Dec. 8, 1959 J. M. RICE 2,915,790

DEVICE AND METHOD FOR EXFOLIATING AND BLENDING ASBESTOS FIBER

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Fig. 1

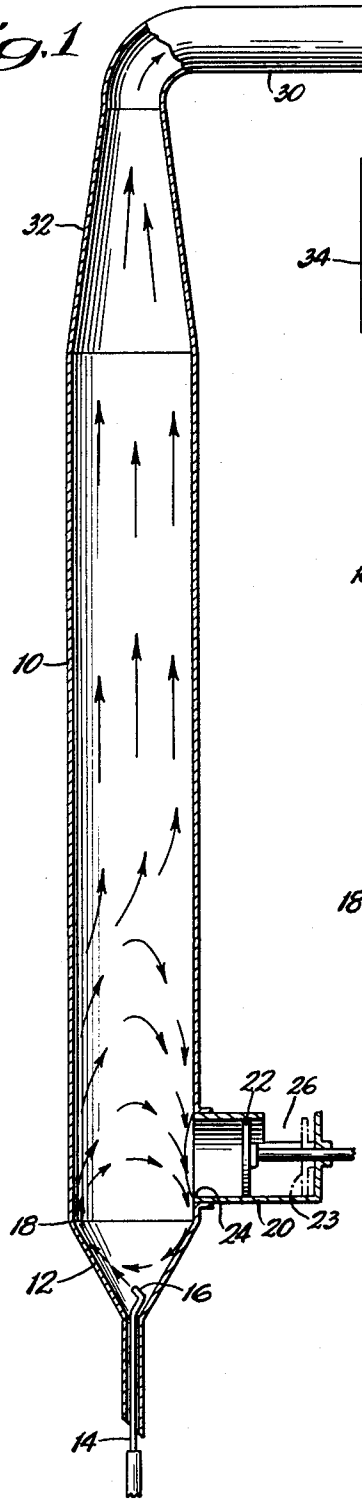
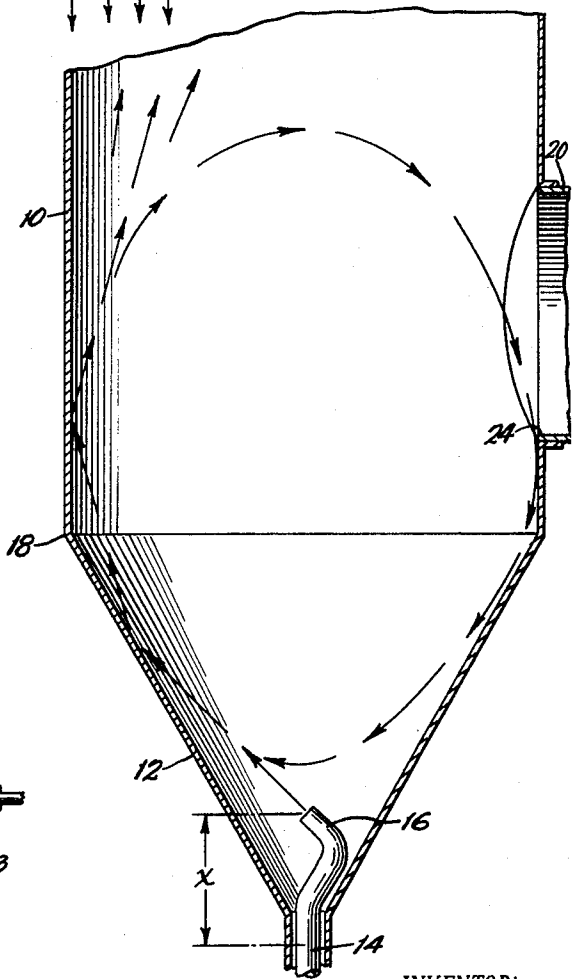


Fig. 2



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DEVICE AND METHOD FOR EXFOLIATING AND BLENDING ASBESTOS FIBER

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10 Claims. (Cl. 19—72)

The invention relates to a method and apparatus for opening or exfoliating asbestos bundles into their component fibers. Devices and methods previously employed for this purpose all had the serious disadvantage of materially reducing the length of the asbestos fiber as the degree of opening was increased. As a result products prepared from asbestos fibers such as textiles, paper and bonded articles have always been rather crude and of poor quality as compared with similar articles made from other fibrous materials which may be obtained in relatively long lengths. The disadvantage of the short lengths of fibers has been a problem long recognized by the asbestos industry, but one to which the industry had become reconciled. It is generally recognized, however, that if asbestos fibers of reasonable length can be obtained, greatly superior end products can be prepared therefrom.

The general object of this invention is to provide an efficient and practical method and apparatus for maximum opening of the fiber bundles with a minimum reduction in fiber length.

My invention consists in splitting or exfoliating the asbestos fiber bundles by erosion with a high velocity fluid stream, preferably air. The fiber bundles are repeatedly subjected to the force of the high velocity stream by recycling within the confines of a suitable chamber. As the exfoliation continues, the diameter and bulk density of the fibers is progressively reduced. The finer lightweight fibers, split from the original bundles, are buoyed up by the rising current of lower velocity fluid flowing out of the chamber and thus are separated by fractionation from the denser fibers, which continue to circulate in the stream until their size is reduced by further subdivision to the point where they too become entrained in the escaping fluid. In a short time all of the fibers are exfoliated to the desired degree, fractionated and collected.

The novel apparatus for carrying out this process consists of a hollow cylinder or column terminating at its lower end in a conical-shaped expansion chamber. A suitable conduit terminating in a nozzle enters the expansion chamber through the lower end of the cone for directing the high velocity fluid stream upwardly against the inclined wall of the cone. The angle at which the stream strikes the cone is such that turbulent circuitous flow will result without blowing unopened dense fiber bundles out the upper end of the column. Suitable means is provided for charging the expansion chamber with fiber bundles to be processed, and at the upper end of the column means is provided for receiving the lightweight opened fibers.

For a better understanding of the invention, reference is made to the accompanying drawings, in which:

Figure 1 is an elevational sectional view through apparatus constructed in accordance with my invention, and

Figure 2 is an enlarged view of the lower portion of the appartaus including the conical expansion chamber.

The cylinder or column **10** may be made from any suitable material, preferably steel, and terminates at its

lower end in a conical expansion chamber **12**. The bottom of the inverted cone is connected to the lower end of the cylinder **10** with a circumferential weld **18**. The lower pointed end of the cone joins a conduit through which a tube **14** enters the expansion chamber. The upper end of the tube **14** carries a nozzle **16** and the lower end thereof connects with a suitable source (not shown) of compressed air or other fluid pressure. The side wall of the cone makes an angle of approximately 60° with the horizontal and an angle of about 150° with the wall of the cylinder or column **10**. The relationship of the angular walls of the two parts of the apparatus is shown more clearly in the enlarged view of Figure 2. It will be noted that the axis of the nozzle **16** lies in a vertical plane, but the end thereof is curved to direct the stream of air against the inclined wall of the cone. The angle of incidence is about 15°. The stream is directed at a point a short distance (about one-fourth to one-third the length of the cone wall) below the circumferential weld **18**. The angle of reflection of the stream is also about 15° and from the wall of the cone the stream is deflected to the vertical wall of the column **10** from which it is again deflected, back toward the center of the column. The angle of incidence and reflection of the stream with the vertical wall of the column is also about 15°. Thus it will be observed that the stream strikes the wall at an acute angle and, consequently, is deflected at an acute angle. With the nozzle disposed in this position with relation to the walls of the chamber, the air stream will follow the circular path as indicated by the arrows in the drawing. This turbulent zone occupies substantially all of the space within the cone and approximately the lower quarter of the column. The fibrous bundles are circulated in this circuitous path until they have been sufficiently subdivided to be buoyed upwardly by the air mass above the turbulent zone moving toward the top of the column. It will be understood that the slope of the conical wall and the angle of incidence of the air stream may be varied, and that the specific values given are for purposes of illustration only. It is essential that the slope of the wall and the angle of the stream and the point at which the stream strikes the wall be correlated to produce a circuitous flow path within the turbulent zone.

For introducing the fibers into the circuitous turbulent fluid stream, I have provided a charging cylinder **20** equipped with double pistons **22**, **23**. The cylinder has an opening **26** in the top through which fibers may be charged. The pistons may be moved forwardly with the inner piston **22** disposed well within the interior of the column so that fibers between pistons **22** and **23** will fall down into the expansion chamber. The inner piston **22** serves to prevent air from flowing to the atmosphere through the charging cylinder when the piston **23** is in the position shown in Figure 1. The charging cylinder **20** is welded to a flanged opening **24** ahrough the wall of the column **10**. The cylinder preferably should be mounted opposite the point at which the stream issuing from the nozzle **16** strikes the wall of the chamber to prevent interference with the deflection of the stream from the walls. In other words, the fibers are introduced on the downstream side.

At the top of the cylinder I have provided a reducer **32** which connects with a conduit **30** of smaller diameter than the column **10**. By reducing the cross-sectional area, the velocity of the air being discharged from the upper fractionating zone of the column is increased so that the exfoliated fibers entrained therein are carried from the column at an increased rate. The conduit **30** turns downwardly and connects with a condenser hood **34**. A stream of air is introduced under the hood through the nozzle **36** for dispersing the fibers.

Generally, the length of the column **10** should be from

four to eight times its diameter. I have prepared an apparatus of this type wherein the diameter is 5 inches and the height is 27 inches. The distance X from the point of the cone to the end of the nozzle shown in Figure 2 was 1½ inches. The angle of incidence of the air stream was 15° with the angular wall of the cone. Using this apparatus I was able to produce asbestos fibers having a bulk density of about 0.1 pound per cubic foot and a diameter of .0005 inch. There was no measurable shortening of the length dimension of the subdivided fibers. The original bulk density of the fibers ranged from 1.5 to 2 pounds per cubic foot.

In operating the device, fiber bundles having a diameter of about .005 inch and an average length of 2.0 to 2.5 inches are preferred. However, the apparatus is suitable for processing bundles having a minimum length of 0.2 inch and a mean diameter of .003 inch without any substantial reduction in length. Defining the size of the starting fibers more accurately, 85% of the longer fibers will pass through a No. 1 screen and 95% will pass through a No. 2 screen. The screens referred to are Quebec screens conventionally used in the industry. The minimum requirements call for 23% of the fibers passing through a No. 1 screen and 65% passing through a No. 2 screen. The long fibers have a bulk density of around 1.1 pounds per cubic foot, while the shorter fibers (0.2 inch) have a density of around 2.1 pounds per cubic foot. Fibers are charged into the apparatus through the charging cylinder 20. The velocity of the air stream at the nozzle 16 must be a minimum of 17,500 feet per minute. If the velocity is not maintained at this rate, the fibers useful for the invention will not remain in suspension. Preferably, the velocity for the particular apparatus described will range between 24,500 feet per minute and 37,000 feet per minute, using a nozzle of 0.43 cm. in diameter. Generally, the fibers of longer length will require a higher velocity stream, say 35,000 to 37,000 feet per minute, for effective exfoliation. It will also be understood that the optimum velocity will vary with the nozzle angle. The closer the angle of incidence approaches 90°, the higher the velocity. Furthermore, the velocity must also be increased with the diameter of the column. In the particular apparatus just described, if the velocity exceeds about 37,000 feet per minute at the nozzle the length of the fibers split off will be shortened. The column-to-nozzle diameter ratio in this apparatus is 29.5:1, which gives a velocity ratio of 1:875. It will be apparent that the diameter of the column and the diameter of the nozzle may be varied together in order to maintain sufficient volume of air to produce a circular flow which will keep the fibers suspended and erode them to the extent necessary to split the bundles and produce long-length small-diameter fibers. I have found that if, in the apparatus described, the velocity of the stream at the nozzle (0.43 cm. diameter) is increased to about 40,000 feet per minute, the fibers will no longer circulate in the turbulent zone in the bottom of the chamber but will pass upwardly through the top of the column and be thrown out. This can be obviated by lengthening the column, but there is no purpose in this since a velocity in the range of 40,000 feet per minute will produce fibers of shorter length than velocities in the specified preferred range. I have also noted that, in the apparatus described, as the velocity of the air stream exceeds 20,000 feet per minute, the geometric configuration of the path changes from circular to parabolic. The greater the velocity of the air, the more parabolic the path becomes. The column height must be greater than the tip of the parabola plus the length of the intermediate transition zone and the upper classifying zone where flow through the column is laminar.

Where air is used as the fluid medium for eroding the fiber bundles, the pressure at the source connecting to the tube 14 may range from 10 to 20 pounds p.s.i.g.

The volume of air will depend, of course, upon the diameter of the nozzle but will range anywhere from 2½ to 6½ cubic feet per minute. This will produce a velocity of from 25 to 42 feet per minute in the classifying zone (where the flow is laminar) of a 5 inch diameter column.

When the raw fibers being processed are short, less pressure is required to exfoliate them than when the fibers are long. The optimum working velocities for fibers having a 0.2 inch average length and a .003 inch diameter will range from 24,000 to 30,500 while the range of velocities for fibers having a length of 2½ inches and a diameter of .005 inch will range from 30,500 to 36,500 feet per minute.

Although specific operating instructions have been given for an apparatus having a column 5 inches in diameter and 27 inches high, it will be understood that for efficient operation these conditions will have to be changed as the dimensions of the apparatus are changed.

When the fibers have been introduced into the expansion chamber through the cylinder 20 they are immediately picked up by the current of air following the circuitous path in the turbulent zone of the apparatus. The fibers continue to remain suspended in the path, all the while being subjected to erosion by the high velocity stream of air entering the chamber through the nozzle 16. The high velocity stream exfoliates the fiber bundles and the bulk density of the fibers split off is considerably less than when they are combined in the bundle. Thus, the mass of air rising upwardly through the classifying zone of the column carries the lighter fibers with it, and they are whisked through the conduit 30 into the condenser hood 34 and onto the conveyor beneath (not shown). The heavier fibers fall back into the turbulent zone and further work is done on them. The disposition of the fibers after charging into the chamber is more or less automatic. The point at which they are discharged depends, of course, upon the velocity of the air stream and the length of time required to open them sufficiently to reduce their density to the point where they become entrained in the slower moving current of air in the classifying zone of the column. The apparatus may be operated continuously by charging raw fibers into the apparatus at the same rate they are discharged, or on a batch basis.

In addition to exfoliating fibers, the present apparatus has also been found very useful in blending fibers. Fibers of different kinds may be charged into the apparatus and will be completely and homogeneously intermixed upon discharge from the end of the conduit 30. This blending action is accomplished simultaneously with the opening operation. Various natural and synthetic fibers (cotton, rayon, nylon, acetate), as well as resinous materials, have been completely intermixed with asbestos in accordance with the invention. Many novel products may be fabricated from such mixtures.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An apparatus for exfoliating and blending asbestos fibers which comprises an unobstructed cylindrical column having an open upper end and a conical bottom, a fluid conduit extending through said bottom and terminating in a nozzle directed generally upwardly toward the wall of said cone, means for introducing fibers into said column, and a source of fluid connected with said conduit for providing a circulating fluid stream within said cone and the lower portion of said column.

2. The apparatus of claim 1 wherein said nozzle is so disposed that the stream from said nozzle is deflected successively from the wall of said cone and the wall of said column in initiating its circulating path.

3. The apparatus of claim 1 wherein said column is a cylinder having a length of four to eight times its diameter.

4. The apparatus of claim 1 wherein said fiber introducing means is connected to said column just above said

conical bottom opposite the point at which said nozzle is directed.

5. A process for treating asbestos fiber bundles which comprises providing a vertically disposed vessel having a high velocity circulating fluid stream flowing into the lower end thereof, entraining asbestos fiber bundles in said stream, directing said stream at an acute angle against the wall of said vessel, repeatedly recycling said bundles in said stream to greatly reduce their bulk density, and separating the lightweight fibers by the buoyant effect of the fluid being discharged from said vessel.

6. The process of claim 5 wherein the fluid is air and the velocity of said stream is in excess of 17,500 feet per minute at the nozzle.

7. The process of claim 5 wherein the velocity of said stream ranges between 24,500 and 37,000 feet per minute at the nozzle.

8. A process for treating asbestos fiber bundles which comprises entraining said bundles in a high velocity fluid stream flowing in a generally circular path within a confined space, recycling said fibers in said stream to exfoliate the bundles until the fibers acquire a predetermined low bulk density and causing the low density fibers to rise above said circular fluid stream and the higher

density fibers entrained therein and to be discharged from said enclosed space.

9. The process of claim 8 wherein high density fibers are charged into said fluid stream at a rate sufficient to replace the low density fibers discharged from the enclosed space.

10. A process for simultaneously exfoliating asbestos fibers and intermixing them with other complementary fibers which comprises entraining a mixture of said asbestos and said other fibers in a high velocity fluid stream, circulating within a confined space, recycling said fiber mixture to exfoliate the asbestos and homogeneously mixing them with said other fibers while simultaneously reducing the bulk density of said mixture, causing the mixture to rise above said fluid stream and to be discharged from said enclosed space.

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Notice of Adverse Decision in Interference

In Interference No. 91,776 involving Patent No. 2,915,790, J. M. Rice, Device and method for exfoliating and blending asbestos fiber, final judgment adverse to the patentee was rendered June 29, 1962, as to claims 5, 8, 9, and 10.

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