Jan. 20, 1970 R. F. DORE 3,490,702

METHOD OF ACCELERATING PRODUCTION OF PORTLAND CEMENT AND SIMILAR MATERIAL

Filed Oct. 24, 1966

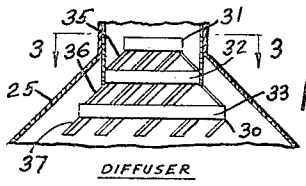


FIG. 2.

FIG. 3.

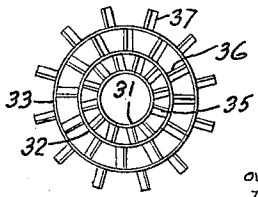


FIG. 4.

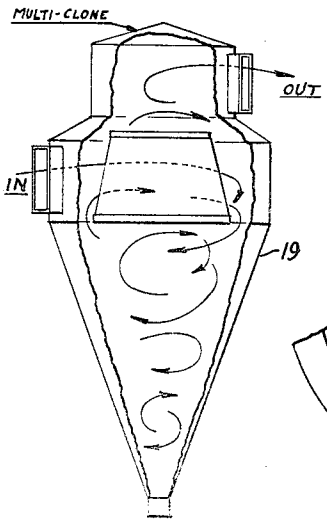
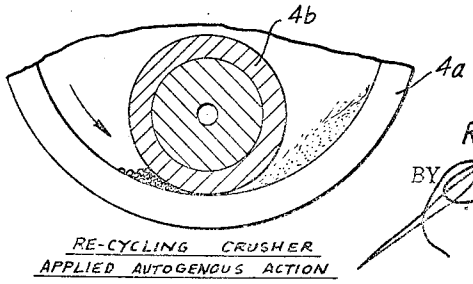


FIG. 5.

FIG. 7.



RE-CYCLING CRUSHER APPLIED AUTOGENOUS ACTION

FIG. 6.

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METHOD OF ACCELERATING PRODUCTION OF PORTLAND CEMENT AND SIMILAR MATERIAL

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U.S. Cl. 241—17 12 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to accelerating the production of portland cement and similar materials and provides a recycling fine crusher and a ball mill in closed circuit in the manner to control excessive heat buildup in the finished material; large, small and minute particles are crushed and ground in a recycled operation directly against a like quantity of new feed materials continuously in direct relation with square feet of crushing surface to square feet of instant discharge.

The present invention relates to a method and apparatus for increasing the production of portland cement and similar materials such as pozzuolana or other rock like materials, where quality control is of the utmost importance in the production of and gradation of particle sizes within the limits of desirable specifications, which specifications may vary from time to time in keeping with finished product requirements for different uses, purposes and applications and in some instances require all or nearly all particles in the finished product be reduced to micron size measurements.

The invention utilizes in the practice thereof a recycling fine crusher and a ball mill in closed circuit for producing portland cement and kindred products. The method of utilizing the recycling fine crusher and the ball mill in closed circuit is such that there is no noticeable power loss to heat or heat buildup in the crushed and conditioned feed materials or recycled materials delivered to the ball mill. Heat buildup in conventional ball milling practice is an important factor as heat often prevents the removal and recovery of a substantial quantity of finished products from the grinding circuit, as well as injuring or destroying the gypsum additive in the finishing grinding of the portland cement clinker, thereby reducing quality.

The recycling action of the present invention serves the dual purpose of grinding out oversized particles contained in the recycled materials and of assisting in the control of excessive heat buildup in the ball mill within the limits of livable tolerances, by the cooling effect of the recycled materials in transit and mixed with new feed material enroute to the ball mill.

An object of the invention is to control excessive heat buildup in the finished material by the recycling action thereof between a ball mill and a recycling crusher.

A further object is an improved method and apparatus for increasing the production of portland cement and similar materials through a controlled pattern of conditioned finely crushed materials without noticeable power loss to heat in sustained operation.

A further object is to increase the production of portland cement and similar material by a recycling operation employing a ball mill and a recycling crusher and to dissipate heat buildup in the recycled materials through the crusher with an air circuit in the same application and in the same interval of time and lessen the source of friction heat buildup within the ball mill by relieving the ball mill of all crushing work to thereby convert the required action therein to fine grinding and sizing only.

A further object is to so regulate the size of the balls in a ball mill to increase the number of balls used over known commercial practice to provide a larger number of small voids between the balls so as to aggregate approximately twice the void space in the ball charge.

A further object is to provide a method and apparatus for increasing the production of portland cement and similar materials which reduces first costs and operating costs in new plant planning and construction as well as existing plants as compared to ordinary conventional grinding pall milling circuits with auxiliary equipment to produce approximately the same quantity of finished products within the same interval of time.

A further object is the method and apparatus for the fine grinding of portland cement and similar materials utilizing autogenous action wherein the material is crushed, ground, and recycled against a blanket quantity of incoming new feed materials.

A further object is a method of producing conditioned feed materials in such a manner as to produce two products which can be separated to desired gradation of finished product and the rejection of the balance of materials to be refed in a recycling operation.

Another object is a method of introducing new techniques to ball mill practice which increases the action and efficiency of the grinding ball charge within the ball mill.

A further object is a method of producing portland cement which entails a crushing and grinding of large, small, and minute particles in a recycled operation diretly against a blanket quantity of new feed materials in a constant and continuous application in direct relationship to the ratio of square feet of crushing surface to the square feet of instant discharge area through the recycling fine crusher.

Other objects and advantages will be apparent from the description of the method and apparatus as hereinafter set forth, among which objects are greater production within a given period of time, controlled efficiency of operation with instrumentation, superiority of product, and inexpensiveness of operation compared to methods now known to the inventor.

In the drawings:

FIGURE 1 is a flow diagram of apparatus which may be used in the practice of the method of the present invention, certain of the apparatus being shown in fragment;

FIGURE 2 is a sectional view on an enlarged scale taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a plan view looking in the direction of the arrows 3—3 of FIGURE 2;

FIGURE 4 is a fragmentary sectional view on an enlarged scale taken on the line 4—4 of FIGURE 1;

FIGURE 5 is a fragmentary view, partly in section, of a multicyclone unit used in the system shown in FIGURE 1;

FIGURE 6 is illustrative of three grinding balls having surfaces in tangent engagement to provide a void area therebetween as shown in the ball mill of FIGURE 1;

FIGURE 7 is a fragmentary elevation of a grinding roll in contact with a drum illustrating autogenous action in the recycling crusher shown in FIGURE 1.

Referring to the drawing, a storage bin is indicated at **1** for new feed material which through the medium of a conduit **2** directs said material to the feed end **3** of a crusher **4** of FIGURE 1. The crusher **4** has drum *4a* supported on and engaging rollers **5** and **6** one of which sets of rollers may be motor driven. The particular structure has a series of parallel grinding rings and a large weighted roller *4b* within the drum as shown in FIGURE 7. The roller *4b* acts on material received within the drum *4a* to crush the same and likewise to provide a continuous peripheral discharge of crushed material from between the grinding rings at a precision mesh size. A crusher of this type is described in my United States Patent No. 2,478,647, issued Aug. 9, 1949 for "Drum Structure for Ring and Roll Mills" and reference is invited to this patent.

A suitable conduit **7** leads from the discharge end of the crusher **4** to the feed end of a ball mill **8** and a discharge from the ball mill is through a conduit **9** leading to boot **10**, the boot directing any material from the ball mill to a bucket type elevator designated generally as **11**. The bucket type elevator lifts the material received from the ball mill upwardly to a point where it is discharged into a conduit **12** leading to a separator **13** of the air type. As shown, the separator has two outlets **14** and **15**, outlet **14** leading to a conduit **16** directed to storage for the product while outlet **15** directs oversize particles from said separator through a conduit **17** to the feed end of the crusher **4**.

Briefly stated, the head of the crusher **4** communicates with a conduit **18** leading to a multicylone unit **19** wherein the fines are separated from the material and directed downwardly through a vertical casing **20**, hence through conduit **21** to the feed end of the ball mill **8**. Dust and other like material of micron size is directed through conduit **22** from the multicyclone unit to a bag house **23**.

The bag house separates the dust and extremely fine particles of materials and exhausts clean heat carrying air to the atmosphere, the materials so separated from the air stream being directed downwardly from said bag house to take off outlets *23b* where the materials if within the limits of desirable specifiations at any given interval of time may be recovered to finished product or diverted into the boot **10** for recycling operation utilizing the elevator and directing such materials by gravity feed back to the air separator to separate out the desirable finished products and reject undesirable oversize particles into the grinding circuit.

A diffuser **30** is placed within the head **25** of crusher **4**. This diffuser may take the form shown in FIGURES 2 and 3 wherein three tiers of annular bands or rings of different diameter are arranged in spaced descending relationship and coaxially positioned with each ring carrying depending blades at substantially a 45° angle to the rings. The rings are shown at **31, 32** and **33** while the blades which depend from each ring are designated as **35, 36** and **37**. The spacing between the blades may vary, however, the function of this diffuser is important in the practice of the method in that air in its passage through the crusher **4** into the head and the conduit **18** may reach a high velocity and lift a heavy material were it not for the character of the diffuser blades. The material lifted by air will strike the diffuser blades causing a swirling action of the air and the bringing of the feed material into contact with said blades deflects the particles thereof down the interior side of the crusher casing to the trap **40** shown in FIGURE 4. The larger particles of feed material are swirled by the diffuser and move outwardly centrifugally which prevents said particles from passing through the conduit **18**. It is important to note at this point that an air lift is not contemplated through the crusher which is in direct communication through the trap with the ball mill **8**. An air lift would tend to effect any fines within the crusher

and direct the same into the conduit **18** leading to the multicyclone unit **19**. The trap **40** of FIGURE 4 is so constructed as to close when the multicyclone **19** is in operation and the crusher is empty of feed material so that any air that enters the recycling crusher is pulled in at both ends of the crusher and out through the peripheral openings between the grinding ring liners with the result that fines and dust will be directed to the conduit **22** and into the bag house **23**. The air flow is such that only a small percentage of extreme fines will be separated. Obviously every cubic foot of air will have large particles carried therein which would escape into the bag house **23**. Fines from the multicyclone unit **19** will be received in housing **20** the lower end of which is connected by conduit **21** to the feed end of the ball mill **8**.

The trap **40** plays an important function in the practice of this invention in maintaining an air circuit through the crusher drum and the trap has suspended therein flaps **41** and an air pull closes the flaps when the crusher **4** is running empty. Weight of discharge material buildup opens the flaps to permit the material to flow freely by gravity at which time the material itself forms an air seal when the crusher **4** is discharging in part or at full capacity. As shown in the drawing, the trap has a rectangular dependent funnel outlet, the trap **40** communicating with the discharge end of the crusher which discharge end leads to the ball mill through the conduit **7** or in certain instances with the conveyor belt at **42**. The trap in its simplest embodiment includes a tubular casing **43** provided with a conical top **44** which casing **43** merges with the sloping slides of the fine crusher **4** as indicated at **45**. The bottom of the casing **43** is spaced above conical wall **46**. The flaps **41** may be of rubberized fabric and adapted to open or close passage of air through the housing **43** from the outside.

The air separator **13**, as previously described, has a discharge side **15** communicating with conduit **17** which leads to the material intake end of the crusher **4**. The air separator shown may be of the centrifugal type having a motor drive at **50** which turns a shaft for rotating selector blades and return air vanes with the usual upper and lower distributing plates for material. The centrifugal air separator of the type shown is manufactured by Sturtevant Mill Co. of Dorchester, Mass. However, no particular type of centrifugal separator is contemplated as separators are obtainable on the market.

The multicyclone unit **19** may of the form shown in FIGURE 5 and of a type manufactured by the Day Company, Minneapolis, Minn., or by Western Precipitation Corp., Los Angeles, Calif. A multicyclone unit acts to separate fines from dust and in the manner depicted in FIGURE 5 wherein the fines are discharged from the housing **20** into condiut **21** for reception in the ball mill **8**. The dust is passed through conduit **22** into the bag house **23**.

The ball mill **8** utilizes a cylindrical drum or container, the axis of which is substantially horizontal and adapted to be revolved at 19 to 21 r.p.m. The container is partially filled with crushing bodies such as balls *8a* which act to grind cement material or like material received within the cylindrical container of the mill. Long established ball milling practice dictates certain diameter graduation of steel grinding balls in a mixed ball charge in keeping with the graduation sizes of mixed feed materials such as large diameter grinding balls for crushing and reductive grinding and smaller diameter grinding balls for fine grinding and sizing. As illustrative of this particular ball mill as presently used in general commercial practice, a ball mill of 6'8" x 24' long two compartment mill is charged with 46 tons of steel grinding balls, consuming 500 horsepower, requiring 13 tons of new feed material per hour, carrying 550% of new feed or 71.5 tons of partly ground and partly finished materials in a continuous recycling load and recovering from the circuit approx-

imately 13 tons of finished portland cement per hour. The conventional grinding ball charge for the mill discussed is as follows:

Dia. of ball (in.)	Wt. per ball	No. per ton	Tons in charge	No. of balls in charge	Size of voids (in.)	Cu. ft. voids per ton	Cu. ft. voids in charge	Size of feed (in.)
3.5	6.35	315	3.0	945	1 1/16	0.31	0.92	1 1/16
3.0	4.0	500	3.0	1,500	3/16	0.39	1.17	3/16
2.5	2.31	682	3.0	2,046	1/8	0.48	1.44	1/8
2.0	1.85	1,688	3.0	5,064	15/16	0.87	2.62	15/16
1.5	0.50	3,980	3.0	11,940	21/32	1.51	4.53	21/32
1.0	0.15	13,500	31.0	418,500	3/8	3.28	101.68	3/8
			46.0	440,445			112.34	

The average particle size required in the feed materials is approximately 63/64". Feed materials required to fill the voids between the grinding balls computer at 100 lbs. per cubic foot, approximate 5.62 tons. The rate of new feed material required approximately 13 tons per hour; the recycling load 550% of new feed or 71.5 tons continuously carried in a recycling circuit, making a total of 84.5 tons of materials in constant state of motion to separate out and recover approximately 13 tons of finished portland cement per hour as the materials pass from the ball mill through an air separator classifier, rejecting the balance of the materials, or 71.5 tons per hour back into the grinding circuit for further grinding action.

Of the 71.5 tons rejected back to the grinding circuit, approximately 65% or 46.47 tons will pass through a 200 mesh screen and of this 46.47 ton fraction, at least 35% or approximately 16.25 tons will pass through a 325 mesh screen, this latter fraction of 16.25 tons has been reduced to micron measurements of 43 microns and finer particles and in most specifications is a very desirable finished product or portland cement, but cannot be recovered to a finished product in the most conventional dry grinding closed circuit ball milling applications due to excessive heat buildup within the ball drum.

As will appear in the statement of operation, the method utilized in the present invention requires a modification of the diameter of steel grinding balls as used for crushing, reductive grinding, fine grinding, and sizing in conventional ball milling applications to smaller diameter grinding balls in the ball charge for fine grinding and sizing only as selected in the following table.

Dia. of ball (in.)	Wt. per ball	No. per ton	Tons in charge	No. of balls in charge	Size of voids (in.)	Cu. ft. voids per ton	Cu. ft. voids in charge	Max. size of feed (in.)
1.0	.1481	13,500	15.34	207,090	3/8	3.2815	50.3382	3/8
0.75	.0625	31.980	15.33	490,253	9/32	5.2103	79.8739	9/32
0.50	.0165	107,950	15.33	1,654,832	3/32	5.8572	89.7908	3/32
			46.0	2,352,175			220	

The present method provides while maintaining approximately the same gross weight of grinding ball charge in the ball mill of some forty six tons utilizing approximately the same number of cubic feet displacement space, 40% to 45% of the ball mill drum area, approximately 2,352,175 active numbers of steel grinding balls, in the ball charge, as compared to 440,445 active balls and some 220 cubic feet of voids between the grinding balls as compared to approximately 112.34 cubic feet of voids between the grinding balls in the conventional fine grinding ball milling applications as indicated in the steel grinding ball charge as previously set forth. This adds up to providing approximately 434% more active numbers of steel grinding balls in the ball charge, creating approximately 434% more numbers of smaller voids therebetween, aggregating approximately twice the void space in the ball charge requiring some 11 tons of conditioned feed materials to fill the voids as compared to approximately 5.62 tons of feed materials to fill the voids in conventional grinding ball milling applications. This void space is as illustrated in FIGURE 6 the space **60** for any three balls in tangent surface contact and the void space is substantially a spherical triangle.

The discharge from the ball mill, as previously described, is through the conduit **9** to the boot **10**, thence by bucket type elevator **11** to the centrifugal separator **13**.

The bag house **23** may be of a type manufactured by Western Precipitation Corp. of Los Angeles, Calif., and in its simplest embodiment includes inlet plenum chambers for distribution of dust laden gas leading to filter elements. The filter elements are of wool felt or heat resisting materials and an air blower is utilized to maintain a constant velocity air jet for cleaning. The purpose of any dust filter is to retain the dust, film or any suspended matter contained or entrained in air or other gas and to allow the gas to pass through the filter in a clarified state

It is generally known that the use of wool felt does not permit a gas to pass directly through it, but the gas is deflected in its passage by the fibers which while providing adequate pore space for the gas retains extremely fine solid material in the range of 0.1 micron and finer. The dust is retained by the filter and much of it will drop into a collecting chamber provided below the filter. The particles of material received in the collecting chamber **23***a* of the bag house is directed into the boot **10** and lifted by the lift apparatus **11**.

The operation, uses, and advantages of the system are as follows.

The conventional ball mill circuit consists of the air separator **13**, ball mill **8** and elevator **11**. The present method of the invention includes in addition to the ball mill circuit, the fine crusher **4**, the multicyclone unit **19** and the bag house **23** to provide a recycling system. The fine crusher **4** is used in conjunction with the ball mill **8** and the air blower for the bag house is utilized to pull through the multicyclone unit **19** substantially 98% of the product desired. The intake to the multicyclone unit **19** and the outlet thereof are of venturi tube form and air is pulled through the venturi tubes and the multicyclone unit in sufficient volume to pick up airborne dust.

Wherein in conventional practice only one material separation is made, with the present invention separation material is refed into the units such as the fine crusher **4** and the ball mill **8**. As the material is fed back it will mix with new feed material and reduce the particles to a finer state. The air from the bag house unit will pick up most of the airborne dust which will be cleaned through multicyclone and in so doing we have a second recovery point. The fines go back into the ball mill again and the air pull is controlled by a variable speed motor. The air specification is 2000 c.f.m. The multicyclone unit may be provided with a water gauge and the control regulates the pull from three to five inches of water. This pull of air is not to be confused with an air lift as an air lift would be sufficient to pull the material from the

crusher. In the present instance the pull is controlled so that only a small percentage of extreme fines will be separated. In practical application, every cubic foot of air will have large particles of material which will escape into the bag house. This becomes the operator's choice wherein he will have a quantity buildup of particles. If the particles fill the specification desired, the product is bled as a finished product. If a different size particle is needed, then there is a rerun back to the elevator **11** and all airborne dust is recovered. If the dust is satisfactory the product from the collecting chamber **23***a* at **23***b* is removed. Two valves are provided for this purpose at the bottom of the collecting chamber. The particles not desired are again placed in circuit and the oversize particles are refused and sent back to the fine crusher **4** from the air separator **13**. The fine crusher **4** is in circuit with the ball mill **8** and thus the output of the ball mill **8** is increased providing there is only one change necessary in the ball mill; that is, to remove the conventional ball charge and substitute smaller balls in keeping with the gradation analysis of feed materials so that said particles of materials will fit within the void spaces **60** between the balls. This produces what is termed attrited action as work is done on the material by the more effective cushioning of ball to ball contact with materials induced by the rotation of the ball mill drum and the constantly changing ball and feed particle sizes.

The recycling fine crusher **4** will operate at almost double the speed of ball mills of the same size and the critical speed of the crusher can be measured accurately.

Thus, I have provided a recycling system wherein the ball mill **8** will accomplish fine grinding and sizing in one unit by using various gradations of ball makeups. The recycling fine crusher **4** modifies and complements the ball mill as all the crushing, reductive grinding, and a perecntage of the fine grinding is accomplished by the fine crusher **4**. This action converts the ball mill from crushing and grinding to a fine grinding and sizing action only. By using the two members together the recycling crusher **4** and ball mill **8** with proper instrumentation the output of any desired specification of finished products can be increased upwards of double or more as compared to conventional ball milling practice.

The recycling fine crusher further provides a positive means of delivering to the ball mill a gradation of prepared new feed materials, which together with recycled materials properly fill the voids between the grinding balls in the ball charge, providing a more direct material cushioning of ball to ball contact in action, to create more than twice the attrited fine grinding and sizing action, induced more effectively by the corrugated shape of the ball mill liners, constantly lifting, rippling and settling something more than 80% of the mass weight of the smaller balls and increased feed charge with a rolling motion of constantly changing void and feed particle sizes by the rotation of the ball mill drum. With something less than 20% of the grinding balls in the ball charge in a constant state of foldover cascading movement there is moved twice the quantity of materials through the ball mill drum, and moving friction heat buildup in the materials with it, in the same interval of time, as compared to conventional fine grinding ball milling circuits in the same service.

The method of the invention provides the lowest horsepower requirement and a low horsepower dissipation is accomplished in the combined full scale uninterrupted operations, as compared to the increased volume of marketable products produced per kilowatt hour of power consumed, to the quantity of marketable products produced per kilowatt hour of power consumed by the present conventional fine grinding ball milling application in the same interval of time.

No mention is made herein or consideration given to the attendent power required to move materials to and from the actual crushing reductive grinding, fine grinding and sizing area of the present fine grinding ball milling application such as conveyors, feeders, elevators, air separator classifiers and dust collecting systems, such equipment is required in conventional fine grinding ball milling circuits in any and all events. The invention does give full consideration to the 40 horsepower required to operate the recycling fine crusher, the 10 horsepower required to operate the exhauster fan in pulling approximately 2000 cubic feet of air through the recycling fine crusher per minute, removing and recovering airbrone dust and dissipating heat in transit, and the 500 horsepower required to operate the ball mill, making a total of 550 horsepower required and consumed by the method to produce upwards of twice or more the volume of finished desirable marketable products, as compared to the conventional fine grinding ball milling circuit herein above described or as a further comparison to the equivalent of two complete conventional fine grinding ball milling circuits together with auxiliary equipment consuming more than double the horsepower requirements of the method, and without the advantage of dissipating heat buildup in the circuit within the limits of easy livable tolerances and without the further important feasible feature of producing most any desired gradation specification of finished product at any given interval of time by adjusting the air separator **13** to classify out the desired gradation specification of finished products.

The recycling fine crusher of FIGURE 7, as described briefly herein, and in detail by U.S. Patent 2,478,467, provides an autogenous action zone. Assuming a grinding roller 4*b* is 32" in diameter and 42" long weighting 11,752 lbs. in a crusher drum of 6' diameter, there is a constant autogenous action zone 10" wide and 42" long or approximately 0.2425 cu. ft. of area by 18.85 lineal feet of travel per revolution. This develops 4.57 cu. ft. of available autogenous area for each drum revolution. Furthermore, as the gravity weight of the roller under consideration is 11,752 lbs. the relative weight at point of materials contact approximates 1402.85 lbs. inreasing 8.38 times to gravity center of 11,752 lbs.

Thus the recycling crusher has the capability of receiving and further reducing a substantial fraction of all finer recycled materials by entrapment in the autogenous action zone between the crushing roll or rolls and the crusher shell along with the controlled quantity of new feed particles to reduce all particles by direct applied autogenous action of driven power, weight, pressure, speed of action and momentum, in crushing and grinding entrapped materials against a blanket of incoming feed materials in direct relation to the ratio of combined square feet of crushing surface to the combined square feet of available peripheral discharge area per crusher drum revolution.

The recycling crusher **4** has the further proven capabilities of removing and recovering airborne dust and a fraction of extremely finely ground particles, together with cooling and dissipating heat buildup in the recycled fraction of materials passing through the crusher with an applied and controlled air suction circuit passing through the crusher in the same interval of time, pulling heat out of the circuit and exhausting clean air to atmosphere.

The different diameter balls shown in the cutaway portion of the ball mill in FIGURE 1, illustrates ball diameters in accordance with the chart appearing at line 45, Column 5 of this specification. When the ball mill is rotated, the different diameter balls tend to stratify under centrifugal force as shown in FIGURE 1 wherein it will be observed that the larger diameter balls lie near the center of the ball mill and the outermost of the smaller diameter balls are adjacent the drum with intermediate diameter balls positioned between the large and the small diameter balls. This stratification of ball diameters is effective in the practice of the present invention as has been set forth in paragraph beginning at line 44, Column 7.

I claim:

1. The method of accelerating production and improving the quality of portland cement and other comminuted materials preferably reduced to dust by a series of crushing, grinding, separating and recycling steps wherein thermal reaction is reduced by the presence of air, the steps comprising crushing new feed material at a first station, air lifting the finer particles of dust and fines away from the crushed mass and delivering the same to a second station, delivering the particles grosser than fines to a third station, air centrifuging the dust and fines at the second station, withdrawing the dust and delivering to storage and delivering the fines to the third station, sizing and fine grinding the grosser particles and the fines at the third station, delivering the product from the third station in the presence of coolant air to a fourth station, at the fourth station grading and separating the product into dust and fines, delivering the dust to storage, and returning the fines to the first station at which the fines are intermixed with new feed material present at said station.

2. The method as defined in claim 1 wherein a roller type crusher is embodied as the first station.

3. The method as defined in claim 1 wherein a multicyclone is embodied as the second station.

4. The method as defined in claim 1 wherein a ball mall is embodied as the third station.

5. The method as defined in claim 1 wherein an air separator is embodied as the fourth station.

6. The method as defined in claim 1 wherein the step of crushing at a first station includes:

introducing a stream of air into the said material during said crushing to reduce heat generated in said material.

7. The method as defined in claim 1, wherein the step of sizing and fine grinding at said third station includes:

minimizing heat generated in said grosser particles and fines during said step by providing relatively small individual sizing and grinding areas in said station.

8. The method as defined in claim 1 wherein the step of delivering the product in the presence of coolant air to a fourth station includes exposing the product to ambient air during said delivery.

9. The method of accelerating production and improving the quality of portland cement and other comminuted materials preferably reduced to dust by a series of crushing, grinding, separating and recycling steps wherein thermal reaction is reduced by the presence of air, the steps comprising crushing new feed material at a first station in the presence of coolant air embodying a roller type crusher, air lifting the finer particles of dust and fines away from the crushed mass and delivering the same to a second station embodying a multicyclone, delivering the particles grosser than fines to a third station embodying a ball mill, air centrifuging the dust and fines at the second station, withdrawing the dust and delivering to storage and delivering the fines to the third station, sizing and fine grinding the grosser particles and the fines at the third station, delivering the product from the third station in the presence of coolant air to a fourth station embodying an air separator, at the fourth station grading and separating the product into dust and fines, delivering the dust to storage, and returning the fines to the first station at which the fines are intermixed with new feed material present at said station.

10. The method of accelerating production of portland cement and similar materials comprising the steps of:

(a) introducing a first amount of new feed material into a feed end of a roller type crusher;

(b) crushing said first amount of material by autogenous action in the presence of coolant air within said crusher;

(c) introducing air into said crusher during said crushing to cool said material;

(d) moving a first portion of said crushed material to a multicyclone by air pressure;

(e) cycloning said first portion of said crushed material whereby said material is divided into air ladened finished product and fines;

(f) discharging said air ladened finished product to a bag house for air removal and storage of said finished product;

(g) delivering said fines to a ball mill;

(h) passing the remaining portion of said crushed material to said ball mill;

(i) intermixing said fines and said remaining portion in said ball mill;

(j) sizing and fine grinding said intermixed material between voids created by a stratified ball charge rotating within said ball mill;

(k) delivering said sized material in the presence of coolant air to an air separator;

(l) classifying said sized material within said air separator into finished material and fines;

(m) discharging said finished material to storage;

(n) delivering said fines to said feed end of said crusher;

(o) adding a second amount of said new feed material to said fines delivered to said feed end of said crusher; and

(p) repeating said steps (b) through (m) until a desired amount of finished material is in storage.

11. The method as defined in claim 7, wherein step (j) of sizing and fine grinding within the ball mill includes minimizing heat generated in said material during said step by providing a relatively large number of relatively small voids within said stratified ball charge.

12. The method as defined in claim 7, wherein step (k) of delivering said sized material in the presence of coolant air includes exposing said sized material to ambient air during said delivery.

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