

[54] **METHOD FOR CONTROLLING THE GRIND IN A SINGLE STAGE AUTOGENOUS GRINDING MILL**[75] Inventor: **Robert M. Funk**, Allentown, Pa.[73] Assignee: **Bethlehem Steel Corporation**[22] Filed: **Dec. 17, 1970**[21] Appl. No.: **99,182**[52] U.S. Cl. **241/24**[51] Int. Cl. **B02c 17/00**

[58] Field of Search 241/24, 33, 34, 69, 79, 80, 241/97

[56] **References Cited****UNITED STATES PATENTS**

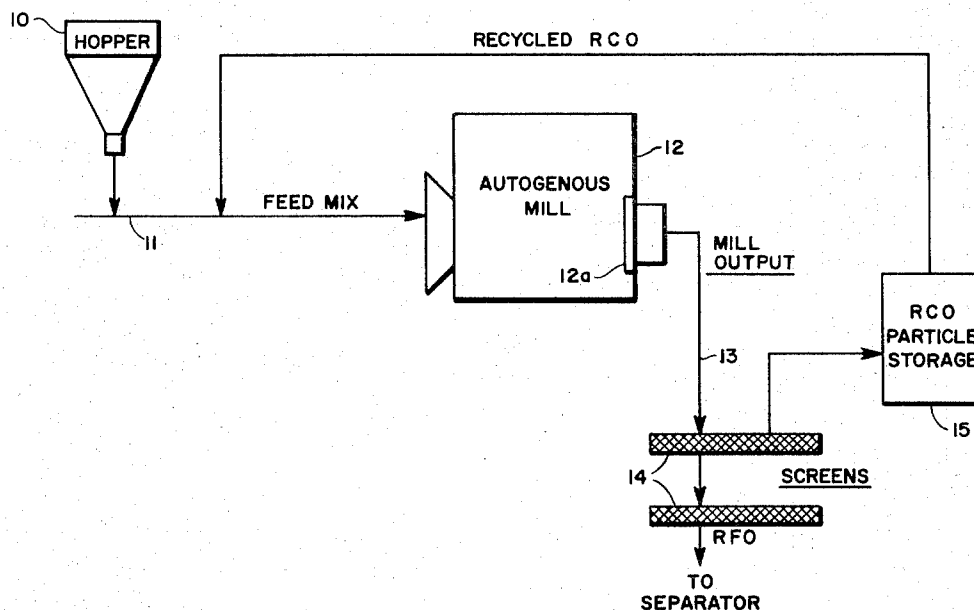
3,231,204	1/1966	Ferguson et al.	241/24
2,381,351	8/1945	Hardinge	241/24 X
2,729,397	1/1956	Weston	241/24
3,078,076	2/1963	Ferguson et al.	241/24 X

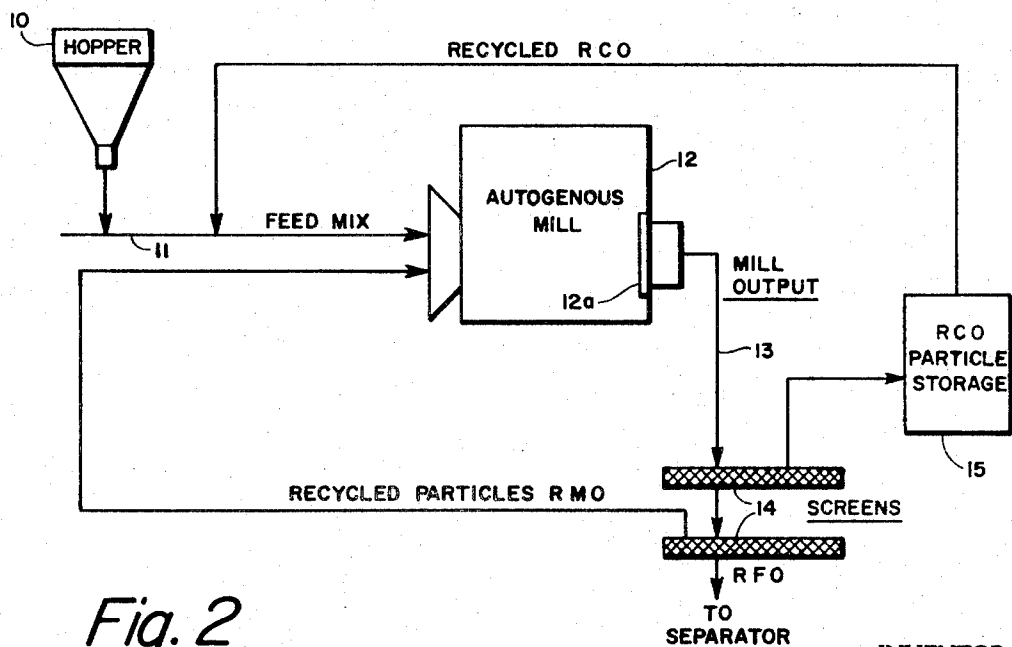
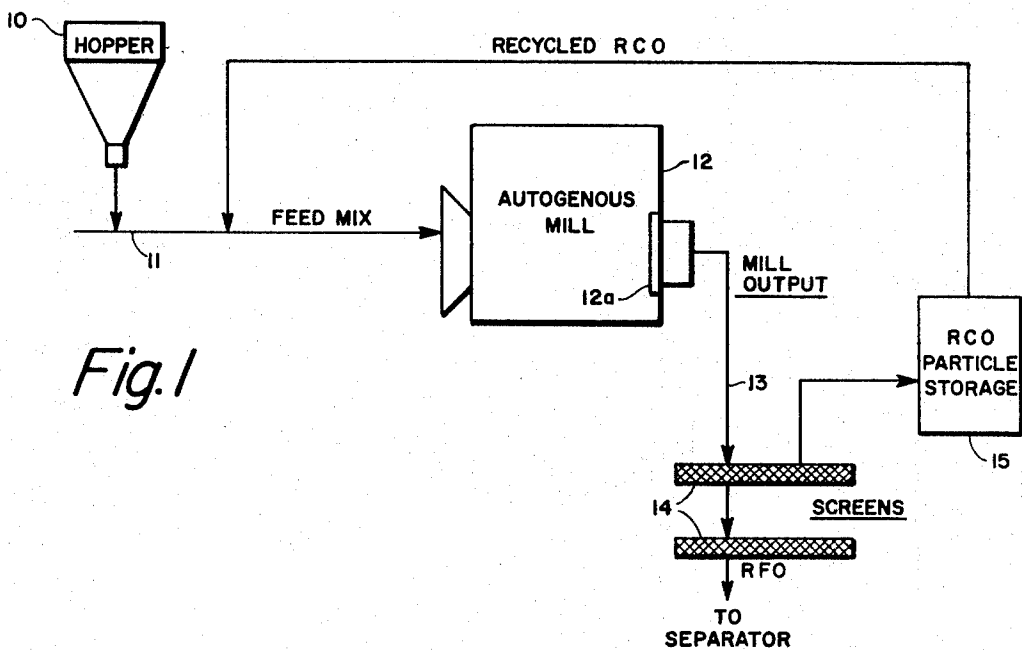
Primary Examiner—Granville Y. Custer, Jr.

Attorney—Joseph J. O'Keefe

[57] **ABSTRACT**

Crushed run-of-the-mine ore is fed to an autogenous mill in size ranges arbitrarily classified as relatively coarse (RCF), relatively medium (RMF) and relatively fine (RFF) particles. The output from the autogenous mill is also arbitrarily classified as relatively coarse (RCO), relatively medium (RMO) and relatively fine (RFO) particles. The particles in the output are smaller than the crushed run-of-the-mine ore fed to the mill. The relatively coarse particles (RCO) of the output are stored, and, intermittently, amounts thereof are returned to the mill as a portion of the feed thereto to maintain a ratio of the size consist in the mill at 35/40 percent relatively coarse:20/30 percent relatively medium:35/40 percent relatively fine particles. The relatively medium particles (RMO) can be recycled to the mill as a part of the feed. The relatively fine (RFO) particles in the output from the mill are passed to beneficiation. Maximum throughput of run-of-the-mine ore at constant power input to the mill is maintained.

1 Claim, 2 Drawing Figures



INVENTOR
Robert M. Funk

BY

Joseph J. O'Keefe
ATTORNEY

METHOD FOR CONTROLLING THE GRIND IN A SINGLE STAGE AUTOGENOUS GRINDING MILL

BACKGROUND OF THE INVENTION

This invention is directed to an improvement in the method of preparing coarse, friable ore containing metal values, such as iron, for beneficiation to recover said metal values. Specifically, the invention is directed to a method of controlling the grind of a raw friable run-of-the-mine ore in an autogenous mill by controlling the size consist therein.

To prepare the run-of-the-mine ore for autogenous grinding, the large pieces of raw ore obtained in mining are crushed to a range of sizes arbitrarily referred to as relatively coarse, relatively medium and relatively fine particles which are fed to the mill. These particles which are fed to the mill hereinafter will be referred to as relatively coarse feed (RCF), relatively medium feed (RMF) and relatively fine feed (RFF). Generally, the above size ranges are set at the primary crusher. However, it is impossible to control the amounts of material in each size range. The autogenous mill produces its own grind of particles hereinafter referred to as relatively coarse output (RCO), relatively medium output (RMO) and relatively fine output (RFO). The size of the RFO particles is less than the size of the RFF particles. The size of the RMO particles is most comparable in size to the RFF particles, and the size of the RCO particles is most comparable in size to the RMF particles. As is well known, a portion of the ore which is ground and passed out of the mill contains particles which are too large to be beneficiated and a portion of the discharge is fine enough to be passed to beneficiation. The particles which are too large for beneficiation are recycled to the mill as part of the feed. The recycled material contains all the particles which are classified as RCO and RMO particles in the output of the mill. If a major portion of the recycled material consists of RMO particles, the amount of the RCF particles and RMF particles in the size consist in the mill is reduced. There is an insufficient amount of RCF particles in the mill for effective grinding. The mill becomes overloaded, necessitating either a cut-back in the amount of run-of-the-mine ore feed to the mill and/or an increase in the power consumption to the mill to maintain production. On the other hand, if the recycled material contains a major portion of RCO particles there is an attendant buildup of this size particle in the size consist in the mill. The mill becomes overloaded with this size particle and a cut-back in the amount of run-of-the-mine ore feed to the mill and/or an increase in the power to the mill is required to maintain production. In either case, production is reduced and power is increased thereby causing an increase in costs and a decrease in efficiency in operation.

It is therefore an object of this invention to provide a method for controlling the size consist in the autogenous mill to control the grinding of a raw friable run-of-the-mine ore in the autogenous grinding mill wherein maximum throughput at constant power to the mill is maintained.

It is another object of this invention to provide a method for grinding raw friable run-of-the-mine ore in an autogenous grinding mill wherein the ratio of relatively coarse, relatively medium and relatively fine particles in the size consist in the mill is controlled to obtain optimum efficiency in the mill.

SUMMARY OF THE INVENTION

Broadly, the method of the invention comprises controlling the amount of the particles having a critical size range recycled to the mill from the discharge therefrom, to control the size consist in the mill.

DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic view of the autogenous grinding mill circuit of the invention.

FIG. 2 is a branch circuit added to the circuit of FIG. 1 whereby the method of the invention can be practiced.

PREFERRED EMBODIMENT OF THE INVENTION

In the practice of the invention, FIG. 1, a raw friable run-of-the-mine ore is crushed in a primary crusher (not shown) and is stored in hopper 10. The primary crusher (not shown) produces crushed raw friable run-of-the-mine ore which contains particles covering a wide scope of particles having sizes which are arbitrarily classified as relatively coarse (RCF), relatively medium (RMF) and relatively fine (RFF). The amounts of each size range from the primary crusher are not readily controllable. Therefore, the crushed raw friable ore delivered to the autogenous mill 12 from storage hopper 10 by the conveyor 11 contains varying amounts of the three size ranges. The size ranges can be +6 inch, -6,+3 inch and -3 inch, respectively. I have found that for optimum grinding efficiency, that is, maximum throughput of ore at constant power, the size consist of the particles in the mill should be in a weight ratio of about 35 percent to about 40 percent particles having a size +6 inch, about 20 percent to about 30 percent particles having a size -6,+3 inch and about 35 to about 40 percent particles having a size -3 inch. Deviations from the desired ratio mentioned above result in either reduced production of the mill at constant power input or increased power input to the mill to maintain production. I have found that by controlling the amount of material from the output of the mill recycled to the feed of the mill, the size consist in the mill can be controlled to contain the above mentioned weight ratio. The particles 13 in the output from the autogenous mill 12 are also classified into three size ranges designated as relatively coarse (RCO), relatively medium (RMO) and relatively fine (RFO). The largest size particles in the output from the mill are controlled by a screen 12a having apertures which will allow all particles smaller than a predetermined size to pass through as the output of the mill. I prefer to use a screen having apertures which will allow particles having a size of up to about -3 inches to pass out of the mill. The particle sizes in the aforementioned output size ranges are fixed by screen 14 having appropriate apertures therein. I prefer to classify the particle size of the output from the mill into the following size ranges: relatively coarse (RCO) +1 inch, relatively medium (RMO) -1,+ ½ inch and relatively fine (RFO) -¾ inch. The size consist of the output from the mill is as follows:

Particle Size	Size	Output from Autogenous Mill
Coarse	+1 inch	7.5%
Medium	-1,+ ½ inch	27.5%
Fine	-¾ inch	75.0%

I have found that the RCO particles are a critical size. The RCO particles are stored in hopper 15. The amount of the RCO particles recycled to the mill is, therefore, easily controlled thereby controlling the size consist in the mill. All the RMO and RFO particles are passed to beneficiation processes (not shown).

As shown in FIG. 2, a variation in the practice of the invention, the RCO particles, that is, the particles +1 inch, from the mill output are passed to storage. Substantially all RMO particles (-1,+ $\frac{1}{2}$ inch) in the output are recycled to the mill and the RFO particles (- $\frac{1}{2}$ inch) are passed to further processing, for example, secondary grinding, froth flotation and/or magnetic separation to recover the metal values therein.

If an imbalance in the size consist in the mill occurs, that is, if the ratio of particles varies from the aforementioned ratio because of the lack of RCO particles, reduction in the mill will be essentially by abrasion rather than by attrition or impact. A material build-up in the mill occurs because reduction by abrasion is a slower and more inefficient method of reducing particle size than is attrition or impact. The result is a net increase in grinding power requirement due to lower feed at the same mill power. To reestablish the ratio of the size consist in the mill, a portion of the RCO particles in the mill output which has been stored is charged into the mill as a portion of the feed thereto. The amount of the critical sized particles in the size consist in the mill is increased. The amounts of the other size particles in the size consist are decreased and the above desired weight ratio in the size consist in the mill is reestablished. Maximum throughput at constant power is now obtained.

If all the RCO particles, +1 inch, from the output are recycled to the mill and an imbalance in the size consist in the autogenous mill is created because the amount of RMF particles therein has increased to more than about 30 percent by weight, the throughput of the autogenous mill is again reduced. The mill will continue to produce an overabundance of RCO particles in the output therefrom. A build-up of this size range in the mill occurs. Power consumption must be increased to maintain maximum throughput. To correct the imbalance, the portion of the RCO particles from the mill output usually recycled as part of the feed to the mill is discontinued. The RCO particles are diverted to a secondary crusher to be reduced in size and passed to beneficiation. The amount of the critical RCO particles in the size consist in the mill is thereby reduced. The desired weight ratio of particles in the size consist is reestablished. The throughput of the mill is reestablished and maximum throughput at constant power is obtained.

In an example of the invention, it was desired to grind 0.6 ton of taconite ore per hour in a pilot plant autogenous grinding mill. The feed to the mill was as follows:

Particle Size	% in Size Consist in Mill
RCF +6 inches	40%
RMF -6,+3 inches	20%
RFF -3 inches	40%

The mill discharge was as follows:

Particle Size	% Discharge from Autogenous Mill
RCO +1 inch	11.3%
RMO (+ $\frac{1}{2}$ inch)	18.5%
(+ $\frac{1}{2}$ inch)	15.4%
RFO - $\frac{1}{2}$ inch	54.8%

The desired particle size for beneficiation was 200 mesh. The mill operated at about 13.4 KW hr./LT. of new feed. Increasing the amount of RCF particles in the size consist in the mill resulted in an increase of the - $\frac{1}{2}$ inch particles in the output. The throughput of the mill was decreased to 0.51 tons per hour. The power to the mill was increased to 14.0 KW hr./LT. of new feed to increase throughput. In order to maintain the desired ratio in the size consist in the mill about 0.10 ton per hour of +1 inch size particles (RCO) from the output of the mill was recycled to the feed to the mill. The desired weight ratio of particles was reestablished in the mill. Throughput in the mill increased to 0.58 tons per hour and the mill power was 13.5 KW hr./LT. of new feed.

Adding an increased amount of RMF particles to increase an amount thereof in the size consist in the mill to more than 20 percent resulted in a drop in the throughput of the mill to 0.52 ton per hour, the power to the mill was increased to 13.8 KW hr./LT. of new feed. The amount of the RCO particles in the mill output which was recycled to the mill was decreased to an amount which reduced the amount of this particle size in the mill to about 20 percent. Throughput of the mill increased 0.58 ton per hour. The power to the mill was reduced to 13.5 KW. hr./LT. of new feed.

In this specification and claims wherever percentages or ratios are referred to, such percentages and ratios are by weight unless otherwise noted.

I claim:

1. An improvement in the method of autogenous grinding run-of-the-mine ore in which the feed to said mill is ore having relatively coarse particles, relatively medium particles and relatively fine particles, the ore discharged from said mill is classified into relatively coarse particles, relatively medium particles and relatively fine particles, and the relatively fine particles discharged from said mill are passed to beneficiation, the improvement comprising passing that portion of the ore discharged from said mill and classified as relatively coarse particles to storage and intermittently feeding a portion of the relatively coarse particles from storage to said mill to control the ratio of the amount of relatively coarse particles, relatively medium particles and relatively fine particles in the size consist in the mill.

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