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METHOD OF AGGLOMERATING ORE

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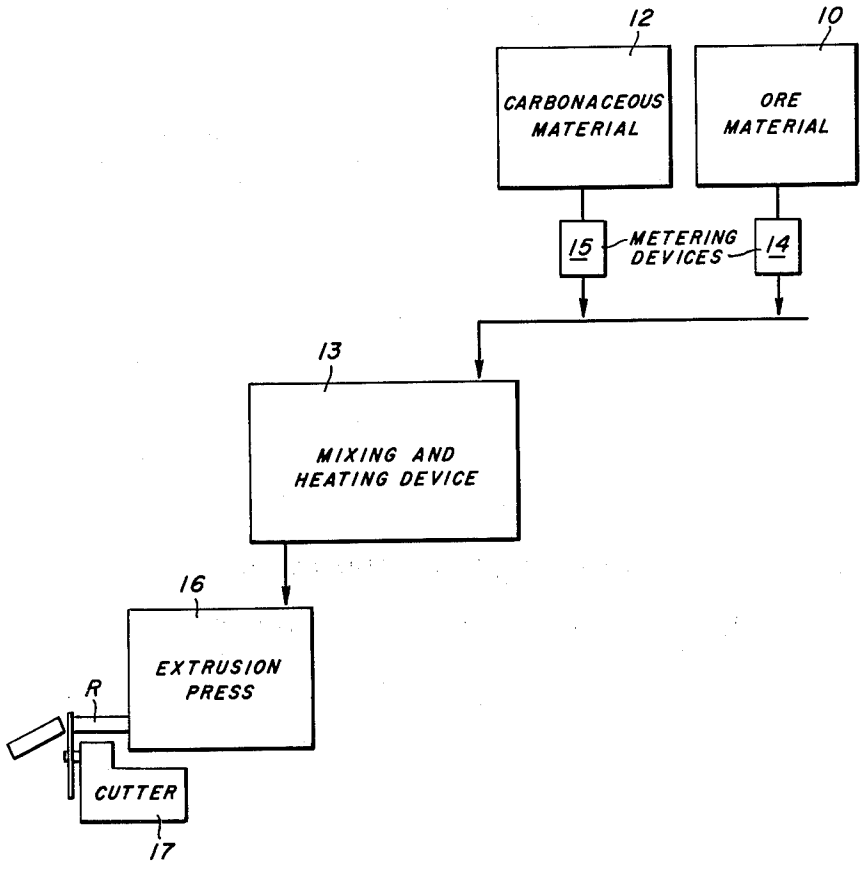


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# METHOD OF AGGLOMERATING ORE

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This invention relates to an improved method of agglomerating ore fines or the like.

An object of the invention is to provide an improved extrusion method of forming finely divided ore material into agglomerates suitable for charging to a blast furnace.

A more specific object is to provide an extrusion method of forming agglomerates in which a finely divided ore material is mixed with a carbonaceous binder having a softening temperature in the range of about 210° to 725° F., and the mixture is extruded at a temperature within this range without coking the binder.

In the drawing:

The single figure is a schematic flowsheet of my agglomerating method.

The drawing shows schematically a source **10** of a finely divided ore material and a source **12** of carbonaceous material. The ore material should be substantially 100 percent minus ⅛ inch and at least 50 percent minus 100 mesh, but can be selected from a wide choice of materials, such as iron ore, finely divided iron-bearing concentrates, sinter returns, ores of other metals like manganese or zinc, or by-product dusts of potential economic value like ferromanganese downcomer dust. The carbonaceous material must soften yet remain viscous at a moderate temperature in the range of about 210° to 725° F.; otherwise it does not have the desired lubricating and shock-absorbent action. It should have a residual carbon content of at least 55 percent. Examples of suitable carbonaceous materials are pitch (coal tar or petroleum) and high volatile coal. The carbonaceous material should be minus 50 mesh or finer, since coarser sizes cannot be depended upon to mix uniformly with the ore material.

I transfer the ore and carbonaceous materials from the sources **10** and **12** to a mixing device **13**, conveniently a pugmill or a ball mill, where I mix the particles intimately. Preferably I provide conventional automatic metering devices **14** and **15** to regulate the proportions of the two materials going into the mixing device. The final mixture contains about 6 to 21 percent by weight of carbonaceous material. When I use pitch, the proportion is in the lower end of this range, that is, about 6 to 15 percent. When I use coal, the proportion is in the upper end, that is, about 15 to 21 percent. The lower limit is determined by the minimum quantity of binder needed to produce a strong agglomerate. The upper limit is determined only by practical and economic considerations, since a large excess of binder serves no purpose.

I heat the mixture of particles to a temperature within a range of about 220° to 725° F., either by applying heat externally to the mixing device or in a separate heater. As pitch is heated, it softens gradually without having a sharp melting point, but specifications of pitch sold commercially usually include a nominal softening temperature. This is the temperature at which a ½ inch cube of the material suspended from a length of B. and S. Gage No. 12 copper wire and heated in an air bath at the rate of 5° C. per minute falls from the wire. When I use pitch, I heat the mixture to a temperature at least 10° F. above the softening temperature of the pitch, but not high enough to cause any significant devolatilization, that is, not more than about 50° F. above the softening temperature. When I use coal, I heat the mixture to a



temperature of about 600° to 725° F., or preferably 650° to 700° F.

Next I transfer the heated mixture to a conventional extrusion press **16**. Although the drawing shows the mixing device and extrusion press as separate items, conveniently they are formed as a single piece of equipment. A conventional extrusion press for particulate material, such as extrudable refractories, customarily includes a pugmill into which the extrusion materials are fed and mixed, a screw or plunger means for urging material from the pugmill into a chamber, and a die through which material is forced as it leaves the chamber. I use a die of relatively small diameter, commonly ¾ to 1 inch. I can apply heat to both the pugmill section and to the auger or plunger section by conventional means, such as electrical heating tape, or gas-fired heaters or a circulating heat transfer medium. The material discharges from the extrusion press in the form of a rod R, which can be broken or cut into pieces of appropriate length in any known manner, such as with a cutter **17**.

*Example I*

As a specific example of my invention, I mixed 88 parts by weight of ferromanganese downcomer dust with 12 parts by weight of pitch (250° F. softening temperature). I mixed the materials in a muller until I achieved a uniform mixture (about 3 to 5 minutes). I heated the mixture to about 260° F. and fed it to an extrusion press and extruded it at a rate of about 15 inches a minute. Simulated blast furnace tests on the resulting agglomerate show that it has properties required for blast furnace use.

*Example II*

I mixed 85 parts by weight of Lac Jeannine iron ore concentrate (75% minus 325 mesh) with 15 parts by weight of Maple Creek coal (100% minus 50 mesh), a high-volatile coal. I performed the mixing in a ball mill. I heated the mixture to about 650° F. and extruded it through a die ¾ inch in diameter at a rate of about 15 inches per minute. The resulting agglomerates again appeared satisfactory for blast furnace use.

From the foregoing description it is seen that my invention affords a simple inexpensive method of agglomerating ore materials and making a product suitable for charging to a blast furnace. It is critical to the successful practice of the invention that prior to the extrusion step the carbonaceous material is heated only to a temperature at which it softens, and not to a temperature at which there is any significant coking. The softened material acts as a lubricant in the extrusion press, while coke is hard and brittle and cannot be extruded. Agglomerates produced by my method contain pitch or coal as a binder in substantially their original state, although of course the binder cokes later when the agglomerates are charged to a blast furnace. For this reason the binder should have a residual carbon content of at least 55 percent.

While I have shown and described certain preferred embodiments of my invention, it is apparent that other modifications may arise. Therefore, I do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

I claim:

1. A method of agglomerating ore material fines comprising mixing minus ⅛ inch fines with a carbonaceous material which has a softening temperature in the range of about 210° to 725° F. and a residual carbon content of at least 55 percent in proportions to provide about 6 to 21 percent by weight of carbonaceous material in the resulting mixture, heating the mixture to a temperature within the range of about 220° to 725° F. to soften the carbonaceous material without significantly coking it, and extruding the heated mixture with the softened carbon-

aceous material acting as a lubricant during extrusion, said carbonaceous material acting as a binder in substantially its originl state in the extruded product after the product cools and the carbonaceous material solidifies.

2. A method as defined in claim 1 in which the carbonaceous material is selected from the group which consists of coal tar pitch, petroleum pitch and high volatile coal.

3. A method of agglomerating ore material fines comprising mixing minus ⅛ inch fines with pitch having a residual carbon content of at least 55 percent and a nominal softening temperature of at least 210° F. in proportions to provide about 6 to 15 percent by weight of pitch in the resulting mixture, heating the mixture to a temperature at least 10° F. above the softening temperature of the pitch but to a maximum of about 50° F. thereabove, thus softening the pitch without significantly coking it, and extruding the heated mixture with the softened pitch acting as a lubricant during extrusion, said pitch acting as a binder in substantially its original state in the extruded product after the product cools and the pitch solidifies.

4. A method of agglomerating ore material fines comprising mixing minus ⅛ inch fines with high volatile coal which has a residual carbon content of at least 55 percent in proportions to provide about 15 to 21 percent by weight



of coal in the resulting mixture, heating the mixture to a temperature in the range of about 600° to 725° F. to soften the coal without significantly coking it, and extruding the heated mixture with the softened coal acting as a lubricant during extrusion, said coal acting as a binder in substantially its original state in the extruded product after the product cools and the coal solidifies.

5. A method as defined in claim 4 in which the mixture is heated to a temperature in the range of about 650° to 700° F.

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