

July 31, 1945.

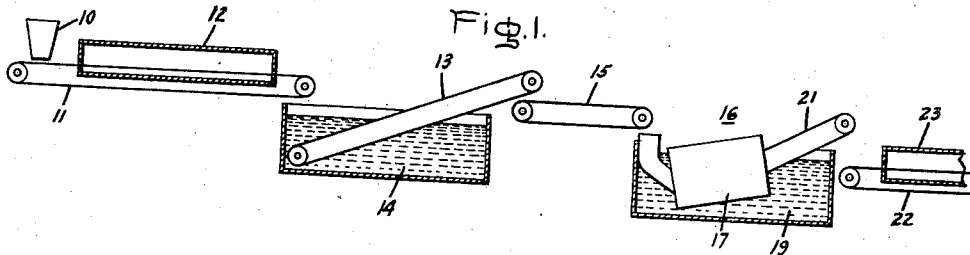
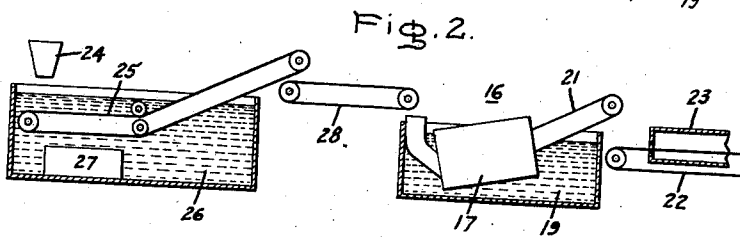
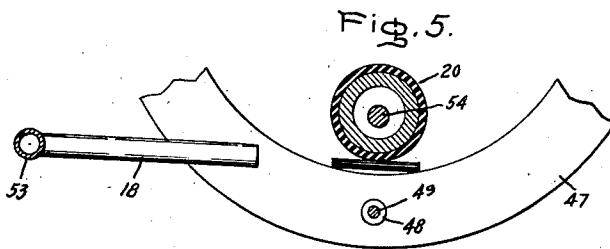
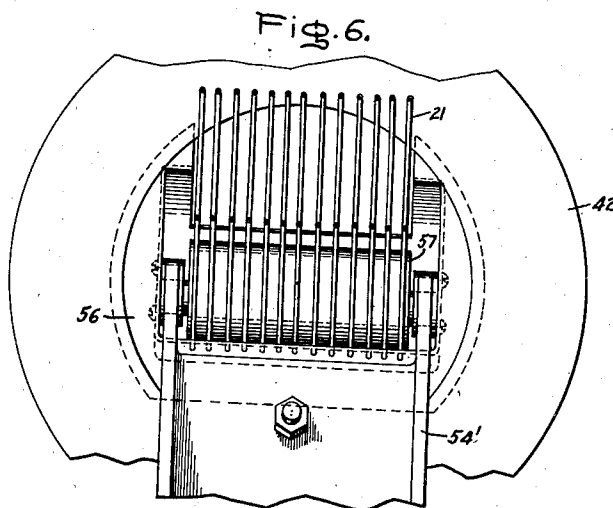
F. E. FISHER

2,380,741

METHOD AND APPARATUS FOR DELAMINATING MICA

Filed Sept. 10, 1943

3 Sheets-Sheet 1



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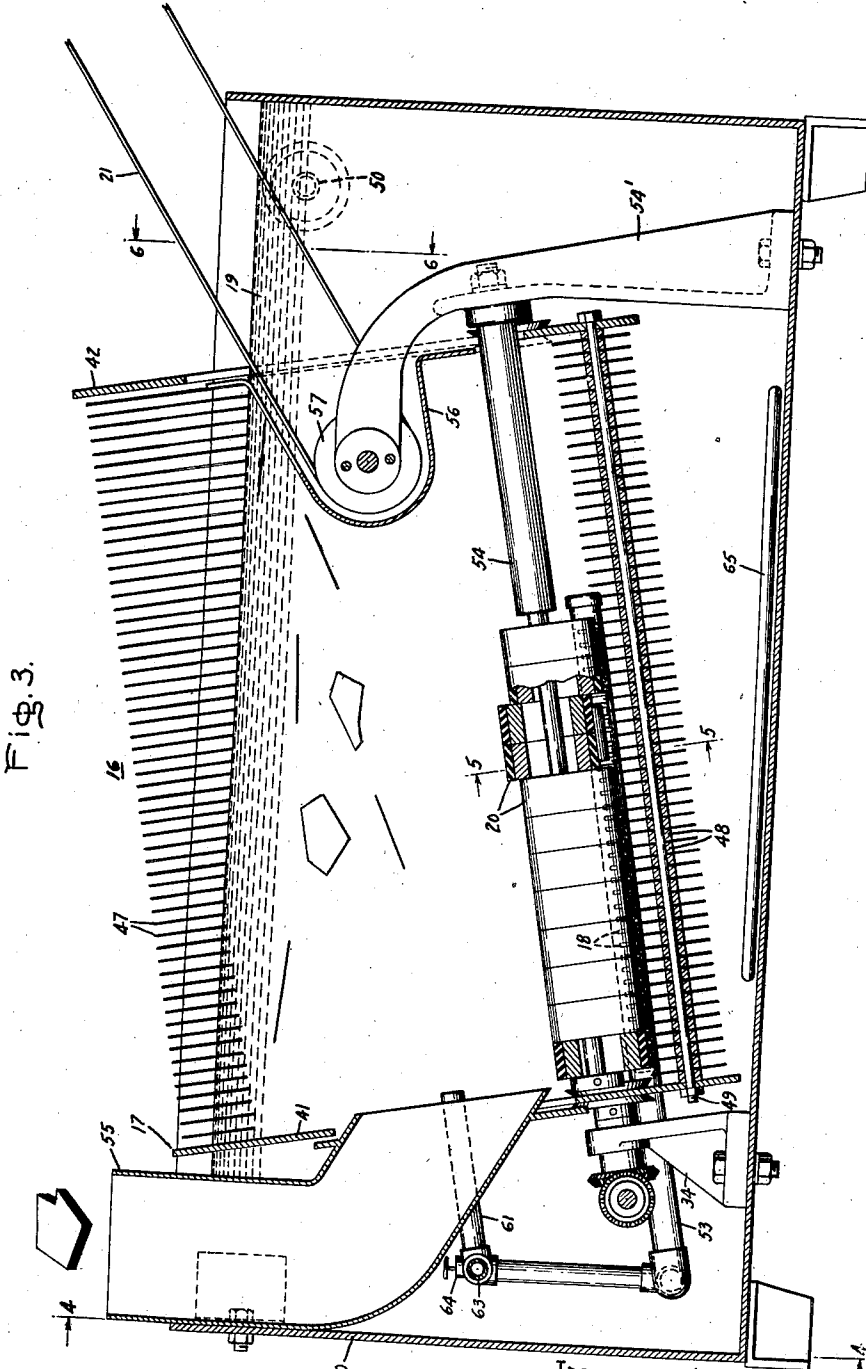
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3 Sheets-Sheet 2



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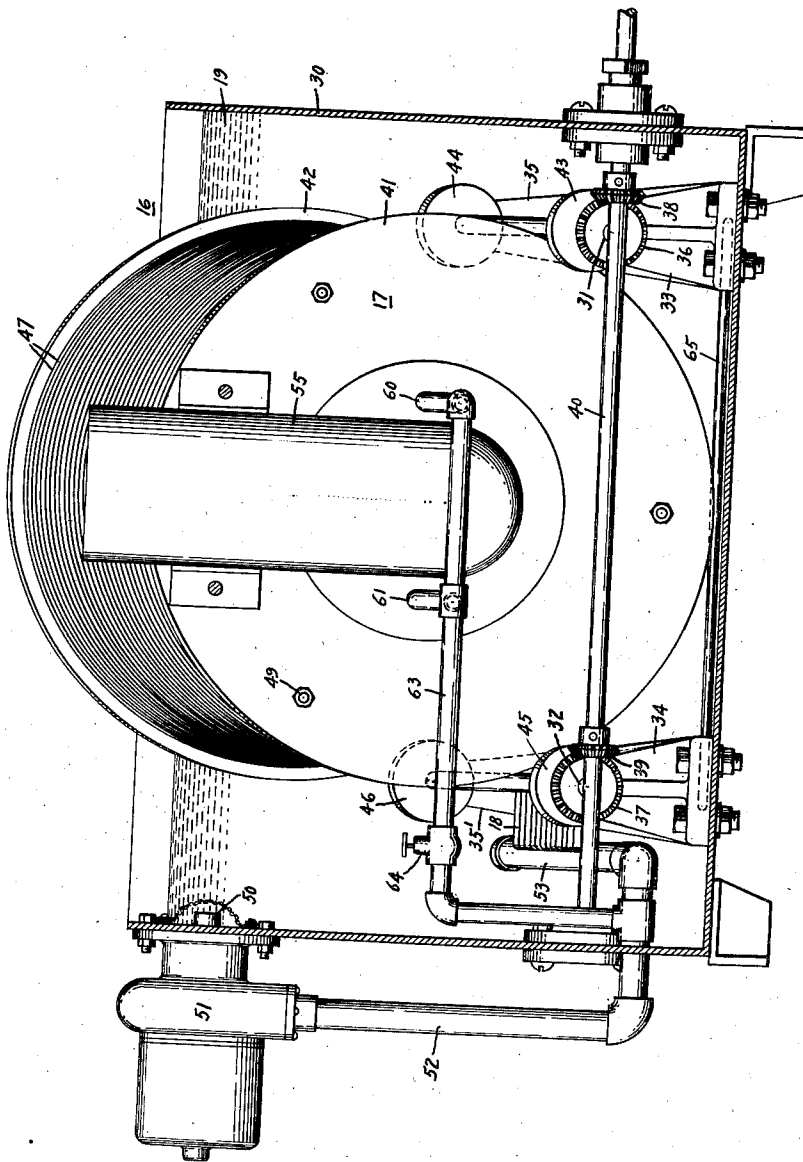
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Fig. 4.



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METHOD AND APPARATUS FOR DELAMINATING MICA

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Application September 10, 1943, Serial No. 501,837

12 Claims. (Cl. 125-24)

The present invention relates to a method and apparatus for delaminating or splitting mica blocks or sheets into mica flakes.

A number of mechanical means have been proposed as substitutes for the time-consuming and laborious manual methods of splitting block mica. Such mechanical devices and methods have included various combinations of means for expanding the mica and for introducing a film of liquid, such as water, between the expanded laminations and means for pulling the mica apart by suction applied to opposite faces of the block mica, means for bending or flexing the block mica in order to separate the individual flakes or laminations, or means for applying unequal or oppositely directed forces parallel to the opposite faces of the mica block to delaminate the block by sliding the individual laminations over one another.

To the best of my knowledge none of these prior devices have been completely satisfactory. Although little trouble has been experienced in introducing a lubricating film of water or the like between the mica laminations, the subsequent mechanical treatments of the water-soaked and expanded blocks to complete the separation of the mica flakes have been too time-consuming for practical purposes or have been so drastic as to render much of the product unfit for commercial use.

In accordance with my invention, block mica, which has been treated to introduce an aqueous film between the individual laminations, is gently delaminated by moving the water-soaked blocks through a bath of hot water.

In accordance with one feature of my invention a jet of hot water is directed against the edges of the block during the time it is immersed in and moving through the hot water bath to aid further in the delamination of the mica.

In accordance with another feature of my invention, a film of water is introduced between the laminations of raw block mica by subjecting the block to sonic vibrations of suitable amplitude while immersed in a water bath.

In accordance with a further feature of my invention, apparatus is provided for moving the water-soaked block mica through a body of water in such a manner that the mica flakes are not damaged during the delamination process.

The above-mentioned and other novel features of my invention will become apparent from the following detailed description of the invention when considered in connection with the accompanying drawings in which:

Figures 1 and 2 illustrate, somewhat diagrammatically, alternative forms of apparatus for carrying out my process;

Fig. 3 is a side view, partly in section, of my machine for separating the water-soaked mica blocks into their constituent laminations;

Fig. 4 is an end view, partially in section, of the machine shown in Fig. 3;

Fig. 5 is a sectional view on lines 5-5 of Figure 3, and

Fig. 6 is a sectional view on lines 6-6 of Figure 3.

To fully illustrate my method of splitting mica there is shown in Figures 1 and 2 apparatus for splitting raw mica up to the point where the splittings are sorted and graded. The sorting and grading of the splittings or flakes may be carried out in any known manner. In the process illustrated in Figure 1, raw mica fed from chute 10 is carried by conveyor 11 through oven 12 wherein the block mica is heated to an elevated temperature, for example to a temperature of 500°-600° C. for a period of about 5 minutes. The heated mica issuing from oven 12 is dropped onto an inclined conveyor 13 the lower, receiving end of which is immersed in a water bath 14. This portion of the process which comprises alternately heating and soaking or quenching the block mica is repeated, preferably from 3 to 7 times, either by providing a series of ovens and quenching baths such as those shown in Figure 1 or by recirculating the mica through the single oven and bath until the mica is sufficiently conditioned, i. e., until most of the mechanical bonds which are existent between the mica laminations are wholly or partially broken and a film of water is introduced between the laminations.

The water-soaked or conditioned mica from the final quenching bath is discharged on to a conveyor 15 and is carried thereby to a splitting machine generally indicated by numeral 16 adapted to delaminate the conditioned mica. In the process carried out in this portion of the apparatus the mica blocks are swept in a substantially edgewise direction through a body of

hot water having a temperature of at least about 165° F. Preferably the forward edges of the moving blocks are periodically subjected to the direct action of a plurality of water jets while immersed in the water. The machine adapted to perform these functions essentially comprises a circumferentially slotted rotatable drum 17 partially immersed in an inclined position in a hot water bath 19 with the inner surface of the lower end of the inclined drum completely submerged in the water. The drum revolves at speed just sufficient to cause the mica blocks or sheets to adhere to the portion of the inner circumferential surface of this member completely submerged in the water bath so that the rotation of the drum continuously moves the mica through the water bath. Rollers 20, loosely and coaxially mounted to roll in contact with the inner surface of the drum may be used to hold the mica against the force of the water jets. I have found that the revolving drum alone delaminates the mica in a matter of minutes. With the water jets and rollers the time is reduced to a matter of seconds.

The thin flakes into which the mica blocks or slabs are separated have considerable buoyancy in the hot water, possibly due to small vapor or air bubbles adhering to the flakes. As a result of their buoyancy, the flakes float to or near the surface of the water near the upper, partially submerged end of the drum where they can be picked up by inclined conveyor 21, the receiving end of which is submerged in the water bath at a point inside the revolving drum. From the conveyor 21 the flakes are discharged to conveyor 22 which carries them through a drying oven 23. After being dried, the flakes are ready to be sorted and graded.

An alternative and, in many respects, preferred method for loosening the mica laminations and introducing water therebetween is illustrated in Figure 2. The raw mica blocks are dropped from a chute 24 onto a conveyor 25 partially submerged in a hot water bath 26 held at a temperature preferably approaching the boiling point of water. While immersed in the bath, the block mica is subjected to sonic vibrations of such magnitude as to cause a partial or complete separation of the laminations followed by an ingress of water between the individual laminations. In Figure 2 numeral 27 indicates a suitable apparatus capable of generating vibrations of the desired magnitude submerged in the water bath beneath the conveyor 25. The sonic means of conditioning block mica has been found particularly useful in processing mica known as low grade Canadian dump mica. When such mica is subjected to sonic vibrations of about 740 cycles for from 5 to 10 minutes in a hot water bath, the mica becomes separated from the stones and other foreign materials and at the same time becomes sufficiently delaminated and water-soaked as to be readily split in the splitting apparatus 16. From conveyor 25 the soaked mica is discharged onto conveyor 28, the stones and other non-micaceous material separated therefrom, and is then introduced into splitting machine 16. It is to be understood of course that the supersonic method, although particularly useful in the treatment of low grade mica, is also applicable to the better grades of mica.

The splitting machine 16, in its preferred form, is shown in greater detail in Figures 3 to 6. The machine comprises a rectangular tank 30 containing water bath 19. The tank is large enough to hold the drum 17 and means mounted on

the floor of the tank for supporting and driving the drum. This latter mechanism comprises two parallel inclined shafts 31 and 32 respectively journaled in supporting members 33 and 34 and 35 and 35' secured to the floor of the tank 30. The shafts are connected through gears 36 and 37 respectively mounted on shafts 31 and 32 and meshing with gears 38 and 39 mounted on a common shaft 40 which in turn is connected to a suitable source of power (not shown). End pieces 41 and 42 of drum 17 rest in the grooves of grooved wheels 43 and 44 mounted on shaft 31 and grooved wheels 45 and 46 mounted on shaft 32 so that the rotation of shafts 31 and 32 results in a rotation of the drum in an inclined position about its longitudinal axis. Generally the drum is inclined at an angle of from 5 to 15 degrees, preferably about 10 degrees, with the horizontal so that the block mica is retained in the submerged receiving end of the drum until fully delaminated. A plurality of elongated circumferential slots or passageways are provided in the sides of the drum through which water may circulate between the interior of the drum and the tank and enter the drum from nozzles 18. The nozzles are so positioned that the water jets issuing therefrom enter the drum in a plane tangent to the inner surface thereof and in a direction opposite to the direction of rotation of the drum so that the jets play on the forward edges of the moving mica blocks. In the form shown in the drawing, the drum is made up of a plurality of thin flat annular disks 47 held in parallel, spaced relationship, preferably at a distance of from $\frac{1}{8}$ to $\frac{1}{4}$ inch, by means of washers 48 interposed between each of the disks, which washers and disks are mounted on and secured together by a plurality of bolts 49 extending through and supported by the annular end pieces 41 and 42. Alternately, the sides of the drum may be constructed of suitable wire mesh desirably having narrow elongated circumferential openings. However, the construction shown in the drawings is preferred since the relatively long openings between the spaced disks offer the minimum resistance to the water jets issuing from nozzles 18.

To provide for a continuous but slow movement of the water towards the outlet end of the drum the water supplied to nozzles 18 is preferably taken from the outlet end of the tank through pipe 50 and is pumped by means of the power driven pump 51 through conduit 52 to header 53 to which nozzles 18 are connected. As is shown in the drawings, a separate nozzle is provided for each of the slots between disks 47 in the lower or receiving end of drum 17 and the tips of each of the nozzles extend a short distance into the slots in a plane substantially tangent to the inner surface of drum 17. The water jets may be introduced into the drum at any point below the surface of the water bath, preferably at any point below the longitudinal axis of the drum.

Rollers 20 which serve to hold the mica against the action of the water jets are loosely journaled on shaft 54 extending longitudinally into the lower part of the drum so that they normally roll on the edges of the annular disks forming the interior surface of drum 17 at the point where the water jets enter the drum. Shaft 54 is fixedly mounted on support 54'. The rollers which are constructed of light weight materials and are preferably surfaced with soft rubber, are free to rise individually to ride over the mica

blocks clinging to the surface of the rotating drum.

In actual operation of the splitting apparatus, the mica blocks introduced through chute 55 into the lower end of the rotating drum are held against the sides of the drum by centrifugal force plus the hydrodynamic force of the water in the rotating drum. Thus, the blocks with their flat surfaces in contact with the surface of the drum are continuously pulled through the water bath in a direction parallel to their laminations. The action of the hot water on the edges of the blocks is sufficient to delaminate the blocks in a matter of minutes. The combined action of the rotating drum, water jets, and rollers reduces this time to a matter of seconds primarily due to the effect of the water jets and to a certain extent due to the slight flexing effect exerted by the rubber surface rollers on the mica sheets.

In connection with the delaminating effect of the water bath, an important feature of my invention resides in maintaining the bath at a temperature of at least about 165° F. I have found that the temperature of the bath has a marked effect on the rate of delamination of the mica blocks. For any given apparatus, temperatures between 165 and 180° F. result in the delamination of the mica at a fair rate of speed. Temperatures in the neighborhood of 195° C. give exceptionally good results, while at temperatures of about 205° F. and approaching the boiling point of water, excellent results are obtained.

The mica laminations or flakes of a thickness of from 1 to 2 mils which are liberated from the mica blocks tend to rise to the surface of the water bath and are picked up by conveyor 21. As water is continuously removed from the bath through pipe 50 located at the outlet end of the tank and reintroduced through jets 18, there is created in the bath a constant flow of water in the direction of the outlet of drum 17 which carries the light mica flakes into a position where they can be readily picked up by conveyor 21. As a means for further controlling the direction of the current, a baffle 56 is provided which substantially closes the lower part of opening in the outlet end of the drum and extends part way around the lower roller 57 on which the conveyor 21 is mounted. The middle part of the upper portion of baffle 56 is cut away in the neighborhood of the conveyor 21 to form an exit for the water and suspended flakes above the conveyor.

Conveyor 21 is shown as being made up of a number of parallel wire loops adapted to travel around roller 57 and a second roller (not shown) in suitable grooves provided in these rollers. By this arrangement, the larger useful mica flakes are retained on the conveyor while the smaller flakes picked up by the conveyor are transferred out of the drum and sifted in the outlet end of the tank from which they may be periodically removed as waste mica.

In the event that the current set up within the water bath by removal of water through pipe 50 and the reintroduction thereof through nozzles 18 is not sufficient to carry the buoyant mica flakes to conveyor 21, it may be found desirable to increase the rate of flow of water in that direction without increasing the force of the water jets issuing from nozzles 18. In that event, an increased rate of circulation can be obtained by providing means for injecting some of the water removed through pipe 50 back into the drum in the neighborhood of chute 55. One such means is shown in Figures 3 and 4 in the form of two inlet pipes

60, 61 connected with conduit 52 by pipe 62. By directing the outlet ends of nozzles 60 and 61 in the general direction of the lower part of conveyor 21 there is obtained a more positive action through the portion of the water bath contained in drum 17. The relative rate of flow of water through nozzles 18 and nozzles 60 and 61 may be controlled by valve 64 inserted in pipe 62 and by varying the speed of circulating pump 51.

Any suitable means may be employed for maintaining the temperature of the water bath. For example, an electric immersion heater such as is indicated by numeral 65 may be placed in the bottom of the tank. With suitable thermostatic controls, such a heating means will keep the water within a few degrees of the desired temperature.

From the above description of my invention it will be seen that I have provided means for gently and quickly delaminating conditioned block mica with minimum damage to the resultant flake mica. By means of apparatus such as that described herein, from 75 to 90 per cent of the raw mica has been converted to usable mica flakes. The apparatus is adapted for either continuous or intermittent operation.

The speed of rotation of the drum will depend on the diameter thereof. The drum should of course rotate fast enough so that the block mica is held against the inner submerged surface thereof but should not rotate at such a speed that the flakes undergoing separation from the block mica are unduly bent or cracked. I have found that a drum having an internal diameter of from 12-13" should be rotated at from 25 to 35 R. P. M. for best results. At such speeds the mica is moved through the water bath at a speed of about 85 to 120 ft. per minute. It is to be understood of course that these particular speeds are not critical and that the linear speed of the mica flakes may be increased or decreased, depending on the type of mica undergoing treatment and the degree of breakage which can be tolerated in the final flakes.

When means are provided for periodically subjecting the moving mica to the effects of a water jet, the jets should no more than double the effective action of the water on the moving mica blocks. In other words, the nozzles should be so regulated that the jets issue therefrom at a speed not substantially exceeding 120 ft. per minute. The resultant momentary increase in the water pressure applied to the edges of the blocks apparently serves to break those mica bonds which can not quickly be broken merely by the rotation of the drum.

Means other than the rubber surfaced rollers may be employed to hold the mica blocks against the increased force of the water jets. For example, the inner edges of the annular disks 47 may be provided with a series of projections which will prevent the mica from slipping along the surface of the drum under the effects of the water jets.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects. I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. The method of splitting mica which comprises treating said mica to introduce an aqueous

film between the mica laminations and thereafter moving the mica in an edgewise direction through a body of water held at a temperature of at least 165° F. at a speed of from 85 to 120 feet per minute.

2. The method of delaminating mica which comprises alternately heating and quenching block mica to introduce a film of water between the mica laminations and moving the water-soaked mica in a substantially edgewise direction through a body of water held at a temperature of at least 165° F. and periodically subjecting the forward edges of the moving block to the effects of a stream of hot water while the block is immersed in said body of water.

3. The method of delaminating block mica which comprises subjecting the block mica to sonic vibrations while immersed in a water bath to introduce a film of water between the mica laminations.

4. The method of splitting mica which comprises moving a water-soaked mica block through a body of hot water in a substantially edgewise direction at a temperature of at least 165° F. and periodically subjecting the moving block to the effects of a stream of hot water directed towards the forward laminated edges of said moving block.

5. The method of laminating mica block which comprises subjecting the block to sonic vibrations while immersed in a water bath to introduce a film of water between the mica laminations, moving the water-soaked mica block in an edgewise direction through a body of water held at a temperature above 165° F. at a linear speed of from 85 to 120 feet per minute and periodically subjecting the forward edges of the moving block to the effects of a stream of water moving at a speed not exceeding about 120 feet per minute.

6. The method of splitting mica which comprises treating block mica to introduce an aqueous film between the mica laminations and thereafter moving the water-soaked mica block in an edgewise direction and at a linear speed of from 85 to 120 ft. per minute through a body of hot water at a temperature of at least 185° F. and, while said block is immersed in said body of hot water, periodically subjecting the moving block to the effects of a stream of hot water directed towards the forward laminated edges of said block, said stream having a velocity not exceeding about 120 feet per minute.

7. A mica splitting machine comprising a rotatable drum-shaped receptacle for mica blocks to be split, the said receptacle comprising a plurality of spaced parallel annular disks forming the side walls of said receptacle, and means for rotating said receptacle in an inclined position about its longitudinal axis with the inner surface of one end of said drum completely immersed in a hot water bath.

8. A mica splitting machine comprising a rotatable drum comprising a plurality of spaced, parallel, annular disks forming the side walls of said drum, means for rotating said receptacle in an inclined position about its longitudinal axis while partially immersed in a hot water bath, and means for introducing a plurality of water jets into said drum in a plane substantially tangent to the inner surface of said drum.

9. A mica splitting machine comprising a ro-

table drum comprising a plurality of spaced parallel annular disks forming the side walls of said drum, means for rotating said receptacle in an inclined position about its longitudinal axis with the inner surface of the lower end thereof immersed in a hot water bath, and means for introducing a plurality of water jets into said drum against the direction of rotation of said drum and in a plane substantially tangent to the inner surface of said drum, said last mentioned means comprising a plurality of nozzles, the outlet ends of which extend into the spaces between said annular disks in a direction opposite to the direction of rotation of said drum.

10. In a mica splitting machine, a rotatable drum having a plurality of narrow circumferentially-extending slots therein, means for rotating said drum in an inclined position about its longitudinal axis while partially immersed in a hot water bath, means for introducing block mica into the lower end of said drum, means for introducing a plurality of water jets into said drum in a plane substantially tangent to the inner surface of said drum and in a direction opposite to the direction of rotation of the drum, means for temporarily holding the mica blocks against the action of said water jets, and means for removing the buoyant mica flakes from the upper end of said drum.

11. In a mica splitting machine a rotatable drum comprising a plurality of flat annular disk-shaped members defining a plurality of slots extending circumferentially about said drum, means for rotating said drum in an inclined position of about 5 to 15 degrees from the horizontal with the inner surface of the lower end thereof completely immersed in a hot water bath held at a temperature of at least 165° F., means for introducing block mica into the lower end of said drum, and means comprising a plurality of nozzles extending into the circumferential slots for introducing a plurality of water jets into said drum in a direction opposite to the direction of rotation of said drum and in a plane substantially tangent to the inner surface of said drum.

12. In a mica splitting machine a rotatable drum having a plurality of narrow circumferentially-extending slots therein, means for supporting and rotating said drum about its longitudinal axis in an inclined position of about 10 degrees from the horizontal with the inner surfaces of the lower end of the drum completely immersed in a hot water bath and the inner surface of the upper end of said drum only partially immersed in said bath, means for introducing block mica into the lower end of said drum, means comprising a plurality of nozzles for introducing a plurality of water jets into said drum near the lower end of said drum in a plane substantially tangent to the inner surface of said drum in a direction opposite to the direction of rotation of said drum, means comprising a plurality of rubber surfaced rollers for temporarily holding the mica blocks against the action of said water jets, and means for removing the buoyant mica flakes from the upper end of said drum comprising a traveling conveyor belt extending part way into the upper end of said drum with the receiving end thereof immersed in the water bath.

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