Feb. 8, 1949. F. J. KOEHNE 2,460,938

METHOD AND APPARATUS FOR CLEANING ASBESTOS

Filed Aug. 5, 1944

2 Sheets-Sheet 1

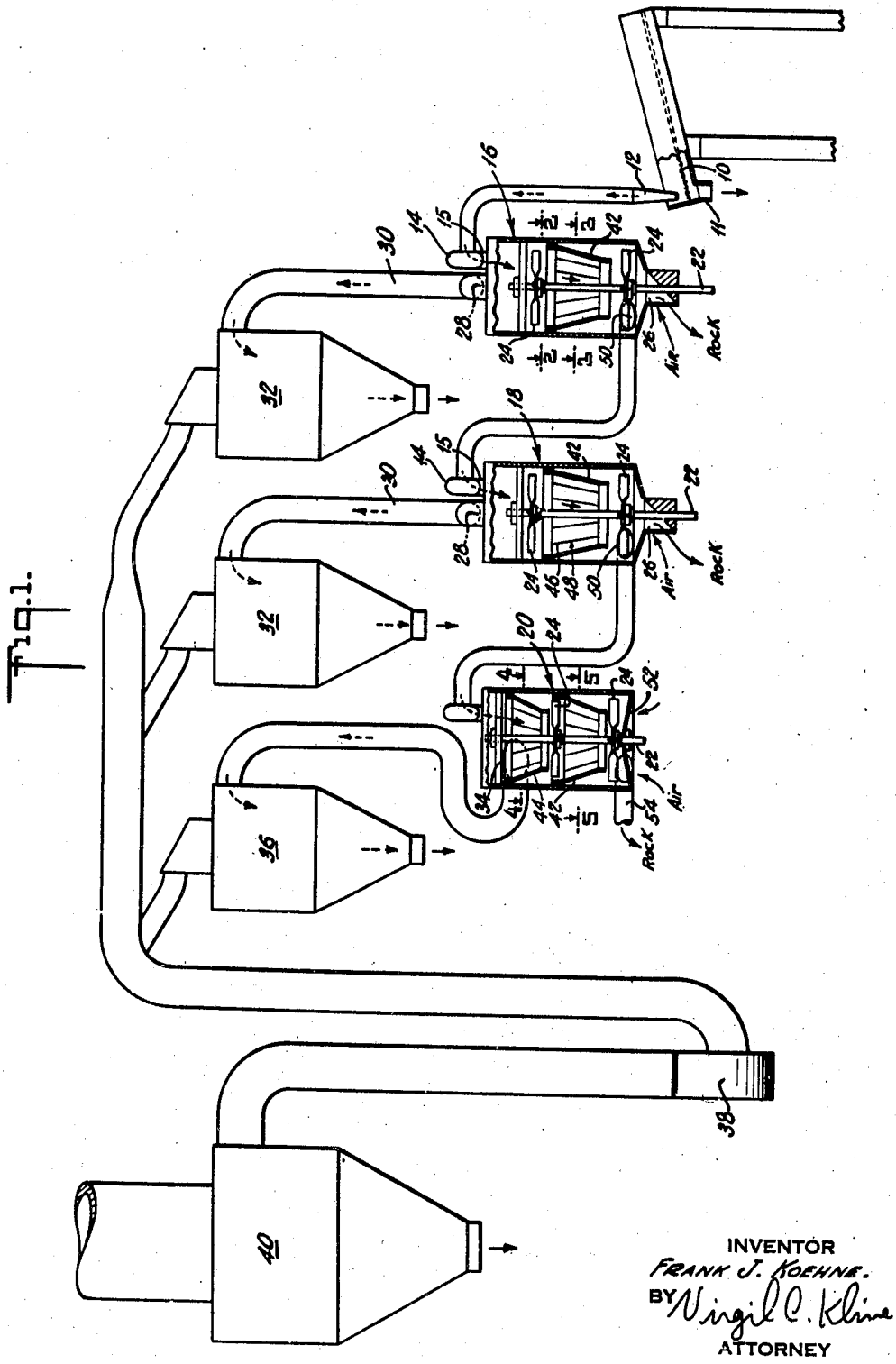


Fig. 1.

INVENTOR
FRANK J. KOEHNE.
BY Virgil C. Kline
ATTORNEY

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/1

Feb. 8, 1949. F. J. KOEHNE 2,460,938

METHOD AND APPARATUS FOR CLEANING ASBESTOS

Filed Aug. 5, 1944 2 Sheets-Sheet 2

Fig. 2.

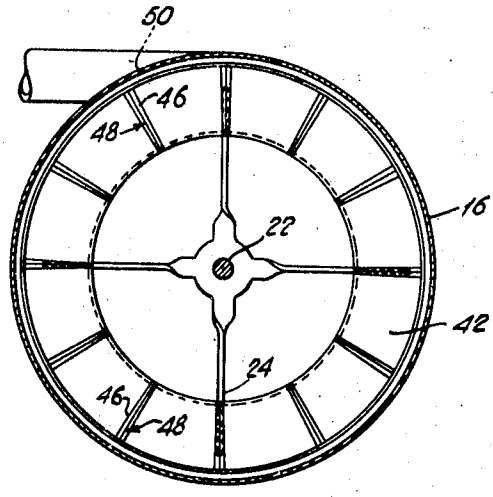


Fig. 3.

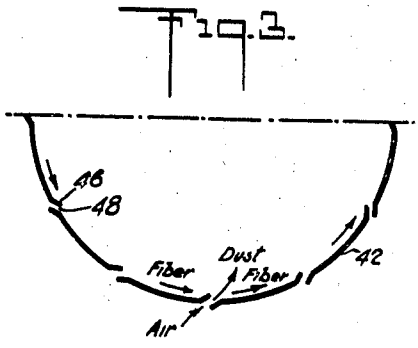


Fig. 4.

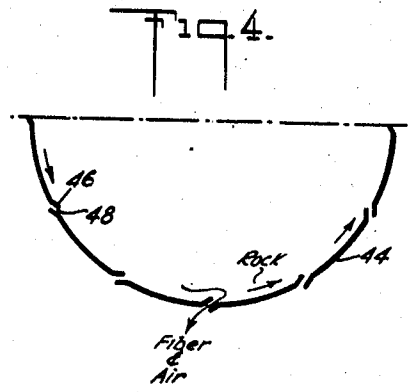
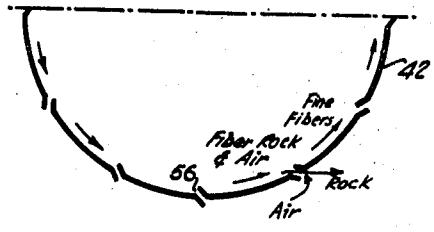


Fig. 5.



INVENTOR
FRANK J. KOEHNE.
BY Virgil C. Kline
ATTORNEY

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/2

Patented Feb. 8, 1949

2,460,938

UNITED STATES PATENT OFFICE

2,460,938

METHOD AND APPARATUS FOR CLEANING ASBESTOS

Frank J. Koehne, Martinsville, N. J., assignor to Johns-Manville Corporation, New York, N. Y., a corporation of New York

Application August 5, 1944, Serial No. 548,295

16 Claims. (Cl. 241—4)

1

This invention relates to the opening and cleaning of asbestos and similar fibrous materials, and is particularly concerned with improvements in method and apparatus whereby asbestos may be simultaneously opened and cleaned to segregate the fibers and fine and coarse impurities including dust and rock particles adhering thereto.

Crude and partially opened asbestos fibers such as are presently available for industrial purposes consist of rodlike bundles of desirable fine asbestos fibers or filaments with which are associated substantial amounts of undesirable impurities including asbestos fines, rock gangue and dust. Conventional methods of treating such unclean asbestos fibers, as by milling, windowing and screening to separate impurities therefrom, develop serious attrition and breakage of the fibers, thus producing a fibrous product which has a market value substantially lower than the potential market value of the unbroken fibers.

Difficulties are to be expected in attempts to apply conventional pneumatic impact pulverizing and cyclone separating and classifying methods and equipment designed for handling granular products, to the problem of cleaning crude and unclean asbestos. Methods and equipment designed for cyclone classification of granular products are predicated on Stokes' Law, which applies specifically to granular particles but not to fibrous materials such as asbestos. The separation of granular particles according to Stokes' Law is effected according to particle size, or more accurately in accordance with the average diameters and masses of the particles. Any attempt to adapt cyclone separating and classifying equipment designed for handling granular materials, to the treatment of fibrous material such as asbestos, would necessitate maintenance of suitable turbulence in the pneumatic system in order to cause the fibers to behave as spherical particles such as the equipment is designed to handle. In the absence of turbulence, the fibers tend to orient themselves into alignment with the longitudinal axis of the cyclone separator and to discharge rapidly under gravity pull from the classification zone. When fibrous materials are subjected to sufficient turbulence to cause them to behave as spherical masses in a pneumatic vortex cleaning system, any cleaning effect which may result from such treatment is at least partially cancelled by the tendency of the opened fibers to attract back to their enormously greater exposed area surfaces impurity fines and dust initially liberated during impact pulverizing

2

treatment. Accordingly, the more thoroughly the fibrous bundles are fiberized or opened by the initial impact pulverizing treatment, and the greater the resultant ratio of length to thickness of the fibers, the less easily can the opened fibers be cleansed of fine non-fibrous impurity particles or dust by conventional cyclone cleaning and classifying equipment.

A primary object of the invention is to provide method and apparatus of improved characteristics adapted to efficiently and economically open and clean crude and unclean asbestos fibers.

A more particular object is that of providing improved method and apparatus whereby crude and unclean asbestos fibers may be simultaneously opened and separated from coarse and fine impurities including rock particles and dust adhering thereto, while avoiding serious degradation of the fibers.

According to the present invention, asbestos fibers undergoing treatment must be thinly suspended in an air stream of sufficient volume to accept and carry away impurity dust particles as they are separated from the fiber filaments. The crude or unclean asbestos fibers are introduced into the upper portion of an upright generally cylindrical opening and cleaning chamber, and the fibers drop gradually by gravity pull through an upwardly rising vortex of cleaning gas or air. Means such as rotating paddle or fan blade assemblies are provided for establishing and maintaining a comparatively high speed of rotational movement in the peripheral portions of the vortex. Centrifugal force acting uniformly on the fibers, tends to suspend them and hold them adjacent the periphery of the vortex and adjacent the walls of the cleaning zone. By maintaining a high ratio of rotational movement in relation to gravitational downward movement, the fibers are caused to travel in a path of such length as to comb them into longitudinal alignment with the rotational direction of their movement. Means such as reentrant fins are provided at intervals along the inside walls of the cleaning zone, which act to intermittently or periodically deflect the rotating body of suspended fibers and suspending gas or air inwardly away from the walls of the cleaning zone. The fibers resist the intermittent deflection impulses thereby created by virtue of their greater momentum. The fibers are thereby flexed and bent by the more compressible and deflection responsive air impulses, as successive portions of each fiber filament length are subjected to these pulsating lateral impulses. The resulting flexing

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/3

and bending opens the fibers and chips off attached impurity particles. Movement of the suspending air or gas transversely back and forth across the fiber filaments scours the filaments of adhering dust and rock particles, while avoiding serious attrition of the fibers or recontamination thereof by the separated dust. This opening and cleaning operation is followed by final classification segregation of clean fibers from liberated granular and dust particles by selective action of centrifugal, gravitational and rising gas vortex suspension forces.

With the aforementioned objects and features in view, the invention consists in the improvements in method and apparatus for cleaning and fiberizing asbestos and similar fibrous materials which are hereinafter described and more particularly defined by the accompanying claims.

In the following more complete description of the invention, reference will be made to the attached drawings, in which:

Fig. 1 is a diagrammatic assembly view, with parts shown in vertical section, of a preferred arrangement of apparatus adapted for the practice of the invention;

Fig. 2 is a horizontal section of one of the fiber cleaning chambers, taken on the line 2—2 of Fig. 1;

Fig. 3 is a horizontal section through a segment of an inverted frusto-conical lining of one of the cleaning chambers, taken on the line 3—3 of Fig. 1;

Fig. 4 is a horizontal section through a segment of the inverted frusto-conical lining in the upper portion of the last cleaning chamber of a series, taken on the line 4—4 of Fig. 1; and

Fig. 5 is a horizontal section through a segment of the inverted frusto-conical lining in the lower section of the last cleaning unit of the assembly shown in Fig. 1, taken on the line 5—5 of Fig. 1.

The improvements in method and apparatus of the present invention are designed to effect the fiberizing and cleaning of fibers while thinly suspended in air, and to develop efficient separation and segregation of cleaned fibers and fine and coarse non-fibrous contaminants in the same operation in which the fibers are fiberized and liberated from such contaminants.

A preferred apparatus assembly for the practice of the invention is portrayed in Fig. 1. This apparatus may include a shaker screen 10 from the top of which fibers to be cleaned are picked up by a suction hood 12 and transported in air suspension through a suction fan 14. From fan 14 the air suspended fibers are discharged into the upper peripheral section of the first of a series of upright cylindrical fiber opening and cleaning chambers or drums 16, 18 and 20. Motor driven vertical shafts 22 are mounted axially in each of the cleaning chambers 16, 18 and 20, each shaft being supported by top and bottom bearings. Two vertically spaced sets of fan blades or paddles 24 are shown as rotatably mounted on each shaft 22 in position to develop suction intake of cleaning air or gas through an intake port 26 at the base of each chamber, and to promote rotation of the air within each cleaning chamber in an upwardly rising air vortex. Air thus introduced into cleaning chambers 16 and 18 finally escapes therefrom through axial top offtakes 28, from which it is conducted by pipes 30 to cyclone dust separators 32. Escape of air which is introduced into cleaning unit 20 is effected through a tangential offtake 34 from which this air is carried to a cyclone fiber separator 36. Central air exit ports of each of the cyclone air separators 32 and 36 may be connected to the inlet of a common suction fan 38. The discharge nozzle of fan 38 is shown as connected to the tangential inlet of a cyclone dust separator 40.

Inverted frusto-conical inner lining members 42 have been shown as mounted in the lower portion of each cleaning chamber 16, 18 and 20. The upper top rim of each lining member 42 is dimensioned for mounting to form a tight sealing fit with the inner cylindrical wall of the chamber. A similar inverted frusto-conical inner lining 44 is shown as mounted adjacent the top of cleaning chamber 20. Reentrant fins 46 and adjacent slots 48 are shown as located at spaced intervals around the lining members 42 and 44 in relative arrangements and for purposes which are hereinafter more fully explained. Each of chambers 16 and 18 has a cleaned fiber exit port 50 located tangentially near its base. Chambers 16 and 18 also have coarse impurity exit ports which coincide with the axial air intake ports 26. Chamber 20 has a gas pervious frusto-conical base 52 and an impurity granule exit port 54 at the base circumference.

In operation, an air or gas suspension of unclean asbestos fibers is picked up by suction from shaker screen feeder 10 (Fig. 1). Vibrating or shaker screen feed tables of the type shown are advantageously employed for initially cleaning mixtures of short asbestos fibers and rock gangue. Fiber containing excessive rock content may be advantageously fed over a shaker or vibrating screen having an air inlet 11 directed through its screen bottom through which air may be forced upwardly for the purpose of elevating and maintaining the fibers in a blanket above the rock on the screen to give the suction hood 12 every opportunity to remove such fibers as were formerly weighted down by rock during the brief interval of their passage under the suction hood. Longer grades of asbestos fibers may be supplied to the cleaning chambers of the present equipment by a picker-belt feed mechanism.

Crude or unclean fiber is delivered through inlet ports 15 into the top portion of each of the cylindrical cleaning chambers 16, 18 and 20. The paddle or fan assemblies 24 operate to suck a large volume of cleaning air into each chamber through the bottom air intakes, and to generate in each of the chambers an upwardly rising air vortex which picks up the unclean fibers and retards the rate at which they settle through the chamber under gravity pull, while transporting the fibers in suspension and under the influence of centrifugal force in a long path around the inner periphery of each cleaning chamber. By thus forcing the fibers to travel in a circular path around the inner lining of the cleaning chamber, their path of travel is so extended as to afford ample time for the orientation of the fibers with their major axes aligned with the direction of rotational travel. This centrifugal force tends to pin the fibers to the outside walls of the cleaning chambers.

Fins 46 which are attached at spaced intervals to the inside surfaces of the chamber lining, serve to periodically deflect the rapidly circulating air and fiber stream toward the axial center of the cleaning chamber in a direction opposed to the direction normally imposed by cen-

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/4

trifugal force. Since the entraining air is compressible, centrifugal force, intermittently opposed by the deflecting action of the fins 46, develops a fluctuating pumping action forcing the air transversely in and out across the path of the moving fibers, whereas the greater momentum of the fibers tends to keep them travelling in a circular path and to resist such deflection. The result of such pulsating of the compressible air carrier is to cause bending and flexing of the fibers, as successive portions of their length enter and leave the areas wherein this lateral pulsation is induced. The flexing and bending of the individual fibers or fiber bundles tends to open and split the fibers and to chip loose from their surfaces any adhering dust and granular impurities. Variations in rate of movement or acceleration between the fibers and the entraining air develop a scouring action upon the flexing fibers, which still further aids separation of nonfibrous impurities from the fibers. The clean air which is brought in from the bottom gradually works its way upward through the cleaning chambers as a vortex from which the air finally exits at ports 28 carrying with it an entrapped load of fine impurity dust liberated from the fibers.

Fins 46 may be attached directly to the vertical cylindrical walls of the cleaning chambers 16 and 18. However, it is deemed advantageous to erect such fins in the form of an inverted frusto-conical cone 42 having its upper and larger rim dimensioned to the inner circumferential dimensions of the cleaning chamber and rigidly attached thereto. With this inverted frusto-conical arrangement of the reentrant fins as an inner lining for the cleaning chamber, part of the air which is introduced to the base of the chamber may be circulated around the outside of the fin lining and finally introduced to the cleaning chamber through slots 48 disposed immediately behind the reentrant fins, in the manner particularly shown by Fig. 3. With this modification, an inrush of additional cleaning air takes place through slots 48 immediately adjacent and behind each reentrant fin 46 in the path of the air and fiber which is circulating within the heating chamber. As the fibers and suspending air travel across and adjacent each fin, a pressure drop takes place in the eddy current immediately behind the fin, and this pressure drop develops inrush of additional cleaning air through a slot 48. After the air and suspended fiber has passed the fin 46 and the slot 48, unopposed centrifugal force operates to again drift the air suspended fiber toward the circumference of the chamber through the additional body of cleaning air thus supplied by slot 48.

The general movement of cleaning air through the chambers 16 and 18 is upward and then inward. As the fibers gradually descend through this rising vortex of air, the air operates to pick up fine dust and fines liberated by the fibers and to carry off such fines in suspension through the air exit. Introduction of cleaning air through slots 48 tends to displace dust laden air inwardly toward the exit 28 of the cleaning chamber, while the outer layers of air suspended fibers are subjected to bathing and scouring by added cleaning air.

The cleaning chambers are designed to operate gently on crude, unopened fiber bundles to fiberize such bundles by flexing and by mild impact against the reentrant fins and chamber linings, while cushioning the fibers against serious disintegration. Any crude unopened fiber

bundles which pass through the treating chamber are finally eliminated through the axial air inlets in the bottoms of the first two cleaners, and through the special rock outlet 54 at the base of the last cleaning chamber 20. The movement of the fibers in process of being cleaned is generally downward and outward during their progress through a cleaning zone, finally exiting tangentially from the bottoms of the principal cleaning chambers. The partially cleaned and crude fibers may be passed in series through several cleaning chambers, or may be recycled through the same individual cleaning chamber, until their classification and physical characteristics meet acceptable specifications.

Suitable dimensions for the cylindrical cleaning chambers 16, 18 and 20 include lengths of about 4½ ft. and internal diameters approximating 3 ft. The fans which develop and maintain a rising vortex of air throughout the chambers may be four bladed fans of approximately 2 inch blade width located in sets mounted respectively at elevations of approximately six inches and 36 inches above the bases of the cleaning chambers. Such fans are rotated at speeds which are adjustable to maintain air velocities in the range 300–1500 ft. per second at the periphery of the upwardly rising air vortex. Peripheral air speeds lower than 300 ft. per second are unsatisfactory because the pull of gravity allows the fibers to settle out of the cleaning unit at a rate too fast to permit suitably efficient fiberizing and cleaning action. Air velocity rates substantially greater than 1500 ft. per second tend to develop excessive fiberizing and breakdown of opened fibers, causing undesirable shortening of open fiber length.

The apparatus shown in Fig. 1 is designed to effect substantially complete separation of fine dust from the treated fibers during their passage through chambers 16 and 18, and to utilize chamber 20 for effecting final separation of clean opened fibers from coarse rock and unopened crude fibers by settling out such coarse impurities. The inverted frusto-conical lining 44 which is mounted in the upper portion of chamber 20 is designed to act as a removal trap or gate for the clean and opened fibers. The fiber with its entraining air is fed into the top of chamber 20, and as it settles it is moved by centrifugal force by the upwardly rising air vortex toward the periphery walls of the chamber. As the fibers travel in a rotational path adjacent the inner face of cone 44, they pass over deflecting fin elements 46 (Fig. 4), behind which fins lie slots 48 which form the only means of egress for the air and opened fibers leaving the cylinder 20. Fibers which have been sufficiently cleaned and opened can be made to reverse their direction of travel and to emerge through the slots 48 in cone 44, while heavier and coarser incompletely opened crude fibers and coarse granular impurities are carried by their greater momentum past the slots 44 and are thereby retained within the chamber while settling under gravity pull into the lower portion of chamber 20.

The arrangement of deflecting fins 46 and slots 48 in cone 42 at the base of chamber 20 may be such as portrayed in Fig. 5. In this case the reentrant fins are turned inwardly in a direction opposed to the direction of rotation of the air within the chamber, with the forward or scalping edges 56 of such fins presented as traps for heavy particles carried by the rotating air in closely abutting relation to the inner wall of cone 42. Centrifugal force rotates the entrained rock and

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/5

crudy fibers directly toward the forward scalping edge of a fin, while a jet of cleaning air is forced toward the center of the cleaning chamber through slots 48 located directly in front of the scalping fins 46. Coarse particles of high momentum and small lateral surfaces are not deflected by the air blast entering through a port 48, and such particles are trapped and ejected outwardly by the scalping edge and fin through the slot louvers forwardly of the fin elements, and settle by gravity to the base of the chamber 20, where they are discharged through the outlets 54. Any sufficiently opened fibers which are present in the air stream flowing past the inner lining of the bottom cone 42 in chamber 20 are deflected away from the scalping edges of the fins 46 by the blasts of air entering through ports 48, and such fibers are carried forwardly out of the lower section of the chamber 20 by the rising air vortex and finally exit from the chamber through the exit ports in cone 44.

The principal fiber opening and cleaning sections of the illustrated apparatus lie in the zones of chambers 16 and 18 which are confined radially by the inverted frusto-conical deflector fin linings. That portion of each of chambers 16 and 18 which underlies the restricted neck at the base of the inverted cone forms a radially extended classification zone in which the opened or partially opened fibers are thrown outwardly by the rotation of the revolving fan blades 24, to be removed tangentially from the base of the apparatus, while heavy impurities of more nearly spherical shape are discharged from the bottom of the inverted cone toward the centrally located air inlet port, in a zone where the centrifugal forces are insufficient to throw such granular particles toward the periphery. In other words, the final segregation of the opened and cleaned fibers from the heavier or coarser impurities takes place in the lower portion of the cleaning chambers below the point at which a powerful vortex is developed. In the upper portions of the chambers 16 and 18 the operation which takes place is primarily that of segregation and classification of crude or partially opened asbestos and of light dust or fine impurities. The light dust particle impurities are carried off by entrainment in the inwardly moving air stream which exits from the axial top center of the chambers, whereas the heavier crude and partially unopened fibers are forced toward the outer periphery of the vortex by centrifugal action.

The method and apparatus which is herein described is particularly directed to the purpose of effecting opening and cleaning of crude asbestos without serious disintegration or attrition of opened and cleaned fibers. To accomplish this purpose, the individual fiberizing and cleaning chambers of the apparatus are preferably limited in size to a comparatively low unit treating capacity, and several of such units are preferably operated in series, in order that the partial fiber opening and cleaning operation which takes place in one unit may be carried forward to completion in a succeeding unit. In traversing one of the fiberizing and cleaning units 16 or 18 from its top fiber inlet to its bottom tangential fiber outlet, the crude or partially opened fibers are subjected to only mild mechanical impact or impingement contact with the wall and fin surfaces of the cleaning chamber and with the blades 24 of the impeller fans. Provision is made to reduce as much as possible such mechanical impact treatment of the fibers, and to substitute therefore a prolonged and repeated flexing, bending and scouring treatment of the fibers while supporting them in gas suspension, as the principal fiber opening and cleaning influence. A substantial fiber opening and cleaning effect is developed by the turbulence obtained at points adjacent the reentrant fins, as a result of impingement and collision of impurity particles and fibers. Important factors in the elimination of mechanical disintegration as the chief fiberizing influence consist of: limiting the velocity of the carrier gas stream at the periphery of the vortex to a maximum of not to exceed 50 times gravity pull; developing transverse pulsations in the path of the fibers by interposing deflector fins which extend not more than an inch or two radially inwardly of the vortex periphery and which extend in a direction forming a small oblique angle with the direction of fiber movement; and introducing blanketing air streams behind the deflector fins and in the direction of fiber flow to partially counterbalance the centrifugal forces acting to push the open fibers into contact with the walls of the cleaning zone. Such factors cooperate to limit serious attrition of fine open fibers, without interfering too seriously with the forces applied to effect opening and cleaning of heavier unopened and crude fibers.

The present method of treating asbestos fibers is a highly efficient and simple operation in which an upwardly rising gas vortex is utilized for substantially simultaneous fiber opening and cleaning operations and for classification and segregation of the resulting cleaned fibers from heavy non-fibrous and light dust impurities. In the inner or axial zones of the vortex the material suspended in the vortex is classified by centrifugal forces, and all fibers and impurities greater than a desired size are returned to the outer periphery of the vortex by a centrifugal force of 10–50 times gravity. By continuing the upward and inward movement of the vortex through a zone which lies above the principal fiberizing and cleaning zone, a highly efficient classification is secured in which substantially all impurity particles below a predetermined size are entrained by the air which leaves the cleaning chamber through the central air exit port. The inverted cone frustrum linings which are mounted in the fiberizing and cleaning sections of each treating chamber operate somewhat as reverse venturis on the upwardly and inwardly spiralling air vortex, by reducing the velocities of the inward and rotational components of the air flow in the upper zones of the chamber, thus concentrating the fiber opening and cleaning section of the apparatus primarily within that section of the apparatus which is bounded by the cones, while promoting final classification and separation of light dust impurities by entrainment, in the upper zone of the cleaning chamber.

Operations which take place in the last cleaning chamber 20 of a series are primarily those of classification and segregation, although this chamber is also designed to carry out some opening and cleaning treatment of crude fibers. In this chamber the general flow of fibers from the top fiber inlet is downwardly and then outwardly and upwardly. Segregation and separation of fine dust particles should have been substantially completed with reference to the partially opened fibers which are introduced to the top of chamber 20, and chamber 20 is operated primarily to effect separation of opened and cleaned fibers from heavier impurities and crude fibers, by an

operation in which the clean fibers are finally removed tangentially from the upper portion of the chamber by entrainment by an upwardly and outwardly moving air vortex, while heavier impurity particles and unopened crude asbestos are discharged downwardly and then outwardly from the base of the chamber.

As an example of the effectiveness of the asbestos fiber opening and cleaning method of the present invention, the following results were obtained by treating a measured charge of unclean crude asbestos fibers in apparatus of the dimensions heretofore given, assembled in the manner portrayed in Fig. 1. The crude fibers as charged to the apparatus contained a usable fiber content of 53% by weight, and said crude fibers classified as to size with an average length of approximately 62 microns and an average diameter of approximately 58 microns. The crude fibers were delivered to the apparatus at a feed rate of 600 lbs. per hour, and the treatment was carried out supplying air to each cleaning unit at the rate of 400–450 cu. ft./minute. The yield of still incompletely cleaned open fibers which was obtained in fiber separator **36** was 63% by weight of the crude fiber charged to the unit, and such clean fibers classified to an average length of approximately 350 microns and an average diameter of approximately 18 microns. The large apparent increase in average fiber length results from removal of a high proportion of very short fibers or fines by the classification process. The heavy gangue which was discharged from the base of the last cleaning chamber **20** analyzed 17.4% of usable crudy fiber, and the light dust which was accumulated in dust separators **32** analyzed 28% of very fine short fibers of a grade suitable for use in the manufacture of asbestos paper, asbestos-cement shingles and plastics. By this opening and cleaning method as applied to crude asbestos it is possible to recover a major portion of the fibrous content within very narrow size classification limits and to separate undesired short fibers in a manner which makes them readily available for other uses as fillers and the like.

Since many variations may be made from the illustrative details given, without departing from the scope of the invention, it is intended that the invention should be limited only by the terms of the claims.

What I claim is:

1. The method of treating asbestos fibers to separate coarse and fine impurities adhering thereto comprising, introducing the fibers to be cleaned into an upwardly spiralling vortex of a gaseous fluid, maintaining a high volume ratio of gas to fiber to provide a thin suspension of fibers, maintaining a high ratio of rotational movement in relation to gravitational movement of fibers whereby to develop a path of fiber travel of such length that the fibers are combed into longitudinal alignment with the rotational direction of their movement, periodically deflecting the rotational gas flow inwardly at spaced points adjacent the periphery of the vortex, thereby developing components of gas movement which are transverse to the direction of fiber rotation and causing flexing and bending of the fibers whereby to loosen and scour impurities from the fiber surfaces, and finally separating the clean fibers from heavy granular impurities and from light dust impurities by removing the fibers peripherally from the vortex while entraining the dust in the upwardly moving gas and removing heavy impurities by gravitational settling.

2. The method of opening and cleaning crude asbestos fibers which comprises, suspending the fibers in an air vortex while rotating the air adjacent the periphery of the vortex at a velocity sufficient to comb the fibers into longitudinal alignment with the rotational direction of their movement, periodically developing air movement adjacent the periphery of the vortex in a direction transversely to the direction of fiber movement whereby to flex and bend the fibers, thereby splitting the fibers and liberating impurities and finally separating clean fine fibers from incompletely opened fibers and from liberated impurities.

3. The method of treating asbestos fibers as defined in claim 1, including the step of introducing streams of clean gas tangentially into the upwardly rising vortex whereby to cushion the rotating fibers against contact with the walls of the cleaning zone and to displace dust contaminated gas from the periphery of the vortex toward the center thereof.

4. The method of treating crude asbestos fibers to open the fibers and separate impurities comprising, suspending the crudy fibers in an upwardly moving air vortex while rotating the air adjacent the periphery of the vortex at a velocity sufficient to comb the fibers into longitudinal alignment with the rotational direction of their movement, deflecting the flow of air at intervals adjacent the periphery of the vortex to effect periodic air movement transversely to the direction of fiber movement whereby to flex and bend the fibers, thereby splitting the fibers and liberating impurities, and adjusting the rotational and vertical components of the air flow to effect separation of fine impurities by entrainment in the upwardly moving air and separation of heavy impurities by gravitational settling, while removing clean opened fibers from the periphery of the vortex.

5. The method of treating crude asbestos fibers to open the fibers and separate impurities comprising, suspending the crudy fibers in an upwardly moving air vortex, rotating the air adjacent the periphery of the vortex at a velocity sufficient to comb the fibers into longitudinal alignment with the rotational direction of their movement, deflecting the flow of air at intervals adjacent the periphery of the vortex to effect periodic air movement transversely to the direction of fiber movement whereby to flex and bend the fibers, thereby splitting the fibers and liberating heavy impurities, adjusting the rotational and vertical components of the air flow to effect removal of fibers by suspension in the upwardly moving vortex, and removing heavy impurities from the periphery of the vortex by centrifugal action while simultaneously introducing clean air laterally to the vortex at the points of heavy impurity removal at a rate sufficient to prevent removal of clean fiber by centrifugal action.

6. The method of simultaneously opening and cleaning crude asbestos fibers while avoiding substantial degradation thereof which comprises, continuously feeding fibers to be cleaned at a measured rate into an upwardly spiralling vortex of a gaseous fluid, maintaining a high volume ratio of gas to fiber to provide a thin suspension of fibers, maintaining a high ratio of rotational movement in relation to gravitational movement of fibers whereby to develop a path of travel of such length that the fibers are combed into longitudinal alignment with the rotational direction of their movement, periodically deflecting the ro-

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/7

tational gas flow inwardly at spaced points adjacent the periphery of the vortex, thereby developing components of gas movement which are transverse to the rotational direction of fiber movement and causing flexing and bending of the fibers whereby to open the fibers and loosen and scour impurities from the fiber surfaces, and finally separating opened and cleaned fibers from heavy crudy fibers and granular impurities by removing the clean fibers peripherally and selectively from the vortex.

7. The method of treating asbestos fibers as defined in claim 6, including the step of removing fiber in suspension outwardly from the periphery of said gas vortex by causing a reversal in the directional flow of the fiber by establishing a pressure drop between the path of fiber removal and the periphery of the vortex, and adjusting the pressure differential thus established to avoid contamination of the removed fibers by gas carrying non-fibrous impurities in suspension.

8. The method of opening and cleaning asbestos fibers which comprises, forming and maintaining an upwardly spiralling vortex of air, introducing asbestos fibers to be treated into said air vortex, maintaining a high volume ratio of air to fiber to provide a thin suspension of fibers, adjusting the rotational and upward flow components of the air body to maintain a high ratio of rotational movement in relation to gravitational downward movement of the fibers, whereby to develop a path of fiber travel of such length that the fibers are combed into longitudinal alignment with the rotational direction of their movement, deflecting the air flow at intervals adjacent the periphery of the vortex whereby to develop components of air movement which are transverse to the direction of rotation, thereby causing flexing and bending of the fibers and loosening and scouring of rock and dust impurities from the fiber surfaces, and simultaneously opening the fibers while avoiding substantial degradation thereof by said flexing and bending treatment.

9. The method of treating crude asbestos fibers to open the fibers and to separate rock gangue and dust adhering thereto comprising, suspending the crudy fibers in an upwardly moving air vortex while rotating the air adjacent the periphery of the vortex at a velocity sufficient to comb the fibers into longitudinal alignment with the rotational direction of their movement, deflecting the flow of air at intervals adjacent the periphery of the vortex to effect periodic air movement transversely to the direction of fiber movement whereby to flex and bend the fibers, thereby splitting the fibers and liberating rock gangue and dust therefrom, and adjusting the rotational and vertical components of the air flow to effect separation of granular gangue particles by gravity settling and of fine dust particles by suspension in the upwardly moving vortex.

10. The method of opening and cleaning crude asbestos fibers which comprises, establishing and maintaining two upwardly spiraling vortexes of air, introducing asbestos fibers to be treated into the upper portion of the first air vortex, discharging partially cleaned fibers tangentially from the bottom of the first vortex into the upper portion of the second vortex, maintaining in each vortex a high volume ratio of air to fiber to provide a thin suspension of fibers, maintaining in each vortex a high ratio of rotational movement in relation to gravitational downward movement of fibers whereby to develop a path of fiber travel of such length that the fibers are oriented into longitudinal alignment with the rotational direction of their movement, deflecting the air flow at intervals adjacent the periphery of each vortex whereby to develop components of air movement which are transverse to the direction of rotation, thereby causing flexing and bending of the fibers and opening and scouring of impurities from the fiber surfaces while avoiding substantial degradation thereof; separating light dust impurities from the fibers in the first vortex by entrainment removal of said dust in air discharged axially from the top of the vortex, and separating cleaned fibers from heavy granular impurities and unopened fibers by entrainment of opened and cleaned fibers in air discharged tangentially from the upper portion of the second vortex.

11. Apparatus adapted for the opening and cleaning of asbestos fibers comprising, two upright cylindrical chambers, means in each chamber for developing and maintaining therein an upwardly rising gas vortex, an inlet port in each chamber for introducing fiber to be treated into the upper portion of the vortex, an exit port in each chamber for removing cleaned fibers tangentially from said chamber, a conduit connecting the exit port of one chamber in series with the fiber inlet port of the second chamber so that fiber discharged from the tangential outlet of the first chamber is introduced through the fiber inlet port of the next chamber, and a fiber opening and cleaning zone in each chamber, said zone being largely confined within an inner wall lining extending throughout a substantial proportion of the chamber length comprising spaced reentrant fins each projecting a short radial distance inwardly into the path of the vortex.

12. Asbestos fiber opening and cleaning apparatus comprising an upright cylindrical chamber, an air inlet port located centrally at the base of the chamber, a tangential air exit port located in the upper peripheral portion of said chamber, means for establishing and maintaining an upwardly rising air vortex within the chamber, an inverted frusto-conical baffle projecting inwardly and downwardly from the upper portion of the chamber wall above and in front of the air exit port, spaced peripheral slots in said baffle, deflecting fins projecting inwardly in front of each slot in the direction of vortex flow, and means in the lower portion of the chamber designed to segregate and separate heavy and coarse impurities from clean fine fibers suspended in the upwardly rising vortex, said means including scalping fins projecting inwardly a short distance at spaced intervals about the periphery of the vortex in a direction opposed to and forming an oblique angle with the direction of vortex flow, and slots positioned immediately in front of each fin in the direction of gas flow, the forward edge of each fin forming a means for trapping and deflecting through said slots heavy coarse impurities brought in contact therewith under the centrifugal force of said vortex.

13. Asbestos fiber cleaning and separating apparatus comprising, an upright cylindrical drum, gas intake and discharge ports located respectively at the base and top of the drum, a fiber charging port opening into the top of the drum, a tangential fiber discharge port at the base of the drum, means for establishing and maintaining an upwardly rising gas vortex within the drum, an inverted frusto-conical inner lining for the lower portion of the drum having its upper rim engaging and attached to the drum walls, said

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/8

lining being spaced from the drum wall over a major portion of its height, slots at spaced intervals around the periphery of said inner lining, and deflector fins extending inwardly a short distance at an oblique angle in front of each slot in the direction of vortex flow.

14. In cyclone opening and cleaning apparatus for unclean asbestos, the combination of an upright cylindrical drum, means for establishing and maintaining within said drum an upwardly rising air vortex, means for introducing fibers to be cleaned into the upper portion of said vortex, an inverted frusto-conical lining mounted in the drum with its top rim engaging and attached to the drum walls, said lining being spaced from the drum walls over major portions of its height slots at spaced intervals around the periphery of said lining, a tangential air outlet ported out of the drum behind the lining, deflecting fins in front of each slot in the lining in the direction of vortex flow, and scalping fins behind each slot in the lining in the direction of vortex flow.

15. Asbestos fiber cleaning and separating apparatus comprising an upright cylindrical drum, gas intake and discharge ports located respectively adjacent the base and top of the drum, a fiber charging port opening into the top of the drum, a tangential fiber discharge port at the base of the drum, a heavy impurity discharge port located centrally at the base of the drum, an inverted frusto-conical inner lining for the lower portion of the drum, said lining having its top rim engaging the drum wall and being spaced from the drum in the path of an upwardly rising vortex over the major portion of its height, slots at spaced intervals around the periphery of said inner lining, deflector fins extending inwardly a short distance at an oblique angle in front of each slot in the direction of vortex flow, and sets of fan blades mounted above and below the frusto-conical lining within the drum and arranged to establish and maintain an upwardly rising vortex within the drum.

16. In cyclone opening and cleaning apparatus for crude fibers, two upright cylindrical drums, means for establishing and maintaining within each drum an upwardly rising air vortex, charging ports for introducing fibers to be cleaned into the upper portion of each drum, a tangential

fiber discharge port at the base of the first drum, a conduit connecting the fiber charging port of the second drum with the fiber discharge port of the first drum, an axial air outlet port at the top of the first drum, inverted frusto-conical lining members mounted in a lower portion of each drum with their top rims engaging and attached to the drum walls, another inverted frusto-conical lining member mounted in the upper portion of the second drum, said lining members being spaced from the drum and positioned in the path of the upwardly rising vortex over major portions of their heights, a tangential air and fiber outlet port for the second drum behind the upper lining member, slots at spaced intervals around the periphery of each lining member, deflecting fins projecting inwardly in front of each slot in the direction of vortex flow in the upper lining of the second drum and in the lower lining of the first drum, and scalping fins projecting inwardly behind each slot in the lower lining of the second drum.

FRANK J. KOEHNE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
505,977	Fletcher	Oct. 3, 1893
1,023,750	Morscher	Apr. 16, 1912
1,484,208	Davis	Feb. 19, 1924
1,505,742	Stebbins	Aug. 19, 1924
1,509,915	Stebbins	Sept. 30, 1924
1,595,257	Stebbins	Aug. 10, 1926
1,595,258	Stebbins	Aug. 10, 1926
1,675,941	Lindsay	July 3, 1928
1,978,802	Lissman	Oct. 30, 1934
2,026,833	Holland-Letz	Jan. 7, 1936
2,032,827	Andrews	Mar. 3, 1936
2,039,692	Van Tongeren	May 5, 1936
2,125,086	Rourke	July 26, 1938
2,128,166	Schmidt	Aug. 23, 1938
2,128,194	Sheldon	Aug. 23, 1938
2,152,114	Van Tongeren	Mar. 28, 1939
2,214,658	Browning	Sept. 10, 1940
2,280,903	Ellison	Apr. 28, 1942

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/9

Certificate of Correction

Patent No. 2,460,938. February 8, 1949.

FRANK J. KOEHNE

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 1, line 16, for the word "windowing" read *willowing*; column 6, line 51, for "periphery" read *peripheral*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of July, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

Published by AsbestosClaims.Law
asbestosclaims.law/library/22992/10