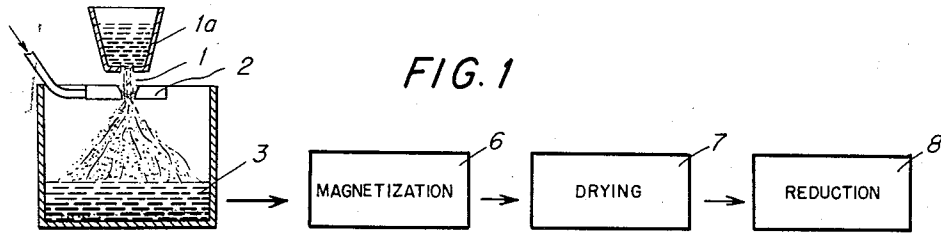
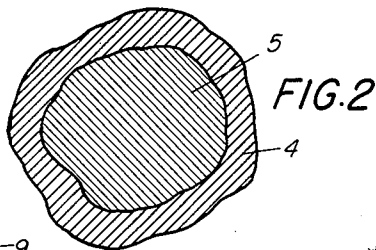
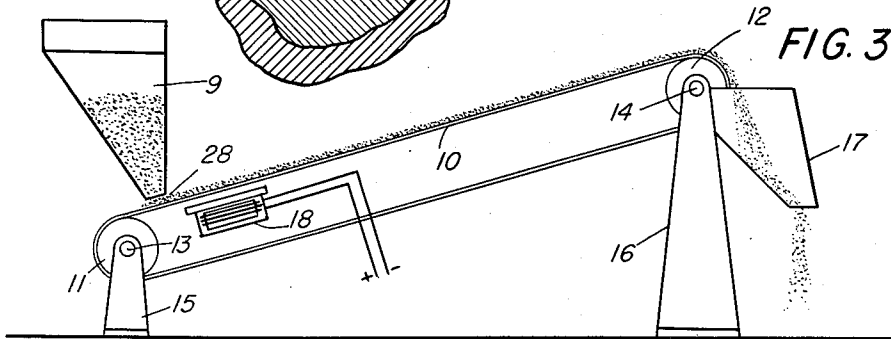
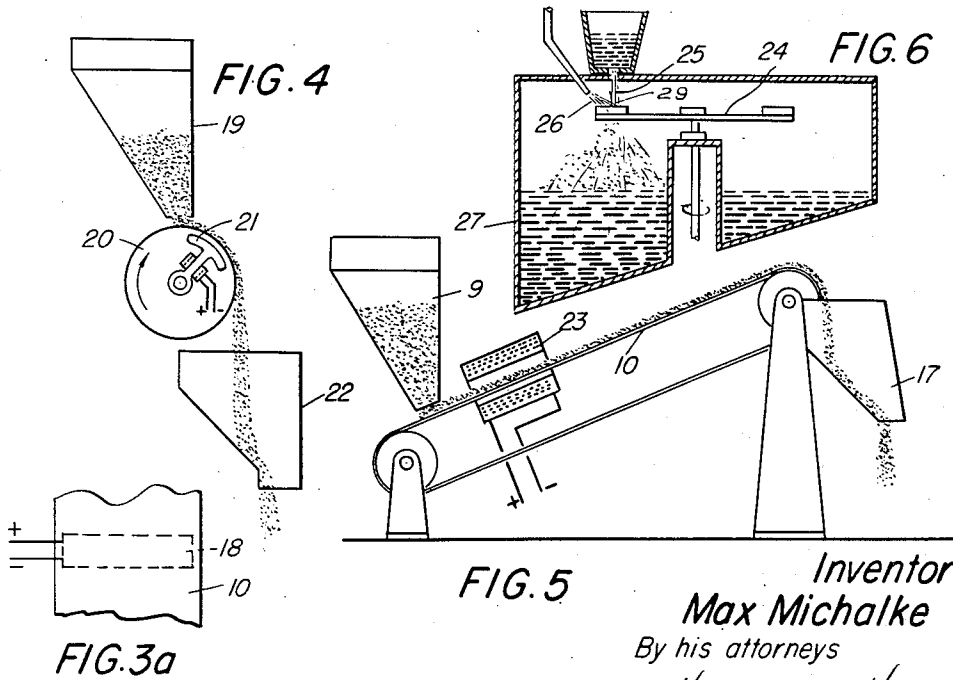


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PROCESS FOR THE PREVENTION OF SEPARATION AND
DUST FORMATION IN MAGNETIZABLE POWDERS
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PROCESS FOR THE PREVENTION OF SEPARATION AND DUST FORMATION IN MAGNETIZABLE POWDERS

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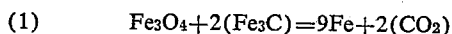
Claims priority, application Germany November 30, 1953

6 Claims. (Cl. 75—5)

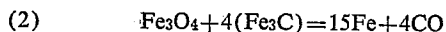
This invention relates to a process for preventing the separation of components in a mixture of magnetizable powders and the formation of dust from magnetizable powders.

The process is applicable to various types of magnetizable powders such as metal powders and is especially adaptable for use in the production of iron powder where problems of separation and dust formation are particularly aggravated. The invention will be described in connection with the production of iron powder, it being understood, however, that the invention is generally useful wherever it is desired to prevent the dusting of magnetizable materials in powder form, or the separation of one component from a mixture of magnetizable powders.

In the preparation of iron powder, raw particles are formed which comprise a core of cementite crystals in a matrix of martensite, and a crust or shell of magnetic iron oxide (Fe_3O_4). This raw powder is charged to a reduction oven, where at a temperature of around 1,000 to 1,100° C. the iron oxide is reduced according to the reactions:



and



In carrying this process into practice, it is found that the outer crust of the particles becomes shattered, releasing very fine particles of magnetic iron oxide. These particles are borne up into the air where they create a great annoyance to the personnel engaged in carrying out the operation.

Moreover, it is found that the powdered magnetic oxide collects on the surfaces of the ducts and hoppers leading into the reduction oven so that the material delivered to the reduction oven is poor in oxygen and hence the finished product is too rich in carbon. On occasion this collected dust will drop off and pass into the oven with the result that every now and again the finished product is too poor in carbon. The over-all result is a non-standard product.

According to the present invention, the separation of one component of a mixture of magnetizable powders from the others, to create a dust problem or otherwise, is avoided by magnetizing the powders, as for example by passing the powders through a magnetic field. In particular, the present invention provides a method for controlling the dust problem in a process for the production of powdered iron by magnetizing the raw iron powder before it has had a chance to form dust.

The invention will be further described with reference to the accompanying drawings, in which:

Fig. 1 is a flow diagram showing the several steps in a process for the production of powdered iron according to the invention.

Fig. 2 is a cross sectional view of a raw iron particle.

Fig. 3 is a schematic view, partly in section and partly

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in elevation, of a preferred apparatus for magnetizing iron powder in accordance with the invention.

Fig. 3a is a fragmentary plan view showing the relation of a magnet and belt in the form of apparatus shown also in Fig. 3.

Fig. 4 is a schematic elevational view partly in vertical section of a second form of apparatus for magnetizing metallic powders in accordance with the invention.

Fig. 5 is a schematic elevational view partly in vertical section of still a third form of apparatus which can be used to magnetize metallic powders according to the invention.

Fig. 6 is a schematic elevational view of an apparatus according to the invention by which molten metal can be simultaneously atomized and magnetized.

The following description will illustrate the invention by reference to a process for the production of powdered iron, it being understood that the invention is applicable to other situations where there is danger of separation or dust from powdered magnetic material.

As shown in Fig. 1, powdered iron may be made by passing a stream 1 of molten iron or steel about 10 to 20 mm. thick and having a carbon content in the neighborhood of 4% from a crucible 1a through a high-pressure circular air jet 2, into a bath of water 3. The pressure in the air jet 2 is normally on the order of about 2 to 6 atmospheres.

Under these conditions, the stream 1 of molten iron is broken up by the air jet 2 into particles having an average diameter of around 0.01 to 1 mm. As the particles are formed, the oxygen of the air reacts with the outer surface of the molten iron particles to form a magnetic oxide (Fe_3O_4) crust. A typical particle is shown in Fig. 2, the portion 4 representing the oxide crust. The central core 5 is composed of cementite crystals in a martensite matrix.

According to the prior practice, these particles from the water bath 3, would have been dried and thence charged to a reduction oven, where as explained above, the iron oxide reacts with the carbon in the steel to form oxides of carbon leaving substantially pure iron as the final product.

During the drying operation and in the subsequent heating in the oven, the oxide crust on the powdered particles would be shattered with the production of a very fine Fe_3O_4 powder. This powder would escape into the workroom causing much annoyance and would also gather in the various pieces of equipment, particularly in the ducts and hoppers leading to the reduction oven, causing variations in the carbon content of the final powder.

It has previously been attempted to prevent this dusting by dampening the iron powder. This expedient, however, caused bridging in hoppers and ducts and spattering in the reduction oven.

In the process according to the present invention, these objections are overcome by interposing a magnetization step 6 before the drying step 7 and reduction step 8 (Fig. 1).

The apparatus used to accomplish the magnetization of the powder may vary widely.

The preferred embodiment is shown in Fig. 3, in which the damp powder from the water bath 3, is placed in a hopper 9, whence it is fed onto an endless belt 10, running between two rollers 11 and 12. The rollers 11 and 12 are supported on trunnions 13 and 14 which in turn are mounted on uprights 15 and 16. One of the rollers, for example, the lower roller 11, is turned by any convenient source of power such as an electric motor (not shown).

The powder falls onto the belt as at 28 and is carried upwardly and dumped into a second hopper 17 whence

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it can be delivered to a drying device (not shown). The magnetization of the powder being carried from the hopper 9 to the hopper 17 is accomplished by means of an electromagnet 18 located close to the lower face of the upper span of the belt 10. It will be understood that the electromagnet 18 or a series of such magnets extends the width of the belt 10 as shown for example in Fig. 3a.

A different form of apparatus is shown in Fig. 4. Here the powder from water bath 3 is placed in a hopper 19, whence it is fed onto a non-magnetic roller 20. The roller 20 is hollow and contains in its interior an electromagnet 21 shaped to correspond with the interior surface of the cylinder. The powder falling from hopper 19 is carried by the surface of cylinder 20, magnetized by the magnet 21, and falls into a second hopper 22, whence it can be passed to the drying stage as described above.

A third embodiment of the invention is shown in Fig. 5. The arrangement there is very similar to that shown in Fig. 3, in that the iron powder from water bath 3 is placed in a hopper 9 and is fed onto a moving belt 10. The magnetization is accomplished, however, by passing the powder carried on belt 10 through the center of a coil 23. The magnetized powder is then delivered to hopper 17.

In the magnetization of raw iron powder, the cores of the powder particles become individual magnets, and bind the oxidized crust to themselves so that the dust is not formed and separation of the oxide from the core is avoided. The intensity of the magnetic field will vary from case to case, but is generally strong enough to saturate magnetically the individual cores of the powder particles. The intensity of the magnetic field is practically independent of the particle size and is also independent of the temperature as long as this is below the Curie point. As a practical matter, however, it is desirable to keep the temperature of the powder before and during magnetization below 100° C., so that the powder is not prematurely dried.

The process has been described in connection with one method for the production of powdered iron in which the iron is atomized with compressed air. It is, however, applicable equally well to other processes for making powdered iron, for example, where the iron is atomized by a jet of steam, or with high-pressure water.

A still different embodiment of the invention is illustrated in Fig. 6. As shown in that figure, a stream 25 of molten iron about 10 to 20 mm. in diameter, and having a carbon content of around 4% is discharged against a spinning disc 24. A jet of water 26, is also discharged at the point of contact 29 between the steel and the disc 24. Contact of the stream 25 with disc 24 atomizes the iron, forming particles having a martensitic core and a magnetic oxide crust as described above. The particles fall into a water bath 27. In accordance with the present invention, disc 24 may itself be magnetized so that the particles are magnetized as they are formed and upon removal from the water bath may be processed in conventional manner.

It will be understood that in the reduction oven the particles are heated well above their Curie point (about 770° C.) and are thus demagnetized. However, even before this temperature is reached, sintering has begun, preventing further dust formation.

The present invention as described above provides a process for rendering powdered magnetic material dust free and prevents the separation of mixtures of magnetic particles. It is particularly applicable to the production of powdered iron by the methods outlined,

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It will be obvious that many variations can be made in the apparatus disclosed for practicing the invention. For example, where electromagnets have been disclosed, it is obvious that permanent magnets may be used instead, without departing from the spirit of the invention.

It is also considered evident that the fullest advantages of the present invention are realized where the material which it is desired to keep from forming dust is a magnetically retentive material. Similarly, where it is desired to prevent the components of a mixture of magnetic materials from separating, it is desirable that at least one of these materials be magnetically retentive.

As applied to the production of powdered iron, it will be evident that the invention is most useful where the raw iron particles contain sufficient carbon to be magnetically retentive. In such case, the present invention not only eliminates the annoyance of air contamination by iron oxide dust and maintains the quality of the final product more nearly constant, but also permits the raw powder to be packed more tightly than has hitherto been found possible.

What I claim is:

1. In a method for the production of powdered iron comprising atomizing molten iron in the presence of an oxidizing agent to form raw iron particles having a shell of magnetic iron oxide and a core containing iron and carbon, and subsequently reheating the raw particles to convert them to elemental iron, the combination therewith of magnetizing said raw particles prior to the reheating to prevent dust formation during the reheating.

2. In a process for the production of powdered iron, comprising atomizing molten carbon-containing iron in the presence of an oxidizing agent to form raw iron particles having a martensitic core and a crust of magnetic iron oxide, and subsequently reheating the raw particles to convert them to elemental iron, the combination therewith of passing said raw particles through a magnetic field to magnetize the cores of said particles, and thereby prevent dust formation during reheating.

3. A method for treating a metallic powder mixture having a plurality of components all of which are magnetizable and at least one of which is magnetically retentive, to prevent separation of said components, which comprises subjecting said mixture to the action of a magnetic field to magnetize at least said magnetically retentive component.

4. In a process for the production of powdered iron comprising atomizing molten carbon-containing iron in the presence of an oxidizing agent to form hot raw iron particles having a shell of magnetic iron oxide and a core containing iron and carbon, putting said hot iron particles into a water bath to cool them, drying the cooled particles and subsequently reheating the particles to convert them to elemental iron, the combination therewith of magnetizing said raw particles prior to drying to prevent dust formation during drying and reheating.

5. The process claimed in claim 4 in which the particles are removed from the water bath and magnetized while still wet.

6. The process claimed in claim 4 wherein the particles are magnetized prior to being put into the water bath.

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