d'alimentation (6) pour distribuer des granulés verts,
caractérisé en ce que le réacteur est un fourneau rotatif (15) où le matériau dans le réacteur est chauffé à une température de près de 800 à 1200 °C.

2. Système selon la revendication 1, **caractérisé en ce que** le minerai en morceaux forme une couche de foyer (5) sur la grille de déplacement (4) pour contenir les granulés verts.

3. Système selon la revendication 1 ou 2, **caractérisé en ce que** le premier dispositif d'alimentation (1) comprend une trémie d'alimentation (2).

4. Système selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**un agencement d'entrée de segmentation (3) est fourni au-dessus de la grille de déplacement (4).

5. Système selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**une unité de granulation (9) est fournie en aval du deuxième dispositif d'alimentation (6).

6. Système selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la grille de déplacement (4) est équipée d'une hotte (12) qui est divisée en plusieurs zones de traitement.

7. Système selon la revendication 6, **caractérisé en ce que** les zones de traitement comprennent des boîtes à vent (13) hermétiques vers la grille de déplacement (4).

8. Système selon la revendication 7, **caractérisé en ce que**, sous les boîtes à vent (13), un conduit est fourni qui comprend un agencement de vannes pour contrôler le flux de gaz à travers la grille de déplacement (4).

9. Système selon l'une quelconque des revendications 6 à 8, **caractérisé en ce que** le réacteur comprend une chambre de post-combustion (18) et **en ce qu'**une conduite de gaz perdu de la chambre de post-combustion (18) est raccordée à la hotte (12) de la grille de déplacement (4).

10. Système selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**une glissière à chemisage réfractaire (16) est fournie entre la grille de déplacement (4) et le réacteur.

11. Procédé pour exploiter un système selon l'une quelconque des revendications précédentes, dans lequel le minerai en morceaux et/ou les granulés indurés sont distribués sur la grille de déplacement (4) par le premier dispositif d'alimentation (1) dans une position en amont du deuxième dispositif d'alimentation (6) de manière à ce que le minerai en morceaux et/ou les granulés indurés forment une couche de foyer (5) sur la grille de déplacement (4) pour recevoir des granulés verts du deuxième dispositif d'alimentation (6), **caractérisé en ce que** le réacteur est un fourneau rotatif (15) pour chauffer le matériau à une température de près de 800 à 1200 °C.

12. Procédé selon la revendication 11, dans lequel du minerai en morceaux et/ou des granulés indurés et/ou des granulés verts forment un lit sur la grille de déplacement (4) et dans lequel la hauteur du lit sur ladite grille de déplacement (4) est contrôlée en faisant varier la vélocité de la grille de déplacement (4).

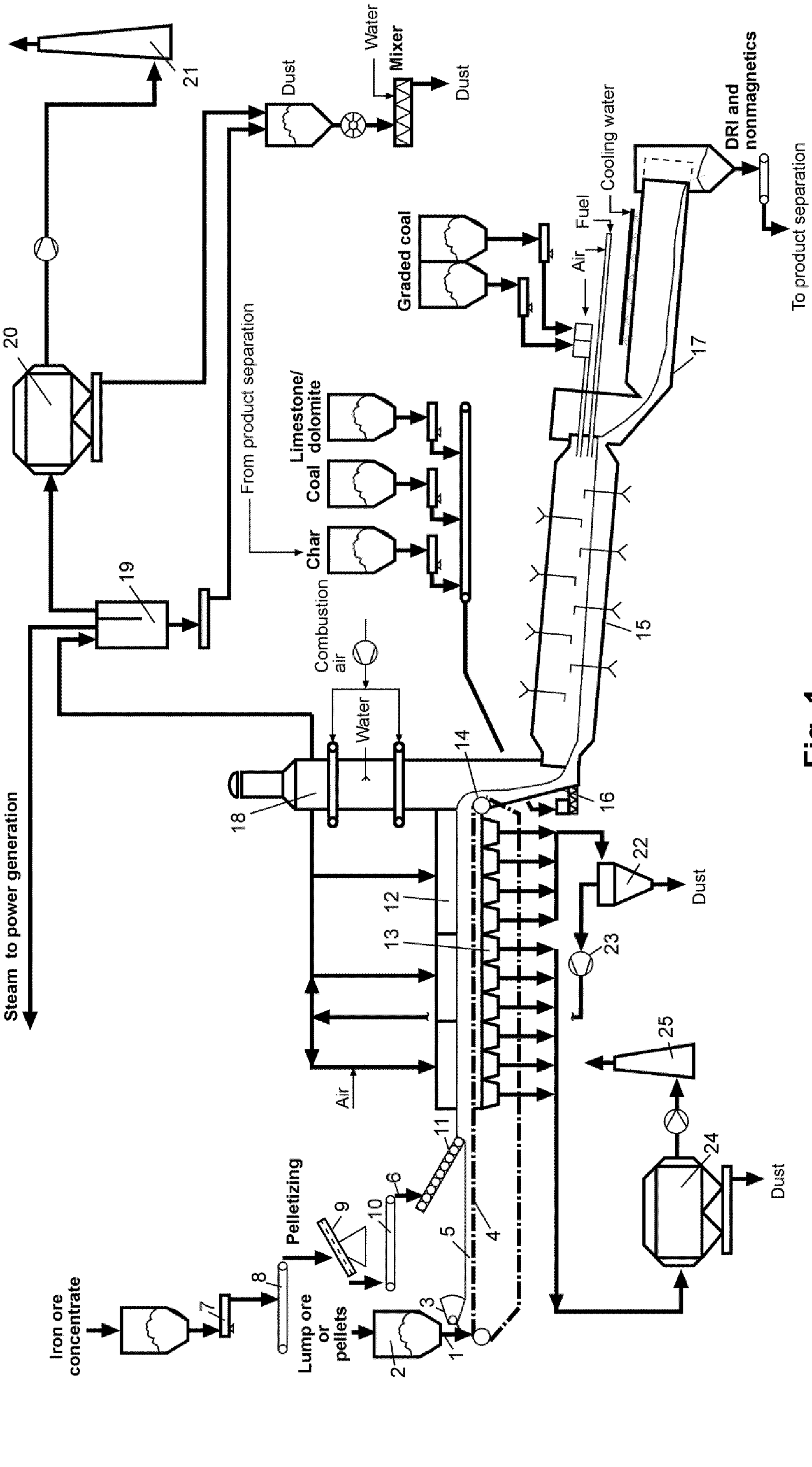
Steam to power generation
21
20
Dust
Water
Mixer
Dust
From product separation
Cooling water
DRI and nonmagnetics
To product separation
Graded coal
Fuel
Air
Limestone/ dolomite
Coal
Char
19
Combustion air
Water
18
14
15
17
16
22
Dust
12
13
23
Air
25
24
Dust
11
Pelletizing
9
10
6
5
4
8
7
3
Iron ore concentrate
Lump ore or pellets
2
1

Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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