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[54] **RECOVERY OF ASBESTOS FIBERS FROM ASBESTOS ORE**

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[58] **Field of Search**..... 241/4, 5, 18, 19, 24, 27, 29, 241/58, 114, 189 R, 229, 240, 241, 275

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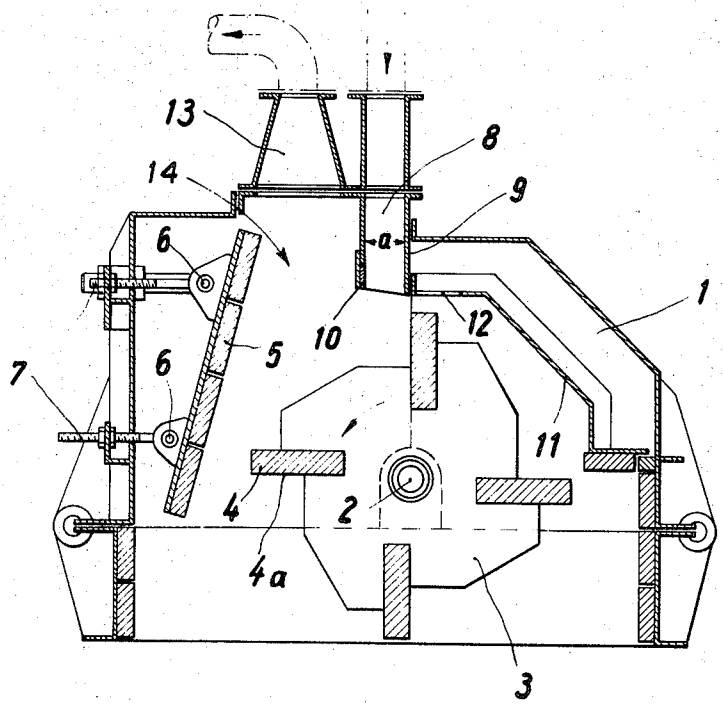
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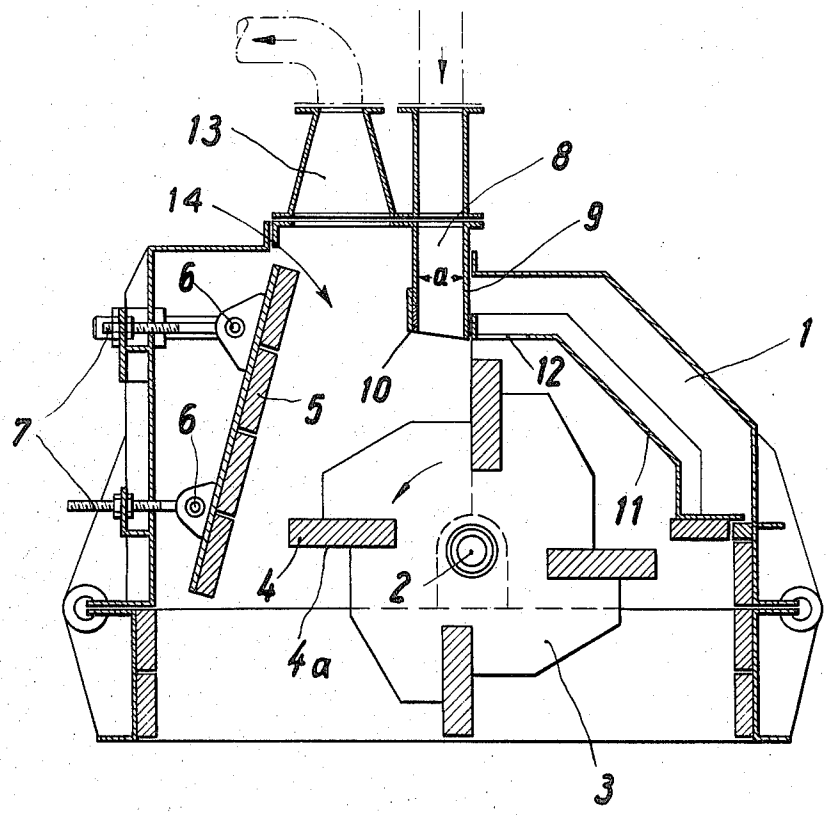
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[57] **ABSTRACT**

An apparatus and a method are disclosed. Asbestos ore chunks are admitted into a housing in a vertical or near vertical path and into the orbit of striking bars on a rotor which turns about a horizontal axis in the housing. Downstream of the point of contact of each chunk with the striking bars, as seen with reference to the direction of rotation of the rotor, is an impact plate and the arrangement is such that each chunk will be struck only once by the striking bar of the rotor and flung only once against the impact plate, thereby becoming crushed by the impact. A suction conduit communicates with the housing in the region where the crushing takes place so as to immediately withdraw asbestos fibers which are liberated by the crushing.

9 Claims, 1 Drawing Figure




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RECOVERY OF ASBESTOS FIBERS FROM ASBESTOS ORE

BACKGROUND OF THE INVENTION

The present invention relates generally to the recovery of asbestos fibers from asbestos ore, and more particularly to a method of recovering such fibers and to an apparatus to carry out the method.

Asbestos fibers are obtained by recovery from asbestos ore wherein layers of tightly adjacent asbestos fibers are embedded between matrix material. The fibers must therefore be separated from the matrix material, that is rock or the like, and the longer the fibers are which are recovered by separation, the more valuable they are because the wider is their range of applicability and usefulness.

Some of the fibers of the fiber layer will become separated in form of clumps (known as copses) which become released from the embedding matrix during the initial breaking of the ore in the mine, for instance by explosive means. After these clumps have been removed the remaining chunks of ore are subjected to one or more fragmenting stages with the aim of separating the matrix and the asbestos fibers to the maximum extent possible, thereby recovering fiber bundles and individual fibers from the matrix.

After this process, the remaining chunks of ore, now smaller than before, still contain bundles of asbestos fibers adhering to or embedded in matrix material. It is already known to continue fiber recovery beyond this step, and various approaches are known in the art for recovering the maximum quantity of fibers still remaining in the ore chunks at this point of processing. Processing of these ore chunks is usually carried out in a so-called Fiberizer, which are well known to those skilled in the art and require no detailed discussion herein. It will be sufficient to recall that Fiberizers are centrifugal-type hammer mills having a rotor which turns about a vertical axis and is surrounded by a series of annularly arranged impact plates. Ore is admitted from above and is flung by contact with the hammers of the rotor against the impact plates, being fractured as a result of the impacts it thus receives and in the process yielding asbestos fibers. These fibers are aspirated out of the region of the rotor as rapidly as possible.

The trouble with this type of recovery apparatus is that the ore chunks are crushed into very small pieces, including a very large quantity of fines; this is true not only of the matrix but also of the asbestos fibers which are rather brittle. Moreover, even if asbestos fibers are liberated intact in such devices, they are frequently not withdrawn rapidly enough out of the reach of the rotor and are subjected to additional strokes and impacts which break them and make them undesirably short, thereby reducing their value and usefulness. In addition, such apparatus produces an undesirably large amount of dust — of a size on the order of 200 mesh — which must later laboriously be separated from the fibers.

This problem has, of course, been recognized in the industry and attempts have been made to overcome it. In particular, it is known from the prior art to provide an alternate type of recovery apparatus in which a rotor having striking elements turns about a horizontal axis. The impact plates associated with this rotor are mounted above the rotor. The ore is supplied to the rotor at the upper half of the rising side of the rotor, that is to say, where the striking elements of the rotor move in upward direction, so that the ore chunks are engaged by the rotor and impelled upwardly against the impact plates. Ore chunks which have not been sufficiently crushed fall back upon the rotor and are impelled again against the impact plates. Fibers which are liberated are withdrawn by suction, preferably in upward direction. An apparatus of this type which has a significantly improved fiber recovery capability as opposed to the first-mentioned apparatus is for instance disclosed in U.S. Pat. No. 2,957,633 to which reference may be had.

Even this last-mentioned type of apparatus, however, is not entirely satisfactory in certain respects. The percentage quantity of asbestos embedded in the matrix is between approximately 3 – 10 percent. Evidently, this rather low proportion of asbestos to matrix makes it essential from an economic viewpoint that the maximum recovery rate be sought. Under these circumstances it is hardly necessary that any increase in the recovery rate amounting even to some fractions of a percent would constitute a significant advance in terms of the economics involved. Furthermore, a reduction in the number of fines resulting during the recovery procedure, and of course including the recovery of inherently longer asbestos fibers which heretofore have become fractured and converted into fines during the recovery process, would similarly constitute an improvement.

SUMMARY OF THE INVENTION

It is, accordingly, a general object of the present invention, to overcome the aforementioned disadvantages.

More particularly, it is an object of the present invention to provide an improved method of recovering asbestos fibers from asbestos ore.

A concomitant object of the invention is to provide such an improved method which not only permits the recovery of a larger percentage of asbestos fiber from asbestos ore than heretofore possible, but which also permits the recovery of a larger percentage of relatively longer fibers than was heretofore possible.

An additional object of the invention is to provide apparatus which is capable of carrying out the invention.

The invention is based on the surprising realization that the quantity of fibers recovered from asbestos ore can be substantially increased if each chunk of ore is subjected to only one strike and only one impact, and if suction is applied at the same time to the region where the strike and the impact take place, that is, where the chunk of ore becomes crushed and where fibers become separated from the matrix material and from fiber bundles.

In keeping with this realization, and in pursuance of the above objects and others which will become apparent hereafter, a method according to the present invention for the recovery of asbestos fibers from asbestos ore, therefore comprises the steps of feeding chunks of asbestos ore in at least substantially vertical path intercepting the chunks and subjecting each of them to only one accelerating strike and one decelerating impact so as to crush the chunk and liberate asbestos fibers therefrom. The liberated fibers are immediately entrained by

suction and conveyed away from the crushing zone and from the crushed chunks.

Of course, the smaller fragments resulting from crushing of each chunk still contain asbestos fibers and may, in accordance with a further concept of the invention, be subjected to the same method steps one more time or several more times, as long as each such fragment (or each correspondingly smaller fragment) is subjected to only one strike from the rotor and one impact on the impact element.

Resort to the present invention has been found to produce asbestos fibers which (if the quantity of fibers recovered is equal to the quantity recovered with method and apparatus according to the prior art) have a much lower content of fines than those recovered according to the prior art. Conversely, if use is made of the present invention to obtain a fiber quality equal to that which can be obtained with the prior-art teaching, the quantity of fibers recovered with the present invention is substantially higher than that which can be recovered with the prior art approaches.

Experience has shown that it is advantageous to subject the small ore fragments — in which most of the moisture of the ore coming immediately from the mine is accumulated — to a drying action, for instance in a drum-type drier and subsequently to subject them to suction in order to withdraw any fibers which may have been liberated as a result of the drying, before they are processed in accordance with the method and in the apparatus of the present invention.

This apparatus comprises, briefly stated, a housing having an interior chamber, supply means for gravity-feeding chunks of asbestos ore in at least substantially vertical direction into said chamber, and suction means communicating with a region of the chamber. It further comprises striking means in the chamber constructed and arranged for subjecting the respective chunks to a single accelerating strike and thereafter to a single decelerating impact in the region where the suction means communicates with the housing chamber, to thereby crush the chunks of ore and liberate therefrom asbestos fibers which are immediately removed from the chamber by aspiration via the suction means.

According to the invention it is advantageous if the outlet opening of the feed path or chute, which latter should be vertical or substantially vertical, is located proximal to the apex of the orbital path travelled by the striking bars provided on the periphery of a rotor of the apparatus, and that it have a width as seen in the direction of rotation of the rotor which corresponds at most to approximately 15 percent of the diameter of the orbital path in which the striking bars of the rotor travel. The inlet to the suction conduit or similar aspirating means may be located above or below the level of the rotor, as long as it provides sufficient aspirating capability (i.e., suction), in the region where the fibers are liberated from the crushed chunks of ore.

Impactors of this general type are not novel per se, and are for instance known from U.S. Pat. Nos. 2,192,606 and 2,292,852. They are not, however, suitable for recovering asbestos fibers from asbestos ore — nor have they even been used for such purposes — because they do not provide suction means for removing the fibers in combination with only a single strike and a single impact of each chunk of ore. Because of this, they cannot afford the advantages achieved with the present invention.

The increased recovery of the fibers and/or improved quality of the recovered fibers which is obtained according to the present invention as opposed to the methods and apparatus of the prior art result from the fact that in effect the chunks of asbestos ore are engaged individually and only in a single particle layer by the striking bars of the rotor, and are thrown in this same relative formation against the impact plate. This means that there is no frictional contact between the chunks themselves, and that fibers liberated from them are subject to a much smaller extent to breakage, especially because they are immediately withdrawn by suction. Of course, the smaller fragments obtained by crushing of the chunks can again be passed through the apparatus and processed in the same manner as the originally larger chunks because all loose fibers adhering to these fragments were previously withdrawn by suction as the larger chunks were fractured, so that such fibers cannot again be subjected to strikes and impacts which would fracture them into small pieces.

According to the invention and in order to obtain despite the relatively thin "veil" of material which is contacted by the rotor at any given time, as high as possible a fiber recovery per unit of time, the rotor is advantageously composed of two or more disk-shaped elements mounted on a rotor axle or shaft and provided in their circumferences with substantially radial slots in which elongated striking bars are mounted. Thus, contrary to the rotors known from the prior art for asbestos fiber recovery apparatus, the rotor in the apparatus according to the present invention does not have a cylindrical body of closed circumference, but has an open circumference intermediate the individual striking bars so that the chunks of ore — which are admitted at relatively high speed (in the simplest manner by permitting them to fall from a relatively great height through a feeding chute of appropriate length) — will enter relatively deep into the interior of the rotor and will thus be contacted by the front faces of the striking bars rather than by the radially outer edges of the striking bars.

Because it has been found that the supply of ore to the rotor in the desired manner can be disadvantageously influenced by eddy currents and airflows resulting from the high speed rotation of the rotor, the invention provides for that wall of the supply chute which is located upstream as seen with reference to the direction of rotation of the rotor — that is which faces oppositely the direction of rotation — to extend with its lower portion close to the orbital path in which the striking bars of the rotor move. The opposite wall of the chute, that is the one which is spaced from the just mentioned wall in the direction of rotation of the rotor, should terminate with its lower portion at a larger distance from the orbital path so that chunks of ore which are struck by the outer edges of the striking bars and which are usually flung slightly upwardly, will not contact this wall.

A further means according to the present invention for reducing eddy current interference and similar phenomena, is the provision of a curved wall which extends from the lower end of the first-mentioned or upstream wall of the supply chute about the periphery of the rotor counter to the direction of rotation of the latter with slight radial spacing from the orbital path of the striking bars of the rotor. When this wall is provided then it is advantageous that it be formed slightly up-

stream of the supply chute — that is at locations slightly spaced from this upstream wall of the supply chute in direction opposite the rotation of the rotor — with one or more apertures through which the air which is dammed by the advancing striking bars, can escape and be vented before it reaches the outlet opening of the supply chute. Otherwise it would disadvantageously influence the speed at which the ore is moving as it encounters the striking bars of the rotor.

The impact element itself is preferably provided with an at least substantially planar impact surface the upper edge of which is closer than the lower edge to the vertical axial plane passing through the axis of rotation of the rotor. Because of this the impacting ore chunks are effectively diverted in downward direction, towards the outlet through which they are intended to fall, without again entering into the orbital path of the striking bars, that is, without being subjected to a second strike from these bars. It is further advantageous if the distance of the horizontal axis about which the impact element is advantageously pivotable and adjustable and which extends in parallelism with the axis of rotation of the rotor, can be adjusted with reference to the axis of the rotor so that the apparatus can be accommodated to the particular characteristics of the ore being processed, such characteristics being not always identical.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of a specific embodiment when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a somewhat simplified sectional elevation through an apparatus according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing the drawing now in detail, it will be seen that reference numberal 1 identifies a housing of the apparatus in which a rotor is journalled for rotation about a horizontal axis defined by the shaft 2. In the illustrated embodiment, the rotor rotates in counterclockwise direction, as indicated by the arrow shown in the FIGURE, but of course this is only in the particular exemplary embodiment.

The rotor itself is composed of two disk-shaped members 3 (one shown, whereas the other one should be imagined to extend in parallelism with it but in front of the plane of the FIGURE) which are mounted on the shaft 2 for rotation therewith. The peripheries of these members 3 are provided with approximately radial slots in which elongated striking bars 4 are mounted. These bars have striking (front) faces 4*a* which also extend substantially radially with reference to the axis about which the shaft 2 rotates.

Laterally adjacent the rotor, at the left-hand side in the illustrated embodiment there is provided an impact element 5, here of plate-shaped configuration, which is mounted for pivotal movement about axes 6 so that it can be tilted and adjusted in the housing 1. The shafts defining the axes 6 can be horizontally shifted towards and away from the shaft 2 by means of the illustrated screw spindle units 7 which are pivoted to the impact element 5 as indicated and mounted on the housing 1.

Above the rotor 2, 3 there terminate, in the housing 1 the outlet opening of a vertical or near vertical feed chute 8 bounded by two walls 9 and 10. The wall 9 is the upstream wall which faces oppositely the direction of rotation of the rotor and its lower portion is located close to the orbital path in which the striking bars 4 rotate. The lower portion of the downstream wall 10 is located at a greater distance from this orbital path for the reasons indicated earlier. A wall 11 extends from the lower portion of wall 9 circumferentially of the rotor opposite to the direction of movement thereof with slight radial spacing from the orbital path of the striking bars 4 and surrounding in the illustrated embodiment approximately one quadrant of this orbital path. The wall 11 can also be curved or otherwise configurated. In the illustrated embodiment it is provided with one or more openings 12 which are located close to but ahead of the wall 9, for the reasons indicated earlier. Downstream of the supply chute 8, as seen with reference to the direction of rotation of the rotor 2, 3 an aspirating or suction conduit 13 communicates with the housing 1.

Chunks of asbestos ore advance through the supply chute 8 preferably in free fall from a great height and enter into the orbital path of the striking bars 4. Because of the open-periphery construction of the rotor 2, 3 and because of their relatively great speed of travel, these chunks are for the most part engaged not by the outermost edges of the striking bars 4, but by the front surfaces 4*a* to which they can penetrate radially inwardly of the rotor. They are struck by the surfaces 4*a* and are flung in approximately horizontal direction against the surface of the impact element 5. The initial strike of the striking bars against the chunks of ore produces in the zone 14 to a significant extent a separation of the fiber bundles in the ore chunks from matrix material, and a separation of the thus liberated fiber bundles into their individual constituent fibers. A further separation takes place in the zone 14 as a result of the impact of the ore chunks and fiber bundles against the element 5. The liberated fibers are immediately withdrawn, in the illustrated embodiment in upward direction, into and through the conduit 13 without having the opportunity to come into contact again with the striking bars 4 which would otherwise break them and make them shorter. The fragments into which the chunks have been separated fall downwardly out of the housing 1, again for the most part without coming into contact again with the striking bars 4. They may then be recycled through the supply chute 8.

As already indicated earlier, the dimension of the supply chute 8 which is indicated with "a" should not be larger than 15 percent of the diameter of the orbital path traversed by the outer edges of the striking bars 4, but preferably it should be even less than 15 percent. In the longitudinal direction of the shaft 2 the chute 8 will of course have a dimension which preferably corresponds to the length of the striking bars 4.

Tests which have been carried out clearly indicate that the method and apparatus according to the present invention achieve the designated goals of recovering greater quantities of asbestos fiber from asbestos ore than was heretofore possible, or of increasing the qual-

ity of such fiber if the recovery rate is held at the same level as is capable of achievement with the prior-art approaches. The economics of recovery of asbestos fibers is therefore greatly improved by the present invention.

While the invention has been illustrated and described as embodied in an apparatus for the recovery of asbestos fibers from asbestos ore, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spriit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention, and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. An apparatus for recovering asbestos fibers from asbestos ore with minimum fiber breakage, comprising a housing having an interior chamber provided with an upper inlet through which asbestos ore chunks having fibers embedded in matrix material are gravity-fed in at least substantially vertical direction; contact means in said chamber for crushing said ore chunks, comprising a rotor mounted for turning movement about a horizontal axis and having a plurality of circumferentially spaced striking elements which move about said axis in an orbital path the apex of which is located below said inlet, said striking elements imparting to the gravity-fed ore chunks a single strike to accelerate them in dircetion transversely of said axis, and an impact element spaced from said rotor in said direction and from which each accelerated ore chunk receives a single decelerating impact, said ore chunks being crushed by said impacts so that the lighter asbestos fibers become liberated from the heavier matrix material in the zone between said rotor and said impact element; an outlet below said zone through which said matrix material falls by gravity and suction means having an intake communicating with said chamber above said zone intermediate said rotor and said impact element, for removing the liberated fibers from said zone by suction immediately following the respective decelerating impact so as to prevent fragmenting of said fibers by further contact of the same with said contact means, ore chunks or matrix material.

2. An apparatus as defined in claim **1**, said orbital path having a given diameter, and said inlet having in direction of rotation of said rotor a width corresponding at most to substantially 15 percent of said given diameter.

3. An apparatus as defined in claim **1**; further comprising a chute having a pair of substantially parallel walls one of which is located upstream and the other of which is located downstream with reference to the direction of rotation of said rotor, and wherein said one wall has a lower end closely proximal to said orbital path and said apex and said other wall has a lower end at a greater distance from said orbital path.

4. An apparatus as defined in claim **3**, further comprising a guide wall extending from the lower end of said upstream wall circumferentially of said rotor in upstream direction and enclosing said orbital path with slight spacing over a portion arc about of the circumference of the rotor.

5. An apparatus as defined in claim **4**, further comprising at least one aperture in said guide wall in the region of said one wall.

6. An apparatus as defined in claim **1**, said impact element including a substantially planar impact surface having an upper and a lower edge which are respectively closer to and farther from a vertical axial plane passing through said horizontal axis.

7. An apparatus as defined in claim **6**, further comprising mounting means mounting said impact element for pivoting movement about an additional horizontal axis, and regulating means for regulating the angular position of said impact element with reference to said additional axis, and for varying the distance of said additional axis relative to said vertical axial plane passing through said horizontal axis.

8. An apparatus as defined in claim **1**, said rotor comprising a shaft extending along and defining said horizontal axis, and at least a pair of axially spaced disk-shaped members mounted on said shaft and each having a periphery provided with a plurality of circumferentially spaced substantially radial slots, said striking elements each extending longitudinally of said shaft and being received and retained in one slot each of the respective disk-shaped members.

9. A method of recovering asbestos fibers from asbestos ore, comprising the steps of feeding chunks of asbestos ore comprising asbestos fibers in matrix material in an at least substantially vertical path; intercepting the respective chunks and subjecting at least most of said chunks to only one accelerating strike at one point and only one decelerating impact at another point which is transversely spaced from said one point, so as to crush the chunks and to liberate asbestos fibers from said matrix material in the zone intermediate said points; and entraining the liberated asbestos fibers by suction in said zone immediately following the respective decelerating impact for conveying them out of said zone and away from said path and matrix material so as to prevent fragmenting of said fibers by further impacting.

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