Aug. 30, 1966 W. H. LYKKEN 3,269,667

EXTRACTION METHOD

Original Filed April 29, 1963 3 Sheets-Sheet 1

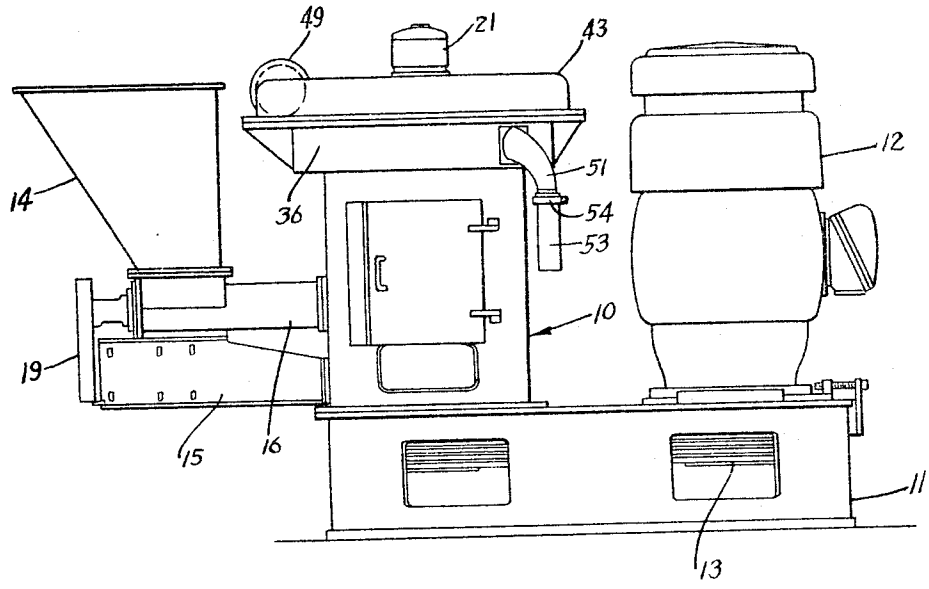


FIG. 1

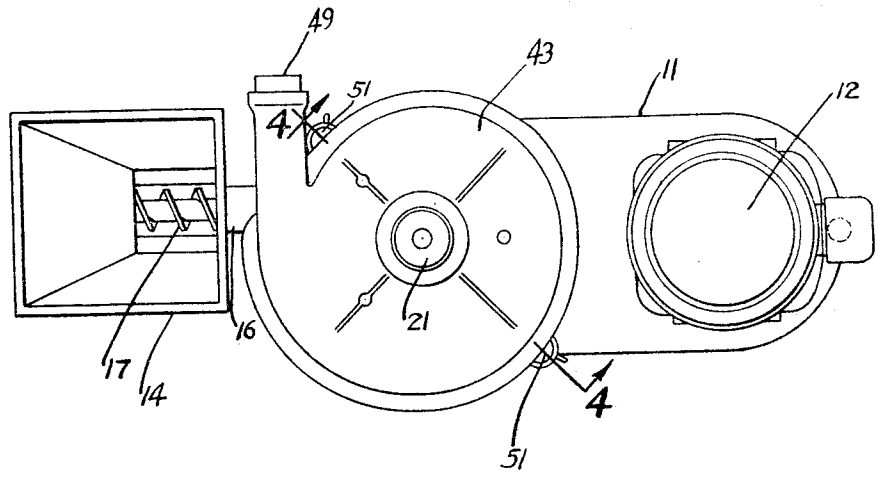


FIG. 2

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EXTRACTION METHOD

Original Filed April 29, 1963 3 Sheets-Sheet 2

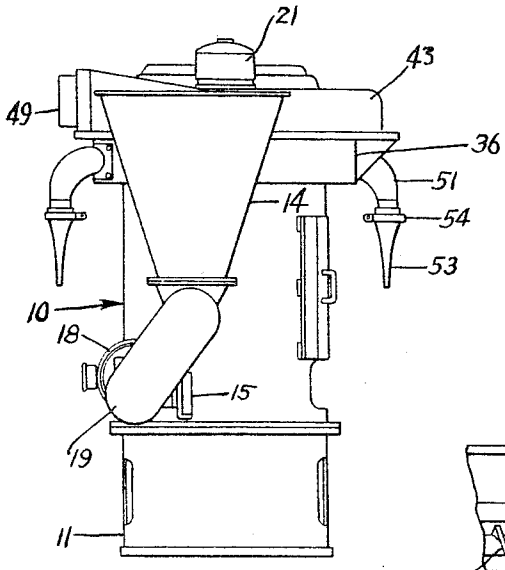


FIG. 3

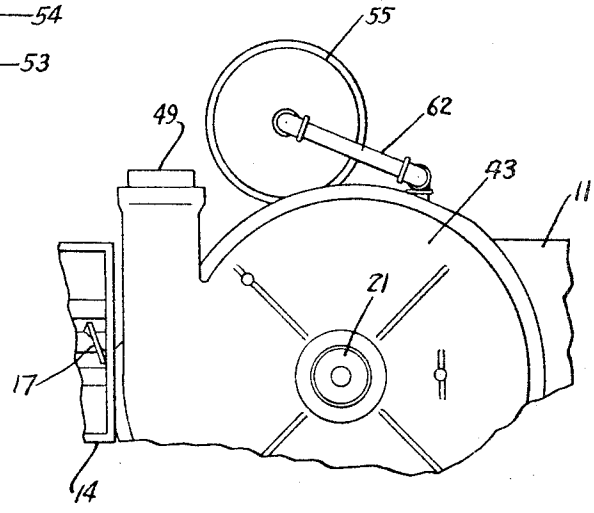


FIG. 6

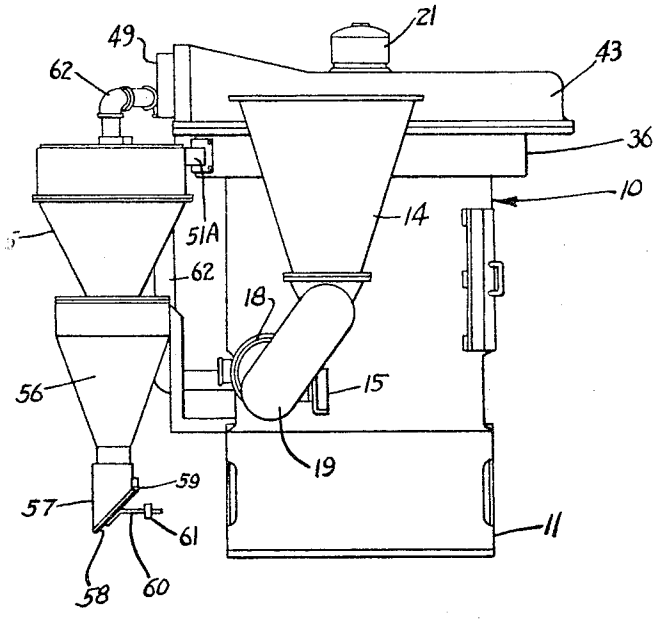
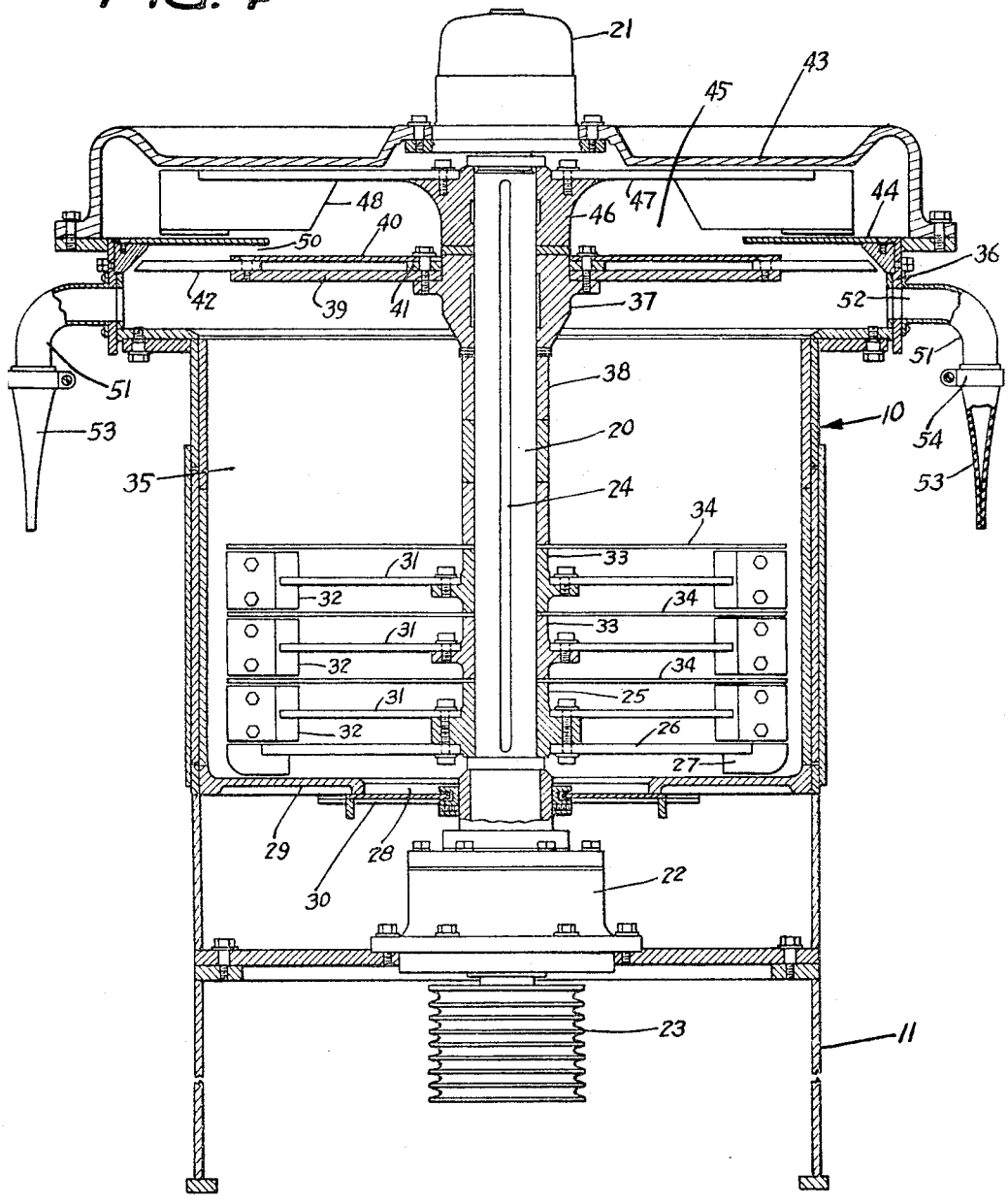


FIG. 5

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FIG. 4



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3,269,667

EXTRACTION METHOD

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Original application Apr. 29, 1963, Ser. No. 276,457, now Patent No. 3,221,998, dated Dec. 7, 1965. Divided and this application Mar. 26, 1965, Ser. No. 462,462
2 Claims. (Cl. 241—5)

This application is a division of application Serial No. 276,457, filed April 29, 1963, and now Patent No. 3,221,998, issued December 7, 1965.

This invention relates to a method for the separation and extraction of solid materials, such as the separation of asbestos fibers from asbestos bearing ores and extraction of gangue, and the like. Other exemplary separation and extraction processes include the extraction of contaminants from clay, talc, and similar non-metallic minerals for the purpose of upgrading them.

The invention is illustrated in the accompanying drawings in which the same numerals refer to corresponding parts and in which:

FIGURE 1 is a side elevation of apparatus for carrying out a separation and extraction process;

FIGURE 2 is a top plan of the same apparatus;

FIGURE 3 is an end elevation of the same apparatus;

FIGURE 4 is an elevation in section and on an enlarged scale through the apparatus and on the line 4—4 of FIGURE 2 and in the direction of the arrows;

FIGURE 5 is an end elevation of a modified form of apparatus; and,

FIGURE 6 is a partial plan view of the modified apparatus.

Referring to the drawings, the apparatus comprises a cylindrical casing **10** housing means for reducing and dispersing the material to be separated and extracted. Casing **10** is supported on a base **11** which also supports a motor **12** of sufficient size and capacity to operate the apparatus. Conventional drive means, such as belts **13**, connect the motor to the mechanism housed within casing **10**. A feed hopper **14** is supported on an arm **15** cantilevered out from the casing **10**. Hopper **14** is connected to the casing **10** by means of a tubular conduit **16** enclosing a helical screw feed **17**. The screw feed **17** is driven by a separate electric motor **18** through an appropriate drive enclosed within a safety housing **19**.

Referring now to FIGURE 4, the apparatus includes a shaft **20** journaled in upper and lower bearings **21** and **22** for rotation about a vertical axis centrally within casing **10**. Bearing **22** is supported on the base **11**. One end of shaft **20** extends through the bearing and base and is provided with a multiple groove pulley **23** to adapt the shaft for rotation through the belt drive **13** from motor **12**. Shaft **20** is provided with a keyway **24** for attachment of rotor elements for rotation with the shaft.

The bottom most rotor element includes a hub **25** to which is attached an annular bottom plate **26** which carries a plurality of spaced radial blades **27** at its periphery. Plate **26** and radial blades **27** function as a fan for drawing air through an annular opening **28** in the annular bottom plate **29** of casing **10** for the purpose of diluting and dispersing the material feed from hopper **14**. Air inlet opening **28** is controlled by a plurality of slide dampers **30** for regulation of the volume of air admitted.

Hub **25** supports a further annular plate **31** which carries a plurality of spaced radial blades **32** at its periphery. Additional hubs **33** are mounted on the shaft **20**. Each hub **33** supports an annular plate **31** carrying spaced radial blades **32**. Each rotor stage represented by an annular plate **31** and series of radial blades **32** is

separated from the adjacent stages by an annular disc **34** supported on the rotor shaft between the hubs.

As is well known in the art, the several rotor stages act upon the material fed into the lower portion of the casing **10** to reduce and deagglomerate the solid material by air attrition and impact between the particles and rotor blades and housing wall. At the same time, the solid material is thoroughly diluted and dispersed in the air stream drawn in through the bottom air inlet. The material is acted upon in intrablade vortices between adjacent radial blades **32** spaced about the periphery of the rotor sections and in a rising vortex between the outer periphery of the rotor sections and the housing wall. The desired particles are physically separated from any bonded impurities or contaminants. The desired particles are generally reduced in size. The impurities are generally more difficult to grind and thus are ground to a lesser extent.

The mixture of reduced and thoroughly dispersed solid material and separated contaminants rises into the upper chamber **35** of the casing **10** and into the cylindrical classifying or extracting casing **36** mounted on top of the casing **10**. A further hub **37** is positioned on shaft **20** for rotation therewith in cylindrical housing **36**. Hub **37** is spaced from the reducing and dispersing rotor elements by means of a series of spacer rings or sleeves **38**. Hub **37** supports a pair of annular plates **39** and **40** held spaced apart by means of a spacer ring **41**. A plurality of finger-like radiating blades or rods **42** are supported between plates **39** and **40** at their outer periphery for rotation within cylindrical housing **36**.

A fan housing **43** is disposed on top of the apparatus above the cylindrical classification housing **36**. An annular diaphragm ring **44** is disposed between the classifier housing **36** and the fan housing **43**. An annular opening **45** defined by the inner periphery of diaphragm ring **44** and the shaft hubs forms an opening communicating between the two housings.

A fan hub **46** is secured to shaft **20** for rotation therewith within fan housing **43**. Hub **46** supports an annular plate **47** which in turn carries a plurality of spaced radial fan blades **48** at its outer periphery. Fan housing **43** is in the form of an involute scroll as is conventional in the art. The scroll housing terminates in a discharge port or conduit **49** which leads to a collector for receiving the material discharged from the apparatus. The fan functions to induce a flow of air and material through the apparatus and to discharge the lighter finer solid materials (which in most cases are the desired materials) separated from the original feed.

In order to get from the top zone **35** of the material reducing and dispersing housing, the finer and lighter material must first pass into classifier housing **36**, where it is freed from the coarser and denser materials, and must pass between the finger-like blades or rods **42** and be drawn centripetally through the narrow passage **50** between the inner lip of diaphragm ring **44** and the outer lip of plate **40**. The material which makes its way through passage **50** is then caught up and entrained in the stream of the fan blades and discharged out through conduit **49**.

The coarser denser materials (which in most cases are the impurities or contaminants) which are rejected by the classifier rotor, are thrown centrifugally outwardly to the cylindrical wall of housing **36** and are caught by one of several coarse discharge or extraction conduits **51** spaced about the wall of the classifier housing **36**. One end of each discharge conduit **51** is in communication with a passage **52** in the wall of classifier housing **36**. The opposite end of each discharge conduit **51** is fitted with a flapper extraction valve **53**.

Extraction valve **53** is composed of a resilient tube of rubber or synthetic rubber-like resinous material. One

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end is attached to conduit **51** by means of a clamp **54** or similar fastening device. The opposite end is flattened and is adapted to normally remain closed. However, because of the resilience of the material of which the flapper valve is formed, the sides of the valve which are normally in face-to-face abutting position are forced apart by the accumulation of coarse dense material in the valve **53** and discharge conduit **51** so as to be discharged from the apparatus. The extraction valve then closes automatically. In most instances the coarser denser material discharged through valve **53** is the unwanted material and is discarded after its discharge from the valve.

In FIGURES 5 and 6 there is shown an alternative form of apparatus in which the extractor or bleeder valve is replaced by a bleeder cyclone. The basic apparatus has substantially the same structure as that already described except that a modified coarse discharge conduit **51A** extends tangentially into the top cylindrical portion of a conventional upper cyclone **55**. The lower conical portion of the upper cyclone **55** extends into the top wall of a lower cyclone **56**. The bottom discharge end of cyclone **56** is fitted with a gravity operated seal or valve **57**. Valve **57** includes a conduit having a diagonal opening against which is fitted a plate **58** hinged at **59** and having a threaded rod **60** extending out from the plate and fitted with an adjustable counterweight **61**.

The extracted coarser and denser particles are separated from the air in the cyclones. The solid material passes downwardly through the cyclones and collects in the valve **57**. When a sufficient weight of extracted particles collect in the valve to counterbalance the plate **58** and its counterweight, the plate pivots on its hinge and opens the conduit to discharge the contents of the valve. The valve then closes automatically due to the weight of the plate and counterweight.

The separated air and any fines entrained therein is desirably recycled through the apparatus. A conduit **62** extending from the top wall of the upper cyclone **55** is provided for this purpose. The conduit extends down to the base between the bottom of the reducing and dispersing rotor and the base for reintroduction into the housing **10**.

The apparatus of the present invention does two jobs simultaneously. It provides precise particle reduction and impurity extraction. The combined apparatus is a pulverizer-classifier including a heavy duty high capacity air attrition mill with an integral classifier. It has found use in upgrading quality in many non-metallic mineral processing operations where precisely controlled pulverization and positive extraction of impurities are required. The present apparatus provides for the sub-sieve size processing of filler clays, technical ceramics, lime, gypsum, rare earth oxides, pigments, asbestos, and similar friable materials. It provides accurate control of particle reduction to any desired average size from 150 microns to less than 1 micron. It provides for the extraction of such impurities as silica, mica, sand iron etc., which are usually found in non-metallic minerals. The effective extraction of impurities produced by this apparatus upgrades the product and reduces the cost of grinding.

The apparatus according to the present invention has been found to be especially useful in increasing the rate of recovery of asbestos. In the past, normal recovery of usable asbestos fiber from asbestos ore was between 4% and 6%. The rest of the ore was discarded as tailings. By means of the present invention tailings piles are being reworked with substantially greater recovery of usable asbestos fiber than resulted from processing of the virgin ore. In the case of new ore, it is crushed to about ¼ inch mesh or finer before feeding to the apparatus. Mill rejects and tailings may usually be fed directly.

Short asbestos fiber is used as a filler in plastic castings, asbestos cement, roofing cement, roof tile and Macadam road surfacing material for strength and improved wearability. Starting with raw rock or mill tailings, recovery rates of acceptable short asbestos fibers have been as high as 40% to 55% by weight of the feed material. Finished asbestos fiber produced by other extraction processes has been upgraded by means of the present invention by opening the fiber bundles to release trapped rock and iron to extract and discharge the same. With such finished fiber starting material, recovery rates have been as high as 88% to 97%.

Clay occurs in huge natural deposits, generally in very fine particle sizes in the range of 2 microns and finer. Clay normally contains relatively small amounts (about 2% to 3%) of impurities in the form of mica flakes, silica and silicates, traces of iron, etc. For many uses the presence of these impurities may not be objectionable. However, where the end use requires a very white color, as in the preparation of paper coatings, fine china and the like, the presence of even 2% to 4% impurities downgrade the product. By passing such clay through the apparatus of the present invention and extracting only 3% to 4% of the total clay feed, enough of the impurities are removed to raise the color of the remaining material 2 to 3 points on the General Electric Color Tester.

Using a 30 inch diameter mill of 100 horsepower, the capacity of the mill is 4,000 pounds of clay per hour. Because the impurities are merely extracted, instead of being ground, this rate of production can be maintained. If it were necessary to grind the 2% to 3% impurities present, the production would have to be cut to 1,000 pounds per hour or less. The wear on the machine would be increased and the color of the finished product would be lower because impurities would still be present although in smaller size.

Talc is upgraded in much the same manner as clay. It occurs naturally in large deposits and contains small amounts of oversize impurities. Gypsum has similarly been upgraded by extracting dolomite. Substantial quantities of gypsum have been recovered from mill rejects. Cocoa contains about 2% to 3% fiber which is hard to grind and adds nothing but bulk and weight to the product. By removing this 2% to 3% of fiber by the extraction process according to the present invention, grinding production of cocoa can be doubled.

It is apparent that many modifications and variations of this invention as hereinbefore set forth may be made without departing from the spirit and scope thereof. The specific embodiments described are given by way of example only and the invention is limited only by the terms of the appended claims.

I claim:

1. A method of upgrading the quality of non-metallic solid materials by the separation and extraction therefrom of coarse and dense impurities and contaminants which are more difficult to grind than the solid materials containing the impurities and contaminants, said method comprising introducing said impure and contaminated solid material into the side of a vertically disposed relatively narrow cylindrical annular grinding and dispersing zone adjacent the bottom end thereof, entraining said impure and contaminated solid material in an air stream in a rising vortex in said zone, subjecting said impure and contaminated material in its ascent in said vortex simultaneously to air attrition in a plurality of stacked smaller vortices spaced around the inner periphery of said zone to reduce said impure and contaminated solid material and to physically separate contained impurities and contaminants from said solid material, further dispersing said separated solid material and impurities and contaminants in air by releasing the same upwardly into an immediately adjacent open cylindrical expansion zone, passing the resulting dispersed mixture of separated solid material and impurities and contaminants upwardly into a cylindrical classification zone, subjecting the mixture of separated solid material and impurities and contaminants in

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that zone to opposed centripetal and centrifugal forces whereby coarser and denser impure and contaminating particles are thrown centrifugally outwardly and extracted from the mixture and the finer and lighter particles of solid material freed from extracted impurities and contaminants are drawn centripetally inwardly and upwardly and discharged to a recovery zone.

2. A method according to claim **1** further characterized in that non-metaallic solid materials selected from the class consisting of asbestos, clay, talc, gypsum and cocoa are upgraded by the extraction from said solid materials of impurities and contaminants selected from the class consisting of mica, silica, silicates, iron, dolomite and fiber.

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