Nov. 17, 1953

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2,659,412

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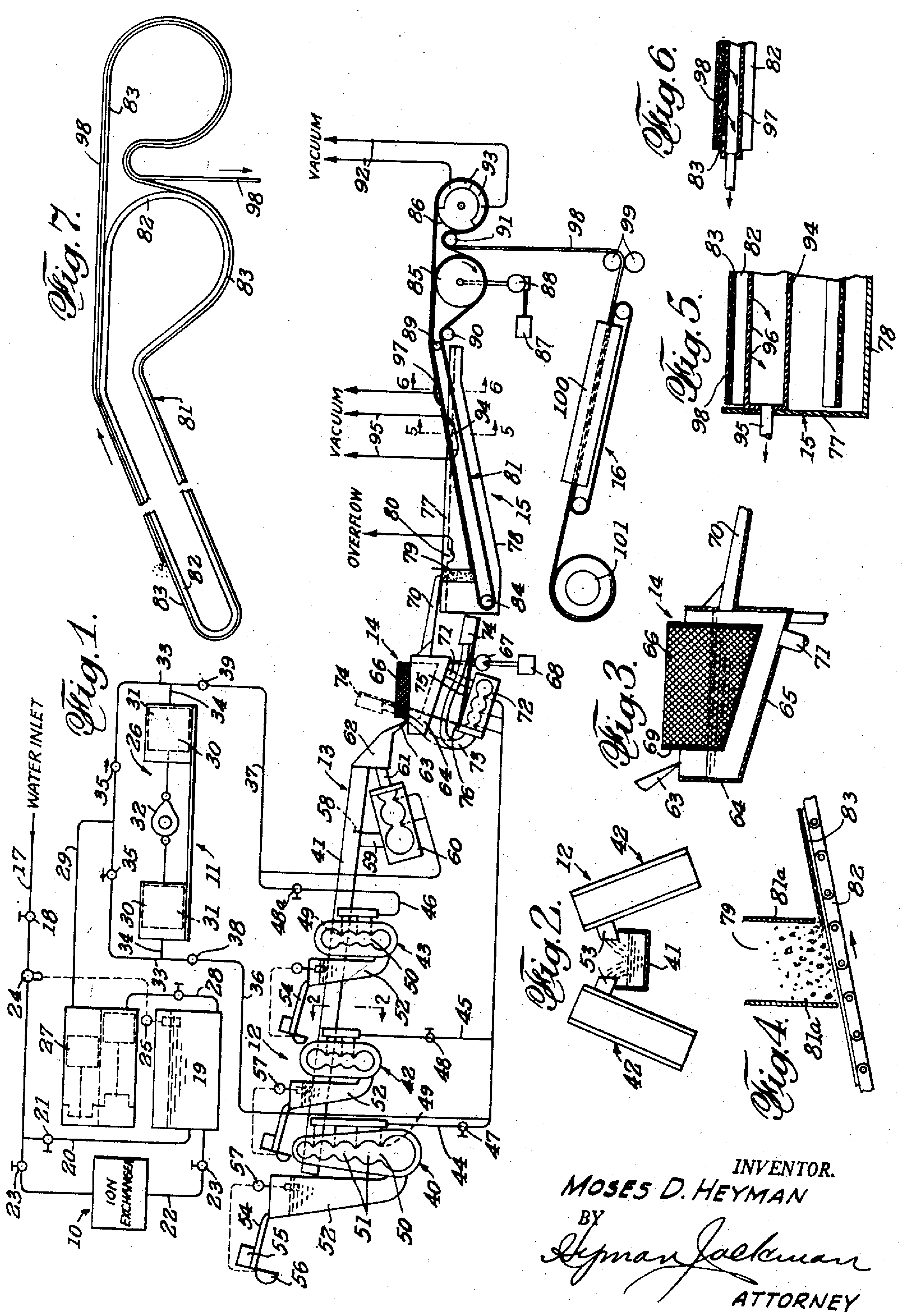
Filed Dec. 15, 1950



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Patented Nov. 17, 1953

2,659,412

UNITED STATES PATENT OFFICE

2,659,412

MEANS AND METHOD FOR PRODUCING A CONTINUOUS SHEET OF INTEGRATED MICA

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Application December 15, 1950, Serial No. 201,020

9 Claims. (Cl. 154—2.5)

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This invention relates to the production of integrated mica sheets formed from layers of thin virgin-faced flakes of mica arranged in random fashion with their surfaces in contiguous relation. The present invention is an improvement of the means and methods disclosed in my Patents Nos. 2,405,576 and 2,490,129 and contemplates the provision of a novel apparatus and method for producing integrated mica sheets of indefinite length.

According to the present invention, it is contemplated and it is an object thereof, to provide improved apparatus for continuously forming sheets of integrated mica of long indefinite and commercial lengths, thereby, materially reducing the cost of production that attended the intermittent operation of my prior apparatus.

It is another object of the invention to provide novel apparatus for producing a continuous sheet of integrated mica that has uniformity of thickness, the apparatus embodying means for varying said thickness as desired.

In the production of integrated mica sheets, I have found that by forming said sheets of flakes having a thickness of less than four microns, I achieve considerable uniformity of product, whereas even a small percentage of thicker flakes among those of desired thickness, results in non-uniformity of the product that, for certain purposes, is not desirable.

It is, therefore, another object of the invention to provide apparatus, of the character indicated, that, after initial disintegration of mica pieces, provides for interception of flakes thicker or heavier than desired and, at least, a second stage of disintegration of said heavier flakes before a sheet is formed therefrom.

In order to more closely control the range of thickness of the flakes, it is an object of the invention to provide interchangeable classifier means in apparatus as above so that, without otherwise changing the apparatus, mica sheets varying in texture, as desired, are formed.

The mica flakes are borne in suspension in a liquid and are split in said liquid in disintegrator means such as disclosed in the mentioned patents. The operation of said means, however, is an intermittent one as disclosed in my pending application, Ser. No. 164,333, filed May 26, 1950, now U. S. Patent No. 2,612,889. It is desired that a specified amount of liquid, for a constant period

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of time, and at a high and constant pressure, be delivered to the disintegrator means. Therefore, a further object of the invention is to provide, in sheet-forming apparatus, means for delivering to disintegrator means, exact amounts of liquid, at required pressure and at uniformly spaced intervals, thereby providing for uniformity of output of the disintegrator means and uniformity of mica-liquid proportion, the same resulting in uniformity of deposit of mica flakes when forming a sheet.

The invention further comprises the novel combination and organization of elements hereinafter more fully described and illustrated in the accompanying drawing.

The foregoing objects of the invention and others that will hereinafter become apparent, are realized in the following description of an at present preferred form of the invention, the same, it being understood, to be considered as by way of example only.

In the drawing:

Fig. 1 is a semi-diagrammatic view of apparatus embodying the present invention.

Fig. 2 is an enlarged cross-sectional view as taken on line 2—2 of Fig. 1.

Fig. 3 is a similarly enlarged vertical sectional view of classifier means employed in the invention.

Fig. 4 is a fragmentary detailed view of mica flake depositing means used in the apparatus.

Figs. 5 and 6 are broken cross-sectional views taken on the respective lines 5—5 and 6—6 of Fig. 1.

Fig. 7 is a semi-diagrammatic view of conveyor means employed to form the mica sheet.

The apparatus illustrated in the drawing comprises, generally, means 10 for providing a source of mineral- and impurity-free water or other suitable liquid; means 11 for pumping said water at uniform intervals of time, in uniform amounts, and at a required unit pressure; disintegrator means 12 receptive of said intermittently supplied water and of mica pieces for splitting up said mica pieces into thin flakes; means 13 in the path of flow of the liquid-borne flakes discharged from the disintegrator means 12 for intercepting flakes that are too thick and/or too heavy, additionally splitting them, and then returning them to the main flow of liquid-borne flakes; classifier means 14 receptive of said flow for effecting final selection of mica flakes of suitable thin size; means 15 receptive of the flakes delivered by the classifier means 14 and for continuously forming a sheet of integrated mica; and means 16 for extracting the liquid resident among the flakes to render the same thoroughly cohesive.

In the present case, water is the liquid medium in which the mica is split and in which the flakes are borne. Other liquids that do not leave a residue upon evaporation may be used. Examples of such alternative media are methyl alcohol, carbon tetrachloride, and aromatic solvents such as toluene, xylene, etc. The term "evaporative liquid medium" is used in the appended claims to define such evaporative liquids.

The means 10 comprises a water inlet pipe 17 that is controlled by a valve 18. A reservoir or tank 19 receives water from pipe 17. When it is not necessary to carefully rid the water of solid matter therein as when the same is already reasonably pure, a pipe 20, with a valve 21 therein open, conducts inlet water directly to tank 19. When water of high purity is desired, any of the conventional ion exchangers may be connected across pipe 20 by a pipe 22 controlled by valves 23, substantially as shown. It is clear that by closing valve 21 and opening valves 23, inlet water is purified by the ion exchanger and directed to tank 19. The level of said tank is maintained by a solenoid valve 24 in pipe 17 and a float-controlled switch 25 in said tank. A predetermined level of water in tank 19 holds valve 24 closed and the same opens to permit inlet flow upon lowering of said level. The simple arrangement shown provides for the optional supply of purified or non-purified water, as the case may be.

The means 11 essentially comprises a proportioning pumping unit 26 and a booster pump 27. The latter pump is generally conventional and, by means of a valved pipe 28, draws water from tank 19 and delivers the same to a pipe 29 under a constant pressure which, in practice, is some one hundred fifty p. s. i. The proportioning pump unit 26 comprises a pair of opposed cylinders 30 in which reciprocate pistons 31 under control of a constant-rise cam 32, said pistons, during their compression strokes, thereby discharging at a constant rate under a uniform pressure. Pipe 29 connects to feed pipes 33 that have branches 34 to the discharge sides of cylinders 30. Check valves 35 in pipe 33 serve to prevent back flow to pipe 29.

It will be seen that pump 27 creates a constant pressure in pipes 29, 33, and 34, and in cylinders 30 so that occluded air in said cylinders is lowered to such minimum amounts that said cylinders, during the suction stroke of pistons 31, will, at all times, fill with substantially the same amount of water. Consequently, assurance is had that said pistons will alternately deliver, for each stroke, the same amount of water under a uniform pressure. Since there is pressure in the cylinders even during the intake or suction strokes, the pressure on cam 32 is minimized and the operation of pumping unit 26 is thereby rendered smooth and efficient.

The water thus alternately discharged by pistons 31 are forced into pipes 36 and 37 past respective flow-control valves 38 and 39. In practice, said valves are set to provide a flow pressure in pipes 36 and 37, as desired, as will later be seen.

The disintegrator means 12, in the present apparatus, comprises a set of six disintegrators, two of which, designated 40, are larger than the other four, said disintegrators, as shown in Fig. 2, being arranged in pairs, on opposite sides of a mica flake flow chute or trough 41. Two sets, 42 and 43, of smaller disintegrators are successively nearer the discharge end of said chute. Pipe 36, by means of a connecting pipe or pipes 44, feeds the larger disintegrators 40; said pipe 36 and connecting pipe or pipes 45, feeds disintegrators 42; and pipe 37, by means of connecting pipes 46, feeds disintegrators 43. A valve 47 controls pipe 44, a valve 48 controls pipe 45, and a valve 48*a* controls pipe 46. Thus, one or two of the three pairs of disintegrators 40, 42, and 43 may be connected to receive flow from pumping unit 26.

When larger pieces are being fed into the apparatus, the larger disintegrators 40 are used. Smaller pieces entail the use of disintegrators 42 and 43. Since the operation of the disintegrators is an intermittent one, as controlled by the pulsations of the proportioning pump unit 26, the jets 49 alternately span across the throats 50 that define the splitting chambers 51 of the disintegrators. When the jets are on, the level of water in funnels 52 rises due to the back pressure created by the barrier effect of the jets. The head of water thus stored in the funnels displaces water in the chambers upwardly to float suspended flakes therein upwardly until said water and suspended flakes are discharged at outlets 53 into chute 41. The mentioned pending application fully describes this action in which the phenomenon, wherein no water is discharged at 53 when the jets are on but wherein water is discharged when the jets are off, occurs.

The mica feed for disintegrators 40, 42 and 43 comprises a chute 54 for each disintegrator, a container 55 to supply each chute and a vibrating device 56. These items are freely suspended and device 56 is electrically controlled by a float switch 57 influenced by the level of water in each funnel 52. When the disintegrators are at rest the level of water in the funnels 52 is the level at the bottom of outlets 53. Each time that the back pressure created by jets 49 raises the level of water in the funnel to cause actuation of float switches 57, vibrators 56 are energized to institute feed of mica pieces from containers 55, through chutes 54 into said funnels. Thus, feed of mica pieces is effected only when the water level in the funnels is high enough to actuate switches 57. By this automatic feed, clogging of the disintegrators by excess feed of mica is obviated and regulation of feed is effected.

The disintegrators are designed to split mica to thicknesses of at least four microns. However, in practice, thicker pieces or flakes will issue from outlets 53 among those that are of suitable thickness. The means 13 is provided to intercept such thicker and heavier flakes that are passing down chute 41 and to subject the same to an additional splitting phase. One-half to one per cent of mica flakes is present in the water flowing along chute 41 and of this mica, a relatively small percentage of unduly heavy flakes will be washed along at the bottom of said chute. These heavier flakes are intercepted by a dam 58 at the bottom of chute 41 while the flakes in flotation pass thereover. A funnel 59 receives and directs such heavier flakes and the water bearing the same into a relatively small disintegrator 60, which functions in the same manner as the earlier-described disintegrators and wherein the flakes are again subjected to splitting forces. The outlet 61 of disintegrator 60 discharges into a collecting chamber 62, the same being at the discharge end of chute 41 and the newly split flakes join the main flow of flakes at this point.

Chamber 62 is relatively wider than chute 41, being formed to have an enlargement laterally offset from the width, at one side, of said chute. The reason for this enlargement will be explained in connection with classifier 14 which receives the flow from the discharge end 63 of chamber 62.

The classifier 14 comprises an outer box-like container 64 that has a sloping bottom 65, and a screen 66 that resides within container 64 with suitable clearance substantially as shown. The frame supporting the classifier is not shown. The screen is affixed thereto and is maintained stationary relative to the container which is vertically reciprocated on suitable guides by one or more eccentrics 67 that are driven by an electric motor 68.

The front wall 69 of screen 66 is impervious to water while the remaining walls are made of a mesh of a desired gauge. Therefore, flakes in the water in container 64 can enter screen 66 only through its mesh bottom and mesh sides. The heavier flakes, of course, will settle onto the sloping bottom 65 of the container.

When the classifier is in operation, the container 64 is reciprocated some two hundred times a minute. Since, the lighter flakes descend or settle quite slowly, they find themselves within screen 66, after being pushed therethrough when the oncoming flow washes them into discharge chute 70. The latter, it will be noted, is located substantially above the bottom of container bottom 65. The heavier flakes within the water in the container cannot find their way through the mesh of screen 66 and are depressed toward the bottom 65 where they flow along the slope thereof to a discharge pipe 71. It will be realized that these relatively heavier flakes are already quite thin, but not thin enough for incorporation in the end product. By providing a small disintegrator 72, that is fed by pipe 71, to further split these heavier flakes, the same can be restored to the main flow.

Disintegrator 72 discharges into a flexible hose 73 at the end of which is provided a flake collector 74 on the end of an arm 75 pivoted at 76. From time to time the accumulation in collector 74 is deposited in the laterally offset portion of chamber 62 to be joined to the main flow. Since disintegrator 72 operates intermittently as do the earlier described disintegrators, a suitable timing device (not shown) may be employed to swing arm 75 to the upward position shown when the jets of this disintegrator are shown. It will be seen that all of the mica introduced in the apparatus is circulated and split and re-circulated and re-split until the same is reduced to the desired flake size for incorporation in an integrated mica sheet.

The sheet-forming means 15 consists of an open-topped and elongated tank 77 that has an upwardly sloping bottom 78 and is deepest at the end receiving the discharge of chute 70. A relatively narrow transverse chamber 79 receives the flow from said chute and the same is located at said deeper end of tank 77. The water level in tank 77 is maintained by an overflow trough 80 substantially as shown. Many experiments have shown that by discharging the flow of water and flakes through a static head of water, the flakes will settle evenly. The chamber 79 defines such a static head since the same is confined by spaced vertical walls 81*a* that separate the same from the remainder of water in tank 77.

A conveyer means 81 is provided to receive the flakes that settle in chamber 79 and the same substantially comprises an inner belt 82 and an outer belt 83. At the deep end of tank 77, both belts are trained over a relatively small pulley 84. The opposite end of belt 82 is trained over a large driven pulley 85, and the same end of belt 83 is extended and trained over a pulley 86 that is driven at the same rate of speed as pulley 85 by a suitable motor 87 through a speed reducer or controller 88. The latter is adjustable to obtain the rate of belt speed desired to, thereby, control the thickness of flakes deposited from chamber 79 on to the upper run of conveyor means 81.

The belt 82 is preferably formed of articulated metal links and is substantially non-stretchable. Belt 83 is formed as a relatively thin woven nylon web that is superposed around belt 82 (at least as far as pulley 85) and is effectively supported thereby. Idler pulleys 89 and 90 are employed to guide conveyor means 81 to separate the upper and return runs thereof as they move along tank 77 and to dispose said runs according to the slope of tank bottom 78. A pulley 91 is provided to train nylon belt or web 83 around the major portion of pulley 86 and, preferably, is heated. The cylindrical face of pulley 86 is perforated and vacuum through lines 92 is created in the inside of said pulley as in non-rotational chests 93. It will be seen that the upper run of the conveyor means 81 is immersed in the water of tank 77 and slopes upward from beneath chamber 79, and leaves the water toward the opposite end of said tank.

As conveyor means travels, at a desired rate in the direction shown, flakes descending in chamber 79 are deposited on nylon web 83 and settle thereon to a thickness according to the speed of travel of said web. The slower the speed the greater the thickness of deposit. The upward slope of the web counteracts displacement of the flakes as they move through the water of the tank since the tendency of said flakes to settle quite slowly keeps them on the web substantially in the manner in which they were deposited. However, these flakes are too light and fine to break through the surface tension of the water in the tank as the web progresses thereabove, with the result that much of the flake deposit would be washed back into the water. To counteract this washback, a vacuum plate or chest 94 is placed beneath the upper run of the conveyor means 81 where the same leaves the water so that vacuum in lines 95 is manifested through perforations 96 in said plate and the interstices in the web upon the flakes to firmly hold the same on the web as the latter breaks through the water film.

While the flakes successfully leave the water in the tank, there is still considerable water among said flakes and they manifest a partial inability to non-displaceably cling to web 83 because of the incline of the water. In order to further dry the flakes to allow their natural cohesive forces to become effective, a second vacuum plate or chest 97 is positioned immediately adjacent plate 94 and between belts 82 and 83. The suction thus applied directly to the under face of belt 83 extracts moisture from among the flakes and more completely integrates the sheet being formed. At this point, web 83 carries thereon a slightly moist integrated mica sheet that is of uniform thickness and in which the thickness is a function of the speed of travel of the web as controlled by controller 88.

When the upper run of the conveyor means 81 reaches pulley 85, belt 82 and web 83 part company, the former being trained around said pulley and the latter continues on to be trained over vacuum pulley 86 and then over heated pulley 91. The mica sheet 98, of course, accompanies the web and is further dried by the vacuum created in chests 93 and by the heat of pulley 91. At this stage, the sheet 98 is sufficiently dry so that it can successfully leave the heated face of pulley 91, the web 83 returning to accompany belt 82.

The means 16, which comprises feed and pressure rolls 99 and an oven 100, receives the mica sheet to completely extract all moisture. If the sheet thus formed is sufficiently thin, say, .003″ or less, the same is wound on a drum as at 101. If said sheet is thicker, it is preferred to cut off lengths thereof as it leaves oven 100.

It is important that the sheet 98 and web 83 not be under strain. Hence, only pulley 85 is tensioned in a direction to tauten the conveyor means. The spacing of the centers of pulleys 85 and 86 are maintained fixed to obviate any strain on web 83 which, therefore, functions only as a carrier for the sheet.

While I have described what I now regard as the preferred form of my invention, the same is, of course, subject to modification, without departing from the spirit and scope thereof. Accordingly, I desire to retain to myself such modifications and variations that may fall under the definitions of the appended claims.

What I claim and desire to secure by Letters Patent, is:

1. In apparatus for producing a continuous sheet of integrated mica, means for splitting mica pieces immersed in an evaporative liquid to disintegrate said pieces into flakes that have naturally cohesive surfaces, an inclined chute receptive above its lowest point of a flow of said flakes and liquid from said splitting means, a continuously moving upwardly sloping endless conveyor including an air-pervious web, a tank in one end of which the lower end of said conveyor is disposed, the upper end of the conveyor extending above and beyond the other end of said tank, a pair of transverse spaced walls in said tank above said lower end of the conveyor and defining a flake-settling chamber, means to conduct the flow from said inclined chute into the top of said settling chamber to effect deposit of flakes onto the upper side of said air-pervious web, the liquid of said flow entering said tank, overflow means to maintain the level of said liquid in said tank, and suction means effective on the under side of the web and upon the flakes located at the point the web leaves the liquid in the tank to bring said flakes out of the liquid in the tank.

2. In apparatus according to claim 1: the upwardly sloping conveyor further including a non-stretchable belt over which the air-pervious web is disposed, the web, beyond said other end of the tank, leaving the belt, separate operatively-connected pulleys over which said belt and web are trained, and variable-speed means to drive said pulleys to vary the speed of travel of the web to, thereby, vary the thickness of deposit of flakes from the settling chamber.

3. In apparatus according to claim 1: the upwardly sloping conveyor further including a non-stretchable belt over which the air-pervious web is disposed, the web, beyond said other end of the tank, leaving the belt, separate operatively-connected pulleys over which said belt and web are trained, and suction means applied to the inner side of the pulley over which the web is trained and effective upon said web and the flakes thereon to extract residual moisture from among the flakes.

4. In apparatus for producing a continuous sheet of integrated mica, a continuously moving upwardly sloping endless conveyor including an air-pervious web, a tank in one end of which the lower end of said conveyor is disposed, the upper end of the conveyor extending above the other end of the tank, a pair of transverse walls in said tank above the lower end of the conveyor and defining a settling chamber receptive of a flow of liquid-borne finely split mica flakes and through which the flakes settle and deposit on the upper side of said air-pervious web while the liquid of said flow enters said tank, overflow means to maintain the level of liquid in said tank, and suction means applied to and effective on the under side of the web and, through the web, on the flakes thereon, said suction means being located at the point where the web leaves the liquid in the tank and partially submerged in the liquid in the tank so as to hold the flakes on the web while passing out of said liquid.

5. Apparatus for producing a continuous sheet of integrated mica comprising, in combination, a sheet-forming unit comprising a liquid-containing tank and a continuously moving liquid-pervious conveyor web moving in the tank upwardly and outwardly therefrom, means to conduct a continuous flow of evaporating liquid, containing a suspension of thin mica flakes, to said tank, a settling chamber in the tank receptive of said flow and through which the flakes in the liquid settle downwardly onto the web in overlapping sheet-forming relation, means in the flow-conducting means to pass to said chamber only relatively thin mica flakes to impart to the sheet substantially uniform texture, a suction device partly submerged in the liquid in said tank, applied to and effective on the web and, through the web, on the sheet of flakes thereon to hold said flakes on the web as the same moves out of the liquid in the tank, and suction and heat means applied to the web after the latter emerges from the tank and effective on the sheet thereon to extract moisture from the sheet to integrate the same.

6. Apparatus according to claim 5: overflow means to maintain the level of liquid in said tank constant to retain partial submersion of the suction device.

7. Apparatus according to claim 5: a variable speed drive for the web to control the thickness of the layer of flakes deposited thereon.

8. The method of producing a continuous sheet of integrated mica that consists in reducing pieces of mica to thin flakes less than four microns thick and continuously flowing of said flakes in an evaporative liquid medium, directing said flow into a statically confined portion of a liquid bath wherein the suspension of flakes in the flow settle downwardly through the liquid, the speed of movement being so controlled as to deposit a sheet comprising overlapped flakes on

an upwardly sloping and upwardly moving transporting web that moves said sheet out of the bath, thereafter, by application of suction and heat to the sheet through the web, the suction being applied at the point where said web and sheet emerge from the bath to obviate washback of the flakes during movement of the web, extracting moisture from said sheet so that the natural cohesive forces of the flakes integrate the sheet and, finally, removing said integrated mica sheet from said web.

9. The method according to claim 8 which includes additionally controlling the continuous flow to provide a substantially uniform settling of the flakes, and varying the rate of movement of the web to vary the thickness of the sheet formed thereon, as desired.

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