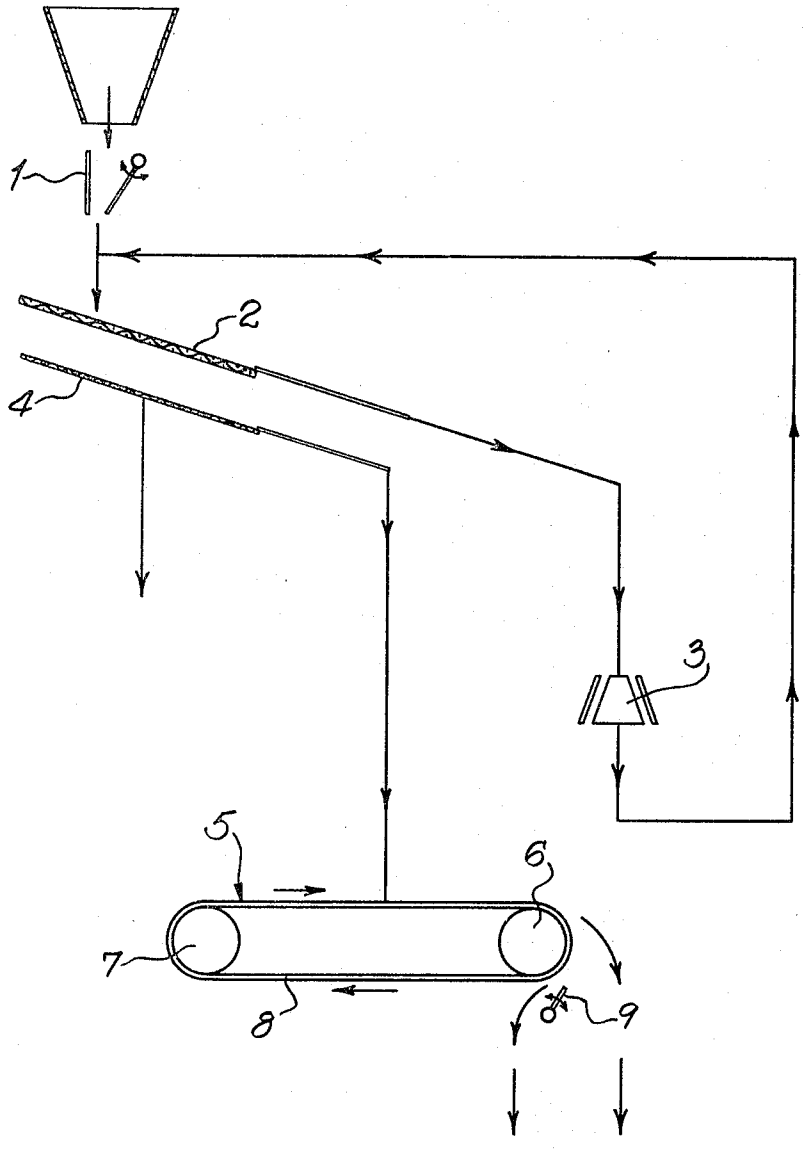
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CONCENTRATION OF ASBESTOS ORE

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CONCENTRATION OF ASBESTOS ORE

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This invention relates to concentration of serpentine type asbestos ore. More particularly it relates to concentrating magnetite-containing serpentine asbestos ore.

Asbestos in the form of fibrous serpentine is known as chrysotile. In serpentine type asbestos ores, the fibrous serpentine or chrysotile is always associated with massive serpentine which is serpentine in a non-fibrous or platy state. Moreover, most serpentine type asbestos ore, if not all of such ore, contains magnetite. I have found that the magnetite contained in such ore is not distributed uniformly through the fibrous and non-fibrous serpentine. Instead such magnetite appears to be associated with the fibrous serpentine (chrysotile) in that it appears to be concentrated at the ends of the fiber. I have also found that, when a particle of such ore contained no fibrous serpentine, there was little, if any, response by the ore particle to a magnetic field. However, where the ore particle contained fibrous serpentine, the particle was found to respond to a magnetic field depending, for any given particle, upon the intensity of the magnetic field in relation to the size of the ore particle.

The invention is based upon the foregoing discoveries. Broadly the invention comprehends introducing into a magnetic field a mixture of asbestos-fiber-bearing and non-fiber-bearing ore particles obtained from a magnetite-containing serpentine type asbestos ore, and separating from the particles in said field a mixture of particles having an asbestos fiber content which is richer than that of the mixture introduced to said magnetic field.

One of the advantages of the invention is that it provides a physical procedure for concentrating asbestos ore. A further advantage is that it provides a procedure for separating fiber-bearing or fiber-rich ore particles from non-fiber bearing or fiber-poor ore particles. Another advantage is that a magnetic procedure is provided for separating fibrous serpentine from non-fibrous serpentine despite the fact that both forms of serpentine are, per se, non-magnetic. A further advantage of the invention is that it provides a procedure for concentrating asbestos ore in which fiber-free or fiber-poor ore particles are separated from the ore at an early stage or stages and before the fiberizing steps in the conventional procedure for recovering asbestos fiber from asbestos ore, thereby reducing the load or permitting an effective increase in capacity of a given plant. Another advantage is that the invention provides a comparatively simple and inexpensive procedure for effecting such separation. Another very important advantage is that the invention permits the exploitation of lower grades of ore than would otherwise be possible in the absence of the invention. A further extremely important advantage of the invention is that it permits the useful life of a mine to be extended. These and other advantages will become apparent from the following more detailed description of the invention.

The invention may be practiced with any serpentine type of asbestos ore containing magnetite and is most useful in connection with the chrysotile asbestos ore of the type found in Quebec, Canada. The mixture of ore particles for feeding to the magnetic field may be prepared in any manner. Thus, for example, the invention may be practiced to concentrate the mixture of ore particles occurring as a result of crusing or milling steps at any one or more of the stages in the procedure employed for recovering asbestos fiber from asbestos ore, including but not limited to, the mixture of ore particles as taken from the mine and the mixture of particles produced in any crushing or milling stage thereafter. Preferably the ore particles treated in accordance with the invention are crushed particles which are not smaller than the oversize particles from a screen having ¼-inch square openings. Most preferably the mixture of ore particles fed into the magnetic field are crushed particles which pass through a screen in which the screen openings are 1½ inch square and which are retained on a screen in which the screen openings are ½-inch square. Most preferably also the invention is practiced at one or more stages in the procedure employed to recover asbestos fiber from the ore, between the primary crushing step after removal of the ore from the mine and the first fiberizing steps.

The magnetic field employed in practicing the invention may be established in any suitable way using any suitable means. Thus a permanent magnet or an electromagnet may be employed to establish the field. At present permanent magnets are preferred because of their relative simplicity, convenience and cost. In general, the magnetic susceptibility of fiber bearing ore particles in a mixture of particles obtained from an asbestos ore of the invention may vary from relatively strong to very weak. For any given mixture of ore particles, the range of magnetic susceptibility displayed by the particles contained in the mixture will depend upon the source of the ore, the particle size and particle size distribution in the mixture, the manner and means used to prepare the mixture, and the magnetite content of the ore as well as the fiber content of the individual ore particle. In general also, with a mixture of ore particles of a given size or within a given size range and which have been obtained from the same ore source, the magnetic susceptibility of the individual ore particles will vary with the fiber content of the particles. I have found that, for any given condition, an increase in the intensity of the magnetic field results in an increase in the weight of the separated fiber rich fraction and a decrease in the fiber value per ton, in that fraction; and that a decrease in the magnetic field intensity reduces the weight of the separated fiber-rich fraction and increases the fiber value, per ton, of such fraction. In accordance with the foregoing, in practicing the invention to effect a desired degree of separation of fiber-containing ore particles from non-fibrous particles in a given mixture of such particles, the mixture is, in accordance with another feature of the invention, subjected to a magnetic field of a predetermined intensity, i.e. an intensity which has previously been determined to effect the desired separation of such particles.

It will be understood that, in the art, the fiber value in dollars per ton of an ore or ore fraction is determined by a determination of the quantity and quality of the fiber contained in the ore in question.

For purposes of this application, the value of the fiber contained in an ore is determined by The Method of Testing Asbestos Fiber, approved by the Quebec Asbestos Mining Association as revised in July 1959, published August 1, 1959.

The invention is further illustrated in the accompanying examples and in the drawing. It should be understood that the examples and the drawing are given for purposes of illustration and that the invention in its broader aspects is not limited thereto.

In the drawing, the single figure, FIG. 1, is a flow sheet, diagrammatic in nature, illustrating the most preferred mode of practicing the invention.

Referring now to the drawing, the numeral **1** represents a conventional crusher, for example a jaw-crusher. Ore to be crushed, which may be ore from the mine or previously crushed ore, is fed into the crusher and the crushed ore is discharged upon the top of a first screen **2**. The oversize ore particles remaining in the top of screen **2** are recrushed in crusher **3** and recycled to screen **2**. The ore particles passing through screen **2** are fed to screen **4** and further screened thereon. The ore particles passing through screen **4** may be further processed in a conventional manner to recover asbestos fiber contained in the particles or they may be discarded depending upon the fiber values contained in them. The ore particles remaining on Screen **4** are fed to magnetic pulley separator **5** of conventional construction and provided, as shown, with magnetic pulley **6**, non-magnetic pulley **7**, non-magnetic endless belt **8** which may be fabricated of rubber or canvas or other suitable material, and adjustable splitter or divider means **9**. The ore particles fed onto belt **8** are passed over magnetic pulley **6**, the non-magnetic or relatively non-magnetic ore particles on the belt being discharged from the pulley to the right of splitter **9** and the magnetic ore particles being discharged to the left of splitter **9**. The non-magnetic ore particles may be discarded from the process or further processed to recover any fiber values that may be contained therein. The fiber rich magnetic ore particles are further processed in a conventional manner to free and recover the asbestos fiber contained therein. Magnetic pulley **6** may be either a conventional electromagnet or a conventional permanent magnet. It will be understood that, in practicing the invention, any free fiber (as opposed to ore particles containing fiber) that is produced as a result of the crushing, screening or handling of the ore may be removed in any conventional manner at any time prior to the magnetic separating step.

Preferably the pulley **6** of magnetic separator **5** is permanently magnetic and means are provided to vary the speed of belt **8**. Preferably also, pulley **6** is selected to provide a magnetic field of the highest practicable intensity. In operation, with this preferred arrangement, the speed of belt **8** and the setting of the adjustable splitter **9** are preferably adjusted to effect the desired separation of the ore particles fed onto the belt. Preferably, also, the ore particles are fed to the belt so as to be disposed thereon as a single layer of ore particles.

It has been found that, under any given conditions, an increase in belt speed is similar in effect to a decrease in the intensity of the magnetic field and a decrease in belt speed is similar in effect to an increase in the magnetic field intensity. Likewise, it has been found that under any given conditions, shifting splitter **9** to the left is similar in effect to a decrease in the intensity of the magnetic field while shifting splitter **9** to the right is similar in effect to increasing the magnetic field. Thus, for example, an increase in belt speed, or shifting the splitter **9** to the left, results in a decrease in the weight of the separated fiber-rich fraction and an increase in the fiber values of that fraction while a decrease in belt speed or shifting splitter **9** to the right results in an increase in the weight of the separated fiber-rich fraction and a decrease in the fiber value of that fraction.

EXAMPLE I

In this example, certain tailings were treated in accordance with the invention. The tailings were those which resulted from the treatment of ore from the Black Lake mine of Lake Asbestos of Quebec Limited, in the latter company's asbestos plant at Black Lake, Province of Quebec, Canada. The ore from the mine is typical of the magnetite containing chrysotile asbestos ore found in the Province of Quebec. The tailings were those obtained, after screening and aspiration of free fiber, from the second fiberization step (i.e. from the Torrey Fiberizer); such tailings normally being discarded and sent to the waste dump. The size of the particles comprising the tailings were such that all of them passed through a screen in which the screen openings were 1 inch squire and were retained in a screen in which the screen openings were ¼-inch square.

The tailings were fed to a magnetic separator of the type illustrated in FIG. 1, provided with an electromagnetic pulley **6** which was 15 inches in diameter. The top of splitter **9** was located 9¼ inches to the right and 11 inches below the center of pulley **6**. The belt **8** was 24 inches wide. The tailings were fed to the belt at the rate 1670 pounds per hour per inch of belt width in a layer which was one particle in thickness. The belt speed employed was 181 feet per minute. The current (in amperes) employed in the electromagnet, the amount (in percent by weight of the total charge) of the magnetic and non-magnetic fraction that was separated by the magnetic separator and the value of the fiber contained in each fraction (in dollars per ton) are given in Table I.

TABLE I

Current to magnet (amperes)	8		6		4	
	Value		Value		Value	
	Percent wt.	Dollars/ton	Percent wt.	Dollars/ton	Percent wt.	Dollars/ton
Magnetic fraction	22.6	0.82	12.9	2.40	3.9	4.50
Non-magnetic fraction	77.4	0.08	87.1	0.10	96.1	0.17

It will be noted that a fiber-rich fraction was obtained by the foregoing procedure of the invention and that an increase in the intensity of the magnetic field resulted in an increase in the weight of the separated fiber rich fraction and a decrease in the fiber value per ton of that fraction.

EXAMPLE II

The procedure of Example I was repeated except that, in this instance, the charge to the belt **8** was ore from the plant, which had been crushed and screened to a size such that all of it passed through a screen in which the screen openings were 1 inch square and was retained in a screen in which the screen openings were ¼-inch square; the belt speed was 137 feet per minute, the ore particles were fed to belt **8** at a rate of 1,000 pounds per hour per inch of belt width and the current fed to the electromagnet was 8 amperes. The magnetic fraction separated from the ore fed to the belt was 32.5% by weight of the charge and the value of the fiber contained in the magnetic fraction was $3.24 per ton. The non-magnetic fraction was 67.5% by weight of the charge and the value of the fiber contained therein was $0.45 per ton.

EXAMPLE III

The procedure of Example I was repeated except that in this instance the charge to belt **8** was crushed and screened ore from the plant, the size of the ore particles in the mixture fed to the belt was such that all passed through a screen in which the screen openings were 1½ inch square and were retained on a screen in which the

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screen openings were ½-inch square, the diameters of pulleys **6** and **7** were 24 inches, pulley **6** was a high intensity permanent magnet, belt **8** was 48 inches wide, the belt speed was 175 feet per minute and the ore was charged to the belt at the rate of 30 tons per hour. The position of splitter **9** was adjusted to provide a non-magnetic fraction in which the value of the contained fiber was as low as possible below one dollar per ton. The non-magnetic fraction was discarded by sending it to the plant tailings pile; this fraction constituting 72% by weight of the ore charged to the belt and corresponded to 24% by weight of the original ore delivered to the plant. The fiber-rich fraction constituted 28% by weight of the ore charged to belt **8** and the value of the fiber contained in this fraction was $4.13 per ton.

In practicing the invention, instead of using a single splitter **9** as illustrated in the drawing, two or more splitters may be employed to separate the particles discharged from belt **8** into three or more fractions. Also, when an electromagnet is employed to establish the magnetic field at the discharge end of magnetic separator **5**, the intensity of the magnetic field may be increased or decreased by increasing or decreasing the electric current fed to the electromagnet. When an electromagnet is employed to separate a desired fiber rich fraction or fractions of ore particles, the current fed to the magnet may be changed with or without changing, either or both, the speed of belt **8** or the position of the splitter or splitters. Alternatively, if desired, a constant current may be supplied to the electromagnet and, either or both, the speed of belt **8** and the position of the splitter or splitters may be adjusted to effect a desired separation of the particles discharging from the discharge end of belt **8**.

What is claimed is:

1. A method of treating a mixture of magnetite containing asbestos fiber bearing serpentine ore particles, said asbestos fiber being embedded therein, and magnetite containing non-fiber bearing serpentine ore particles which comprises introducing said mixture into a magnetic field in a gaseous medium, said magnetic field having an intensity predetermined to be sufficient to provide an effective magnetic response in said fiber bearing ore particles and separating from the particles in said field a mixture of particles having an asbestos fiber content which is richer than that of the mixture introduced into said magnetic field.

2. The method of claim **1** wherein said first mixture is subjected to said magnetic field while on a moving surface above the source of the magnetic field.

3. The method of claim **2** wherein the ore particles introduced into said magnetic field are crushed particles of a size sufficient to be retained on a screen having ¼-inch square openings.

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