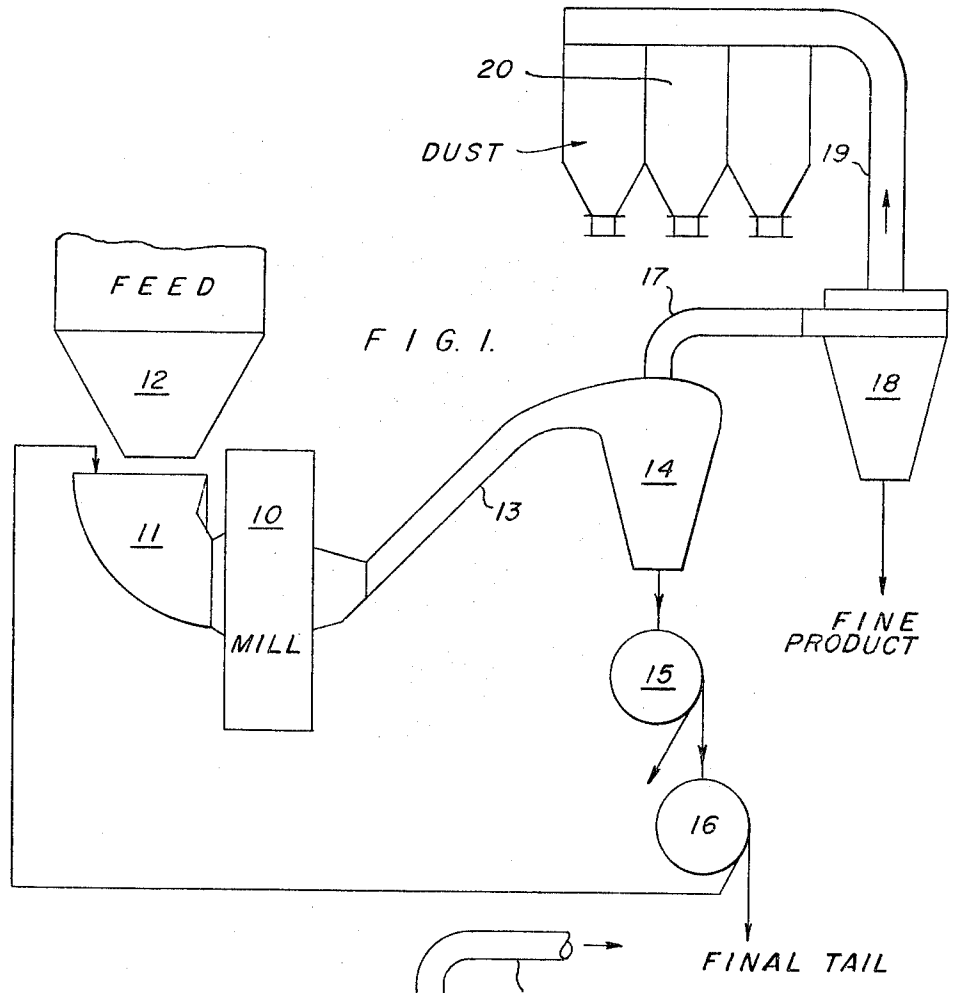
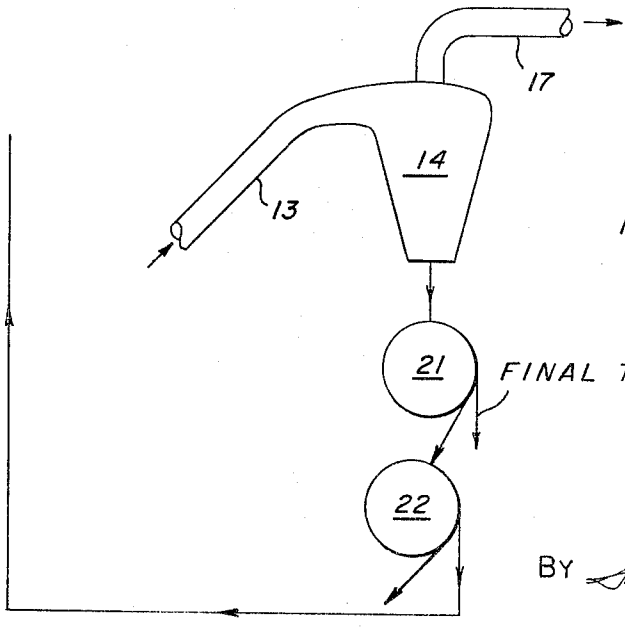
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BENEFICIATION OF MAGNETIC IRON ORES

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F I G. 1.



F I G. 2.

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BENEFICIATION OF MAGNETIC IRON ORES

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This invention relates to the beneficiation of magnetic ores and more particularly to the beneficiation of ores containing components amenable to magnetic separation wherein the ore contains aggregates of substantially barren gangue particles and a non-uniform distribution of aggregates and free individual crystals of the mineral to be recovered. Typical of such ores are the so-called "magnetic" taconites of Minnesota which up to the present time have represented a major reserve of iron-ore, and in which extreme difficulty has been encountered in producing high grade iron concentrates.

In prior Weston Patent No. 2,962,231 granted November 29, 1960, there was disclosed a method of beneficiation of iron-ores containing aggregates of primary crystals of iron mineral which involved recycling a coarse concentrate to a dry comminution circuit.

While the process of the said patent has proven effective on ores where the iron mineral is to be found mainly in aggregates of primary crystals, we have found that when the iron-ore contains a substantial amount of iron mineral both as aggregates and as individual crystals, a much more effective concentration of the iron mineral can be accomplished according to the present invention.

The present invention comprises a method of beneficiating magnetic iron-ores containing aggregates of substantially barren gangue particles and a non-uniform distribution of aggregates and free individual crystals of the mineral to be recovered in which the ore is passed through a dry comminution circuit consisting, for instance, of a dry combined crushing and grinding mill of the type described in prior Weston Patent No. 2,704,636 issued March 22, 1955 which is equipped with an air system adapted to carry the product away from the mill in an air stream and to deposit a coarse product in a coarse products collecting system, a fine product in a fine product collecting system and conventional means such as a multicyclone collector to remove fine dust from the air system. According to the present invention, a coarse product, which consists essentially of material which is primarily of a particle size larger than the natural crystal size of the ore, is separately collected and subjected to dry magnetic concentration to produce a coarse concentrate consisting essentially of aggregates and free individual crystals of the mineral to be recovered, a middling consisting essentially of aggregates of primary crystals of mineral and gangue, and a discardable tailing. The middling is then returned to the inlet side of the milling circuit while the tailing may be discarded and the coarse concentrate may be treated as a final concentrate or subjected to cleaning in the usual way.

According to one embodiment of the invention, the separately collected coarse product is first of all passed over a high speed dry drum type magnetic separator which produces a coarse concentrate which may be treated as a final concentrate or which may be reground for cleaning purposes and a "high speed" tailing which is then passed over a low speed drum type dry magnetic separator which produces a final tailing on the one hand, and a middling on the other, said middling being returned to the inlet side of the milling circuit.

According to the second embodiment of the invention, the separately collected coarse product is first of all passed over a low speed drum type dry magnetic separator which

produces on the one hand a final tailing and on the other a "low speed" concentrate which is then passed over a high speed drum type dry magnetic separator which produces on the one hand a coarse concentrate which may be treated as a final concentrate or passed to regrind prior to cleaning and on the other hand a middling which is returned to the inlet side of the dry milling circuit.

The portion of the milling circuit product which is not separately collected and which consists essentially of separate particles of mineral and gangue of naturally occurring crystaline particle size is collected as a fine product and together with the dust collected in the dust collection system, is subjected to conventional metallurgy for the concentration of the iron mineral. Suitably, the concentration circuit employed will utilize wet magnetic separation.

The invention in its operation will be more fully understood from the following detailed specification taken in conjunction with the accompanying drawings wherein

FIG. 1 is a schematic illustration of a circuit embodying the invention, and

FIG. 2 is a schematic illustration of a portion of the total circuit illustrated in FIG. 1 but illustrating an alternative arrangement of the low and high speed drum type dry magnetic separators.

Referring now more particularly to the drawings, in FIG. 1 there is illustrated schematically a dry comminution mill 10 equipped with a feed chute 11 adapted to receive mill feed from bin 12. The air duct 13 is adapted to conduct air and entrained mill product to the coarse products collector 14 which is adapted to discharge a separately collected coarse product to a high speed drum type dry magnetic separator 15 which is adapted to produce a coarse concentrate and a "high speed" tailing which is passed over low speed drum type dry magnetic separator 16 which is adapted to produce a final tailing and a middling which is returned to the feed chute 11 as indicated.

The fine product of mill 10 which is not collected in coarse products collector 14 passes out therefrom in duct 17 to fine product collector 18 which may consist of one or more conventional cyclone collectors which is adapted to collect fine product and pass the same either to storage or directly to a metallurgical circuit. The dust which is not collected in the cyclone 18 is carried by the air through duct 19 into a dust collecting system which may suitably be of the conventional multicyclone type as indicated by numeral 20 or which may take the form of a venturi scrubber. The product of the duct collection system will normally be combined with the product of the fine collection system for purposes of the subsequent metallurgy.

In the alternative arrangement illustrated in FIG. 2, the dry milling circuit is the same as illustrated in FIG. 1 but the product from the coarse product collector 14 is discharged to low speed magnetic separator 21 which produces a final tailing and a "low speed" concentrate which is passed directly to the high speed drum type dry magnetic separator 22 which produces a concentrate and a middling which is returned to the mill feed hopper 11 as illustrated.

The benefits obtainable according to the process of the invention are quite substantial and are illustrated by the following example which compares the results obtained using the process of this invention with the results obtained by using the process of prior Patent 2,962,231.

Table A illustrates the results obtained in Pilot Plant work on Mesabi Iron Range Magnetic Taconites from Minnesota. A pilot scale dry comminution circuit producing, under conditions of the test, at a rate of approximately half a long ton per hour was brought into balance during test No. 31 with a single dry drum magnetic separator receiving a separately collected coarse product from a coarse products collector similar to that indicated by

reference numeral **14** in FIG. 1, the separator being operated at a slow speed to produce a discardable tailing and a concentrate (in reality a combined concentrate and middlings) which was returned to the inlet side of the comminution circuit (i.e. corresponding to feed hopper **11** on FIG. 1). This operation was in accordance with the teachings of Weston prior Patent No. 2,962,231 and the results achieved under balanced conditions are indicated on the first line of Table 1.

In another test, No. 34, on the same ore using the same comminution circuit, two dry drum type magnetic separators were arranged in the manner illustrated in FIG. 1 to receive a separately collected coarse product as in test No. 31. This separately collected coarse material was fed to a high speed drum to produce a dry coarse concentrate, and a tailings which as fed on to the second drum which was operated at low speed to produce a "dry discardable tailings" and a middlings product which was returned to the dry comminution circuit, i.e., to feed chute **11**. After achieving balanced conditions in the circuit the results obtained were recorded and appear in the second line of Table 1. During both test **31** and **34** the material which was not separately collected from the coarse separator **14** was collected as a fine product and subjected to wet magnetic concentration using the same procedure for each test.

tion of product in a size range larger than the primary crystal size of the contained mineral; collecting separately all of that portion of the milling circuit product which is primarily of a particle size larger than the primary crystal size of said ore; subjecting said collected product to dry magnetic concentration to produce a coarse concentrate consisting essentially of aggregates and free individual crystals of the mineral to be recovered, a middling consisting essentially of aggregates of primary crystals of mineral and gangue and a discardable tailing; and returning the middling to the inlet said of said milling circuit.

2. A method as defined in claim **1** in which the magnetic concentration comprises subjecting the separately collected portion of the milling circuit product to dry magnetic concentration on a drum type dry separator oprated at high speed to produce a coarse concentrate and a "high speed" tailing subjecting the said "high speed" tailing to magnetic concentration on a drum type dry magnetic separator operated at low speed to produce on the hand a discardable tailing and on the other hand a middling for return to the inlet side of the milling circuit.

3. A method as defined in claim **1** in which the magnetic concentration comprises subjecting the separately collected portion of the milling circuit product to magnetic concentration on a drum type dry separator operated at low speed to produce on the one hand a discardable tailing and on the other hand a "low speed" concentrate, subjecting the said "low speed" concentrate to magnetic concentration on a drum type dry magnetic separator operated at high speed to produce a coarse concentrate on the one hand and on the other hand a middling for return to the inlet side of the milling circuit.

Pilot Plant Test Number	Production, Long Tons Per Hour	Dry Coarse Concentrate			Wet Fine Concentrate			Dry Discardable Tailings			Percent wt. of Original Ore recycled to Comminution Circuit
		Percent wt.	Percent Iron	Grind Percent Minus 325	Percent wt.	Percent Iron	Grind Percent Minus 325	Percent wt.	Percent Iron	Grind Percent Minus 325	
31	0.50	None	None	None	38.3	62.8	42.0	33.16	12.77	5.44	150
34	0.49	17.43	63.20	10.16	19.83	64.88	67.96	32.29	13.49	5.23	196

Noteworthy in the results listed is the grade of the dry coarse concentrate in test No. 34 which at 63.20 compares with a wet fine concentrate in test No. 31 at 62.9. Also of significance is the fact that the grind of the coarse concentrate in test 34 was only 10.16% minus 325 as compared to 42.0% minus 325 for the fine wet concentrate of test No. 31. The wet fine concentrate in test No. 34 graded at 64.88 as opposed to 62.8 for test No. 31 indicating an overall improvement in grade of about 1.2% in favour of test No. 34.

What we claim is:

1. A method of beneficiating magnetic iron ores containing aggregates of substantially barren gangu particles and a non-uniform distribution of aggregates and free individual crystals of the mineral to be recovered, said method consisting in; passing the ore through a dry comminution circuit, which is adapted to produce a substantial propor-

References Cited by the Examiner

UNITED STATES PATENTS

2,962,231	11/1960	Weston	241—24
2,990,124	6/1961	Cavanaugh	241—24
3,081,954	3/1963	Heckett	241—24 X
3,148,838	9/1964	Cavanaugh	241—24 X

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