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Towne et al.

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[54] **PROCESS FOR MANUFACTURING MICA SHEET COMPOSITES**

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[52] **U.S. Cl.** **264/87**; 264/86; 264/110; 264/128
[51] **Int. Cl.** **B28b 1/26**
[58] **Field of Search** 264/110, 128, 87, 86

[56] **References Cited**

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[57] **ABSTRACT**

Mica is ground dry to yield finely divided mica particles prior to forming a sheet. A single sheet of uniform thickness is formed at one time by pouring a colloid mixture of the ground mica, water and a colloid agent onto a mesh screen. Vacuum means and a hydraulic press are used to complete the formation of a sheet. The sheet also includes a resin binder. The resin may be coated on the ground mica prior to the formation of the collodial mixture, or the resin may be applied to the sheet after the sheet has been subjected to vacuum treatment and prior to being pressed.

14 Claims, 4 Drawing Figures

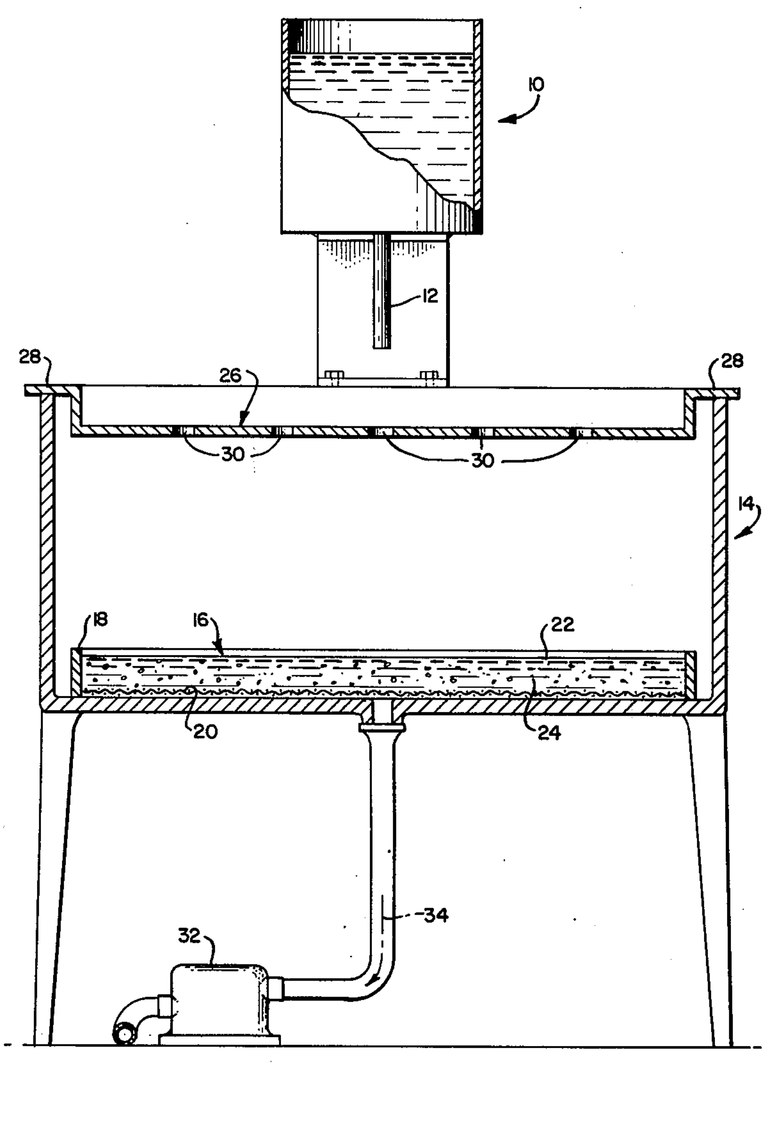


FIG. 1.

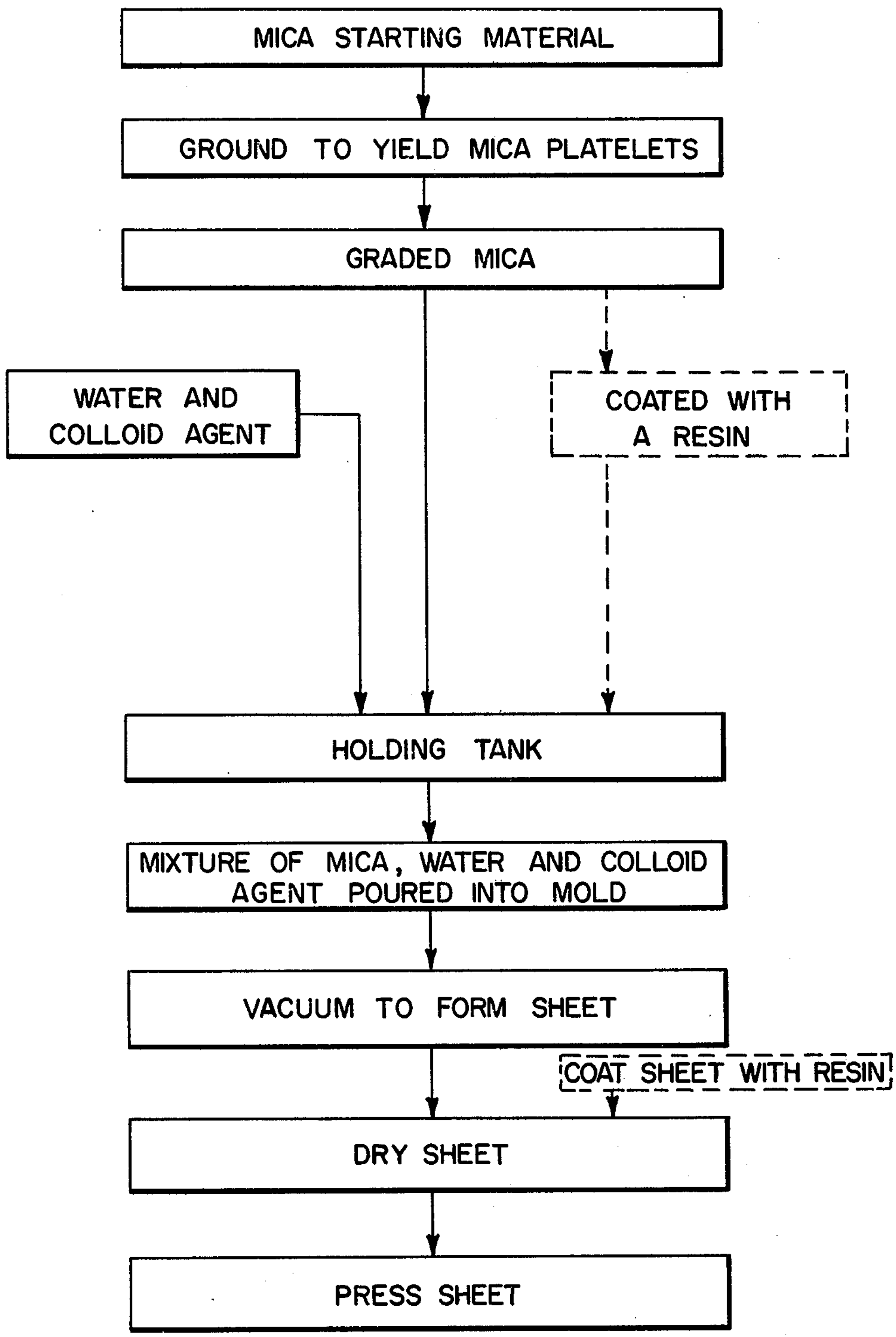

MICA STARTING MATERIAL
GROUND TO YIELD MICA PLATELETS
GRADED MICA
WATER AND COLLOID AGENT
COATED WITH A RESIN
HOLDING TANK
MIXTURE OF MICA, WATER AND COLLOID AGENT POURED INTO MOLD
VACUUM TO FORM SHEET
COAT SHEET WITH RESIN
DRY SHEET
PRESS SHEET

FIG. 2.

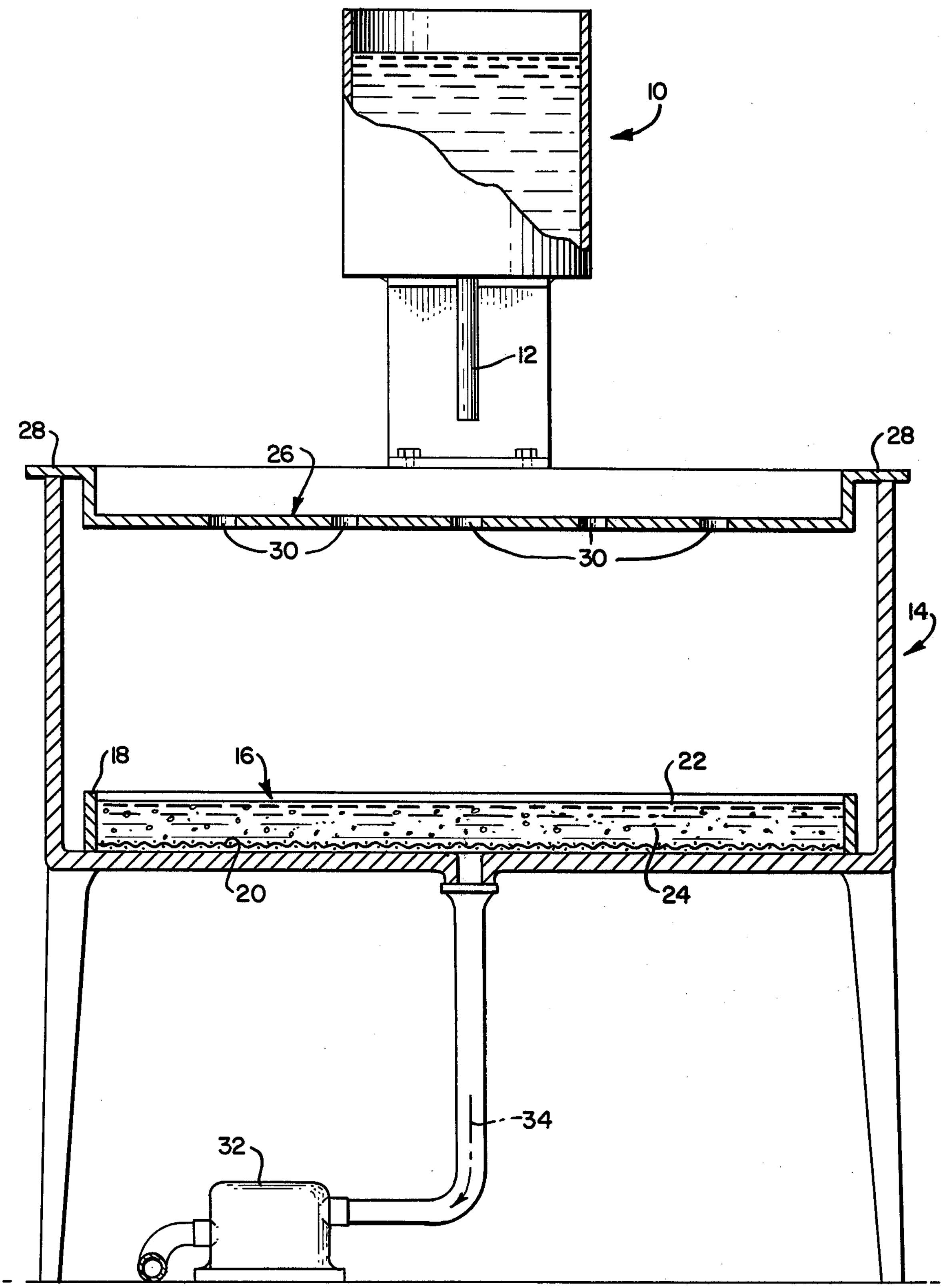


FIG. 3.

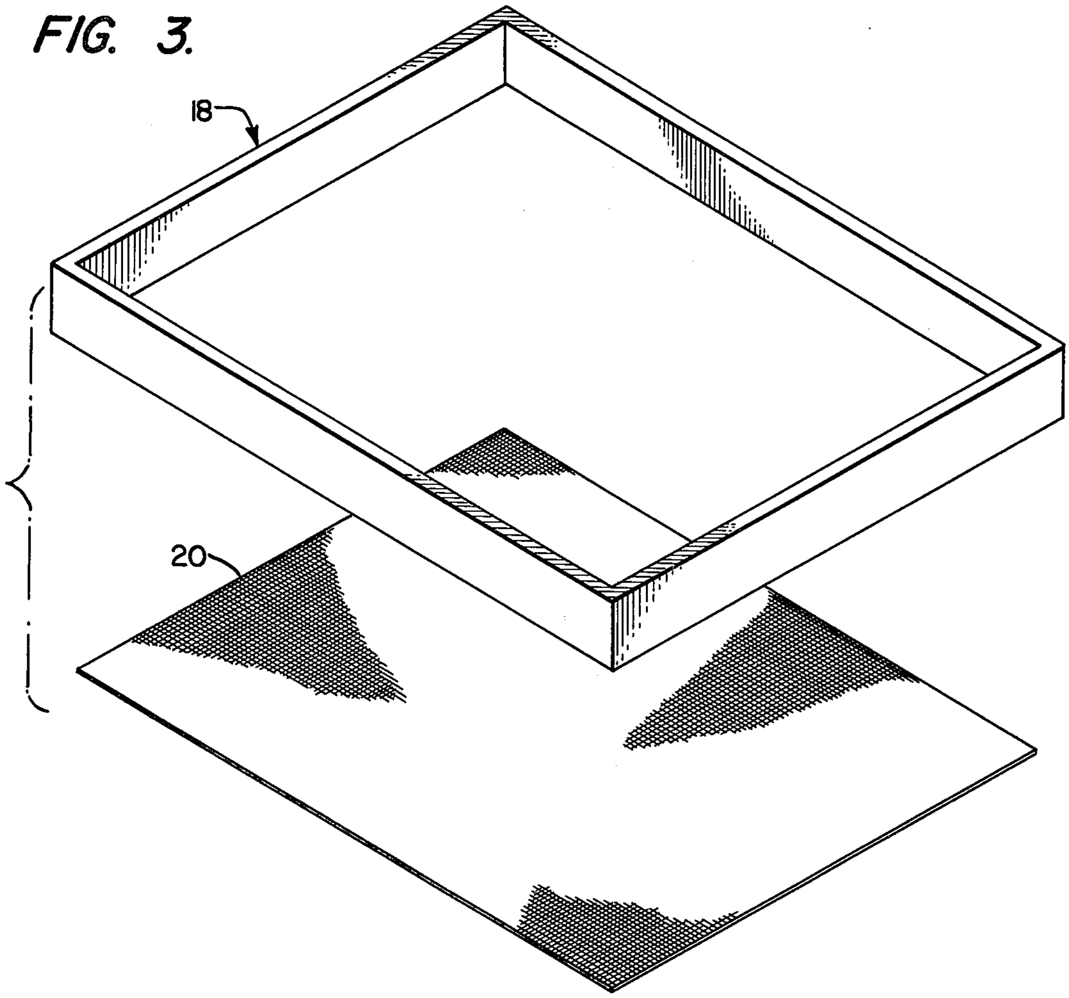
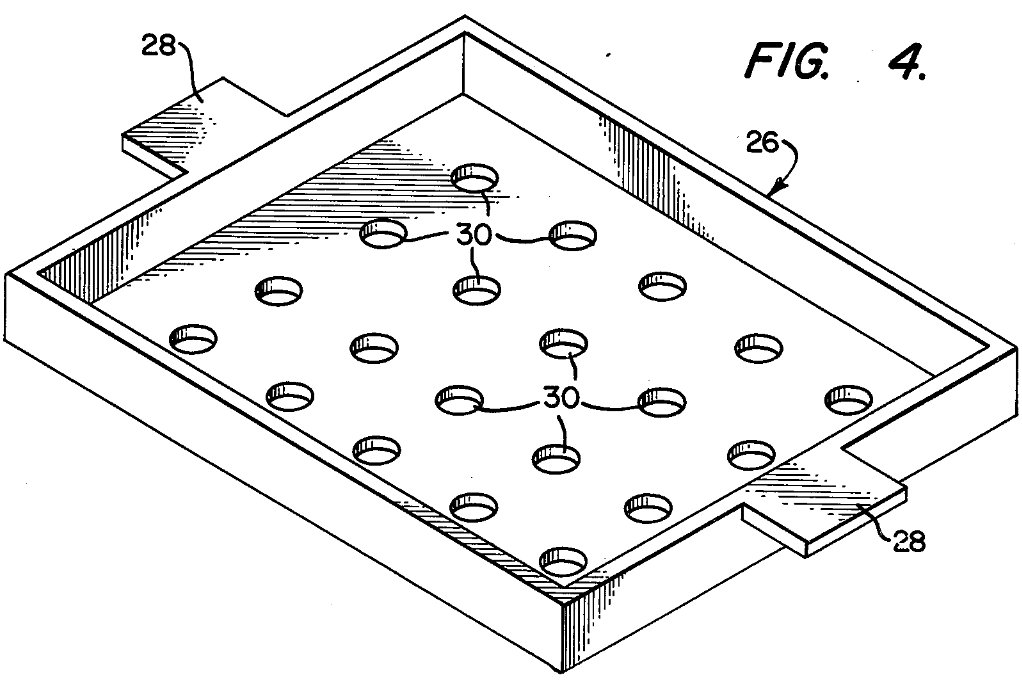


FIG. 4.



PROCESS FOR MANUFACTURING MICA SHEET COMPOSITES

BACKGROUND OF THE INVENTION

The field of the present invention is micaceous insulating structures. More particularly, the present invention relates to a novel method for making finely divided, highly-flaked mica sheet composites having a resinous binder constituent uniformly incorporated therein to give the mica sheet added strength. The fact that finely divided exfoliated and/or delaminated flaked mica is capable of being formed into paper-like sheets on conventional paper-forming equipment has been known commercially for many years, and many procedures have been suggested for reconstituting natural mica into such form. For example, the following patents are representative of the state of the art:

Canadian Pat. No. 887,003 - D. J. Chen, "Reconstituted Mica,"

U.S. Pat. No. 2,405,576 - M. D. Heymen, "Integrated Mica and Method of Making Same,"

U.S. Pat. No. 3,215,590 - R. J. Purvis, "Mica Sheet Composite and Method of Making Same," and

U.S. Pat. No. **3,618,753** - D. W. Glasspoole, "Large Flake Reconstituted Mica Insulation."

Since mica has excellent electrical, mechanical, and thermal properties, paper-like sheets of mica have wide applications. For example, such paper-like mica sheets, after impregnation with a resinous binder material, and after being heatpressed to cure the impregnated composite, have excellent dielectric properties and have found substantial use as insulation materials. Thus, they are widely employed as insulating commutator segments for electric motors, commutator V-rings and insulating spacers and washers. Such insulating materials usually have thicknesses ranging from 10 to 60 mils (0.25 to 1.5 mm.) after they have been finally molded and pressed.

One of the most significant deficiencies of the known procedures for forming mica sheet composites is the high capital investment required to provide machinery to produce such mica sheet composites. A significant factor adding to such cost is that in many of the prior art processes, mica particles which are formed from larger pieces of mica, are split and quickly pressed together immediately after being split. In this type of procedure, storing dry mica particles between the splitting step and the sheet formation step, is thought to be undesirable. Indeed, it is the consensus of those skilled in this art that mica splittings should be made with water jets which not only split the mica, but protect the splittings from contamination prior to being rejoined to form a sheet.

When a piece of mica is split, two virgin surfaces are formed. It is the consensus of those skilled in this art that immediate rejoining of splittings enables the virgin surfaces to recohere with substantially the same force that held the mica together before being split apart.

One theory widely accepted in this art is that blocks of mica contain layers that are held together by van der Waals forces. When layers are split, the van der Waals forces must be overcome. With a new surface exposed, the molecules on the surface shift so that the van der Waals forces redistribute through the splitting. Immediate joining of splittings, however, will prevent the van der Waals forces from redistributing and result in surfaces with a force of attraction for each other.

It is also widely accepted that virgin surfaces of mica when touched by a finger, knife or any other substance will no longer recohere and that virgin surfaces which are exposed to ambient air for any length of time will no longer recohere.

Since it is believed that no amount of cleansing will reestablish the cohering forces that originally held the mica particles together, great effort is taken in prior art processes to split mica without marring or contaminating the surfaces. As is set forth above, an accepted and widely used procedure for splitting mica is to utilize water jets because the water jets not only split the mica, but result in a mica water slurry which protects the surfaces from contamination. With this type of procedure, after a preliminary water washing to remove dirt and debris, the mica blocks are split by means of water jets striking the mica blocks at an angle substantially parallel to the point of cleavage. This method is disclosed in U.S. Pat. No. 2,405,576. The mica flakes are then reconstituted with standard paper-making equipment to form a mica sheet composite.

As is immediately apparent, a great deal of expensive equipment is required for a process in which mica is split with water jets and is immediately rejoined to form a sheet.

Another major disadvantage in the known processes for making paper-like mica sheets is the difficulty of forming thick sheets of uniform thickness in excess of 5 mils.

SUMMARY OF THE INVENTION

These and other disadvantages of the prior art process are significantly reduced in the process of the present invention which includes grinding mica in a dry condition to produce finely divided mica platelets. The finely divided mica platelets are added to a mixture of water and a colloid agent to yield a colloid mixture. The colloid mixture is sufficiently viscous to yield a homogeneous mica sheet of uniform thickness when the mixture is

Accordingly, it is an object of the invention to provide an improved process for making mica sheet composites of uniform thickness.

A further object of the invention is to provide a process for manufacturing mica sheet composites which utilizes equipment that is less expensive than the equipment utilized in various prior art processes for forming mica sheet composites.

It is another object of the invention to provide a process for making mica sheet composites wherein it is possible to store mica platelets in a dry condition prior to the formation of a mica sheet.

A further object of the invention is to provide a process for manufacturing mica sheet composites wherein a mica starting material is ground while dry to produce the mica platelets from which the mica sheet composite is fabricated.

A further object of the invention is to provide a process for forming mica sheet composites wherein the mica platelets in the mica sheet composites are produced by pulverizing mica in a hammer mill.

A further object of the invention is to provide a process for forming mica sheet composites in a mold wherein a colloid agent is utilized to insure uniform thickness of a sheet formed in a mold.

Another object of the invention is to provide a process for manufacturing mica sheet composites wherein the resin and mica platelets are combined prior to forming a sheet in a mold.

Still another object of the invention is to provide a process for manufacturing mica sheet composites wherein the resin is added to the sheet in a solventless powder form prior to forming a sheet.

A further object of the invention is to provide a process for manufacturing mica sheet composites wherein the resin is applied in a solution.

A further object of the present invention is to provide a process for forming mica sheet composites wherein the resin is added to the sheet in latex form or in suspension.

DESCRIPTION OF THE DRAWING

FIG. 1 is a flow sheet illustrating the process of the present invention;

FIG. 2 is a diagrammatic view partially in cross-section of an apparatus suitable for forming mica sheet composites in accordance with the present invention;

FIG. 3 is a perspective view of the mold assembly of FIG. 2; and

FIG. 4 is a perspective view of the baffle of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

At the outset, the process of the present invention is described in its broadest overall aspects with a more detailed description following.

The process of the present invention is in many respects similar to prior art processes for forming mica sheet composites. The present process, however, differs from the prior art in several ways. Perhaps the most significant difference is that by following the teachings of the present invention, it is possible to grind the mica while dry without any deleterious effects on the resulting mica sheet.

Similar to some prior art processes for forming mica sheet composites, such as the one disclosed in U.S. Pat. No. 3,215,590 to R. J. Purvis entitled "Mica Sheet Composite and Method of Making Same," mica sheets are formed in a mold one at a time. However, with the present process, a uniform mica sheet thickness is obtained by the use of a thixotropic colloid agent or a suspending agent or a stabilizing agent which is dissolved in the water in which the mica is carried. The purpose of the agent is to thicken the resulting mixture and uniformly suspend the mica platelets. The thixotropic agent functions to form a colloidial gel and insures the formation of a sheet having a desired uniform thickness by preventing "channeling" and by preventing the lateral movement of mica platelets in the mold as the sheet is being formed. Thus, with such an agent present in the mixture which is suspended in a mold, the liquid which is extracted from the bottom of the mold by the application of a vacuum is extracted evenly with the platelets being deposited evenly to result in the formation of a mica sheet having a substantially uniform thickness. Thus, with the present process, the thickness of the sheet can be held to close tolerances i.e., plus or minus 10 percent in thicknesses from 0.005 inches to 0.100 inches.

As with most processes for forming mica sheet composites, a resin is included in the sheet to give the sheet strength. Merely by way of example, resins usable with the process of the present invention include inorganic resins such as boron phosphates, potassium borates, silicones, and organic resins such as shellac, copal, epoxys, alkyds, polyesters, and varnish. The actual choice of a resin depends on balancing the cost, temperature resistance, flexibility, and electrical resistance that may be required. It should be noted, however, that those resins which have been previously used in prior art processes for forming mica sheet composites may be advantageously used in the process of the present invention. In the present process, however, there are two alternate procedures for including resin in the finished mica sheet composite. In one alternate embodiment of the invention finely divided mica is coated with resin prior to the formation of a mica sheet. In this embodiment, the resin is coated on the mica either in dry form, in solution or in suspension. In another embodiment of the invention, a mica sheet is formed, and the sheet is coated with a resin solution or suspension and thereafter pressed in a heated hydraulic press to yield the mica sheet composite.

The embodiment of the invention wherein finely divided mica is coated first with a resin includes the following steps:

1. The mica starting material is ground in a hammer mill,
2. the ground mica is graded,
3. the ground and graded mica is coated with a suitable resin,
4. the coated mica is introduced into a tank containing water and a thixotropic colloid agent,
5. the resulting mixture of water, coated mica and thixotropic colloid agent is poured into a mold having a mesh screen bottom,
6. a vacuum is applied to the surface of the mesh screen under the mixture to extract the liquid therefrom and form a sheet,
7. the sheet is then dried, and
8. the dried sheet is pressed with a heated platen hydraulic press.

The embodiment of the invention in which a mica sheet is formed first and coated with a resin later includes the following steps:

1. The mica starting material is ground in a hammer mill,
2. the ground mica is graded,
3. the uncoated mica is introduced into a tank containing water and a thixotropic colloid agent,
4. the resulting mixture of water, uncoated mica and thixotropic colloid agent is poured into a mold having a mesh screen bottom,
5. a vacuum is applied to the surface of the mesh screen under the mixture to extract the liquid therefrom and form a sheet,
6. while the mica sheet is slightly damp or dry it is coated with a solution containing a suitable resin,
7. the coated sheet is then dried, and
8. the dried sheet is pressed with a heated platen hydraulic press.

As is set forth above, a significant difference between the process of the present invention and other methods for making mica paper slurry is that with the present process, the mica may be ground dry, if desired. It should be noted that the ability of the present process to provide acceptable results when mica is ground dry and then graded is advantageous in that the equipment which would be otherwise necessary to split mica in a water environment is not required. However, it should be emphasized at the outset that the steps other than grinding and grading which are described below can be advantageously utilized with mica paper slurry that has been formed in a conventional water jet system.

Preferably, the mica starting material is ground dry in a micropulverizer, such as a hammer mill, that has small perforations. A hammer mill having one-fourth of an inch perforations has been advantageously employed in the presence process.

The mica starting material may be scrap mica or blocks of the laminated mineral such as biotite, muscovite, phlogopite, or zinnwaldite. It is preferable to grind or pulverize the mica starting material to yield mica platelets with a maximum diameter of one-fourth of an inch.

Once the mica is ground, it is graded through screens. A range of screen sizes is employed so that the ground mica will pass through a six mesh screen and be retained on a thirty mesh screen. It should be noted, however, that the grading is controlled by the mesh size of the screen utilized on the mold bottom which is described below. As is apparent, the mica particles are graded so that the graded particles will be retained on the mesh screen which forms the bottom of the mold. In the preferred embodiment of the invention, the size of the mesh in the mold screen is 60 mesh. Thus, with a 60 mesh screen bottom on the mold, the ground mica is graded or classified to yield platelets which range in size from ⅛ inches to 250 microns in diameter. Since conventional equipment is employed in the grinding and grading steps, such equipment is not shown in the drawing.

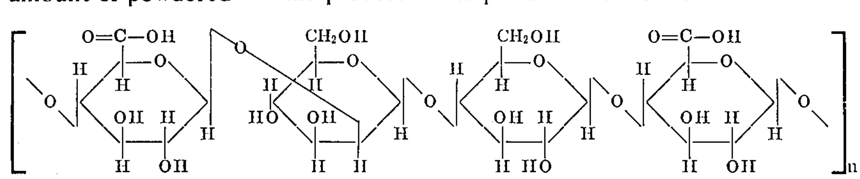
As is set forth above, a resin may be coated on the mica prior to the formation of the mica sheet in the mold. Thus, the present process differs from other known processes in that dried mica flakes are coated with a resin prior to making up a water slurry. Coating the dry mica flakes with the resin permits the resin and mica to be deposited at the same time. The dry mica platelets can be coated with either a dry powdered resin or a solvent solution of the resin When the embodiments of the invention in which a resin is coated on the mica prior to the formation of a mica sheet is practiced, it is advantageous to employ a finely divided powdered resin having particle sizes in the order of 100 mesh. The powdered resin is coated on the mica by placing a charge of mica in a mixer and making it damp with a small amount of water. A weight of water is used that is 18–22 percent of the weight of the mica. Thereafter, an amount of powdered resin is added to the mixture and mixed for between two to five minutes at a speed of 60 rpm. Preferably, the amount of powdered resin added to the mixer is ten to fifteen percent of the weight of the mica in the mixer. The foregoing procedure has been found to be very effective in attaching resin to the mica flakes. As set forth above, however, the mica does not have to be coated with resin to make an adhesive sheet of mica. Thus, in the next step in the process, either coated or uncoated mica may be mixed with water and the colloid agent.

As is shown in the flow sheet of FIG. **1,** mica platelets are introduced into a holding tank into which a mixture of water and a colloid agent has been added.

The amount of ground mica that is added to holding tank **10** is preferably between 0.5 – 2.0 percent of the total weight of the mixture of water and colloid agent in tank **10.** The solution of water and colloid agent preferably contains about ⅛ of one percent to ½ of one percent by weight of a colloid agent with the remainder of the solution being water. It should be noted that the weight percentages given above indicate ranges which have been effectively employed in the process for manufacturing mica sheet composites in accordance with the present invention. As is apparent to those skilled in this art, the ranges indicated above are merely given to illustrate the process of the present invention and are not intended to be restrictive in any way.

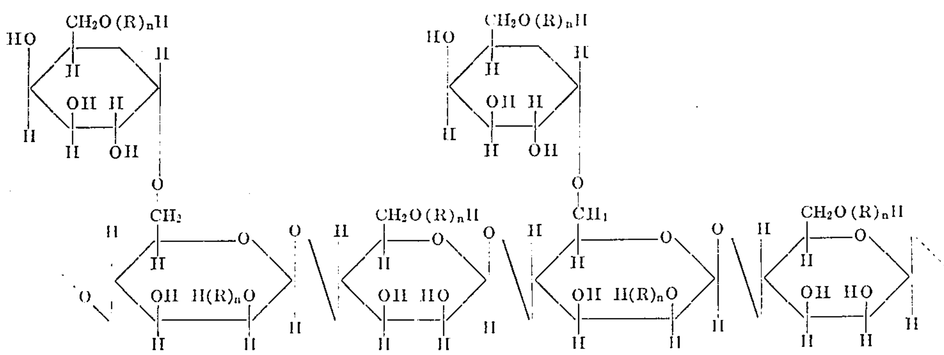
The function of the thixotropic colloid agent is to insure that a sheet of uniform thickness will be produced. In this regard, a large number of thixotropic colloid agents are usable in accordance with the present invention. One type of thixotropic colloid agent which has been found to be satisfactory is a high molecular weight linear polysaccharide which gives the mixture, in holding tank **10,** pseudoplastic properties and holds the mica platelets in stable suspension. It should be noted, however, that the important characteristic in the selection of a thixotropic colloid agent is that the agent be capable of maintaining the mica platelets in suspension while being poured into the sheet mold. Thus, any agent which functions to suspend the mica platelets in a water carrier so that there is little lateral movement of the mica platelets in a mold when water is being extracted from the mold, is intended for use in the process of the present invention. One thixotropic colloid agent that has been found to be effective in practicing the process of the present invention is a xanthan gum. Xanthan gum is a high molecular weight linear polysaccharide which functions as a hydrophilic colloid to thicken, suspend and stabilize water based systems.

Xanthan gum is classified as a carbohydrate. The xanthan gum utilized in the present process is a complex polysaccharide gum having a molecular weight of more than one million. This high polymer is linear in structure with a B-linked backbone containing D-glucose, D-mannose and D-glucuronic acid with a **1** D-mannose side-chain unit for every **8** sugar residues and a **1** D-glucose side-chain residue for every **16** sugar residues. The polysaccharide is partially acetylated and contains pyruvic acid attached to the glucose side-chain residue. The molar ratio of D-glucose to D-mannose to D-glucuronic acid is 2.8:3.0:2.0. The generally accepted structure of the xanthan gum used in the process of the present invention is



The solution of water and colloid agent in holding tank **10** may be prepared by sifting a dry thixotropic colloid agent, such as xanthan gum, into water with sufficient agitation to bring about a physical separation of the particles.

Another thixotropic colloid agent that is useful in practicing the present invention is a hydroxyalkyl guar which is a modification of a standard guar gum that is prepared by reacting the guar molecule with ethylene oxide or propylene oxide. The chemical structure of a hydroxyalkyl guar is derived from the guar gum molecule which is essentially a high molecular weight straight chain mannan branched at quite regular intervals with single membered galactose units on alternate mannose units. The mannose units are linked to each other by beta (1 → 4) glycosidic linkages. The galactose branching is accomplished through an alpha (1 → 6) linkage. Under proper conditions, treatment of guar gum with either ethylene or propylene oxide results in hydroxyalkylated products. The widely accepted structure for the hydroxyalkyl guar gum molecule is



where R is CH_2CH_2O or $CH_2CH(CH_3)O$

Other colloid agents usable in accordance with the present invention include alkali metal silicates such as sodium silicate (water glass) and potassium silicate and metal sulfates such as calcium sulfate.

As is shown in FIG. 2, the colloidial mixture in tank **10** is delivered by a conduit **12** into a tub **14** which contains a mold assembly **16** for forming the mica sheet composites. Conduit **12** is equipped with an appropriate valve or nozzle (not shown) for commencing and terminating the flow of the liquid from holding tank **10** into tub **14.** In the embodiment of the invention shown in FIG. **2,** gravitational forces cause the colloidial mixture in tank **10** to flow into tub **14.**

Mold assembly **16** is comprised of a lateral support member **18** and a screen bottom **20** (see FIG. 3). The screen bottom **20** is a 60 mesh screen formed of teflon. A teflon screen is employed because of its widely known non-sticking and heat resistant properties, although the use of a teflon screen is not essential. Lateral support member **18** is designed to produce a 39 inch × 39 inch sheet of mica composite.

To begin the molding cycle, screen **20** is placed on the bottom surface of tub **14.** Lateral support member **18** is then placed above screen **20** to form the mica sheet mold. The mold assembly **16** is then filled to an appropriate height as is indicated by upper surface **22** of colloid mixture **24** in FIG. 2. The height is determined by the thickness of the mica sheet desired. For example, for sheets having a uniform thickness of 0.020 inches, tub **14** is filled to a depth of four inches.

As is shown in FIG. **2,** a baffle member **26** is supported by the upper walls of tub **14.** A more detailed view of baffle **26** is shown in FIG. **4.** As is shown in FIG. **14,** baffle **26** has the configuration of a tray with side walls for initially containing the colloid mixture flowing from conduit **12.** Handles **28** on baffle **26** support baffle **26** and allow the bottom surface thereof to extend into the inner chamber of the tub. A plurality of apertures **30** formed on the bottom surface of baffle **26** allow for the passage of colloid mixture **24** into the mold assembly **16.**

The purpose or function of baffle **26** is to deliver the colloid mixture uniformly to the mold assembly. After the mold assembly **16** is filled to the pre-determined height to establish a mica sheet of a pre-determined thickness, a vacuum pump **32** withdraws liquid from mold assembly **16.** Vacuum pump **32** is connected to a drain (not shown) on the bottom of tube **14** by an appropriate conduit. With the vacuum pump drawing a vacuum at a range between 12 to 18 inches in the direction of arrow **34,** it takes only a few minutes for a sheet to form with the liquid in mold assembly **16** being extracted from the mold assembly through screen **20** and out of the tub through the drain situated on the bottom thereof.

Of course, as the liquid is extracted from the mold assembly, the mica platelets are deposited uniformly on screen **20**

To facilitate removal of liquid, it has been found advantageous to cover the mica platelets that are deposited on screen **20.** The foregoing step is accomplished with a sheet of a water proof fabric having a shape which allows it to cover the surface of screen **20.** Since the waterproof fabric, which is utilized as a cover during the final stages of vacuum withdrawal is nothing more than a rectangular mat of rubber or plastic, it is not shown in the drawing. In connection with the use of such a cover, it should be noted that the vacuum arrangement connected to the drain on tub **14** is capable of extracting substantially all of the liquid (water) which carries the mica platelets. However, by covering the mica platelets after the sheet of platelets are formed, the mica platelets on screen **20** are compressed and in a slightly damp condition.

After forming a sheet in the manner described above, the mold assembly is disassembled and screen **20** which supports the mica sheet is delivered to an oven wherein the mica platelets on screen **20** are dried at a temperature of 450°F. for one hour to yield a dry mica sheet.

As set forth above, it is possible to coat the sheet with a resin after the sheet has been removed from tub **14.** In this embodiment of the invention, the sheet can be coated while slightly damp, or dry, with a resin solution before being dried in an oven. An acceptable procedure for coating a sheet with a resin solution is to coat a 15 percent by weight silicone resin in toluol solution on to the damp, or dry, sheet.

In the final step of the process, the dry sheet is pressed at a pressure of about 200 pounds per square inch and a temperature of 260° – 280°F. in a heated platen hydraulic press to yield the finished mica plate.

In a third embodiment of the invention, a binder or resin is coated on the dry ground mica platelets in the manner described above with a binder solution being utilized to apply a second coat of binder to the mica sheet after the sheet is formed.

The procedures set forth above are illustrated with the aid of the following non-limiting examples.

EXAMPLE 1

To produce a 39 inch by 39 inch 20 mil thick sheet, 890 grams of mica, which is ground and graded to yield particles which range in size between 6 mesh and 30 mesh, are added to 20 gallons of water containing ⅛ percent by weight of the xanthan gum thixotripic colloid agent and stirred gently to prevent settling.

This **20** gallon charge is dropped into tub **14** through baffle tray **26.** The water is then drained through a 60 mesh screen **20** situated in the bottom of the tub. When all the surface water has been removed, a sheet of teflon coated glass is laid over the mica. This cover is cut to fit smugly inside mold **16.**

Vacuum at **14** inches is then applied through the drain line to remove most of the residual water and densify the mica sheet through the pressing action of the teflon glass cover.

The combustion of screen **20,** mica sheet and teflon glass is then removed from the tub and placed between two pieces of cardboard, turned upside down and the screen **20** is stripped from the mica sheet. The mica sheet on the teflon glass cover is then placed in a rack and allowed to dry overnight.

The air-dried mica is then coated with a 24 percent silicone resin in toluene solution to produce a 15 percent binder content and dried in an oven for ten minutes at 475°F. The silicone resin is Dow-Corning 2,106.

The teflon glass cover is removed, and the mica layers are then pressed in a steam heated hydraulic press at 270°F., **15** minutes at touching pressure followed by 30 minutes at 200 psi.

The pressed sheets are then cured in an oven for **18** hours at 600°F. to yield a finished mica plate.

EXAMPLE 2

To produce a 39 inch by 39 inch 20 mil thick sheet, 890 grams of mica, which is ground and graded to yield particles which range in size between 6 mesh and 30 mesh, are added to a rotating drum.

The mica charge is tumbled in the rotating drum while being sprayed slowly with a silicone latex (35 percent solids). The latex is prepared in conventional form by dispersing solid resin powder in water and stabilizing. The amount added is such that the final product contains 15 percent binder content. The tumbling is stopped when the water content of the mix is approximated 20 percent (mica particles barely cling to sides of drumtotal tumbling time approximately 10 minutes).

The coated mica platelets are then added to 20 gallons of water containing ⅝ percent by weight of the xanthan gum thixotropic colloid agent and stirred gently to prevent settling.

This 20 gallon charge is dropped into tub **14** through baffle tray **26.** The water is then drained through a 60 mesh screen **20** situated in the bottom of the tub. When all the surface water has been removed, a sheet of teflon coated glass is laid over the mica. This cover is cut to fit smugly inside mold **16.**

Vacuum at 14 inches is then applied through the drain line to remove most of the residual water and densify the mica sheet through the pressing action of the teflon glass cover.

The combination of screen **20,** mica sheet and teflon glass is then removed from the tub and placed between two pieces of cardboard, turned upside down, and the screen **20** is stripped from the mica sheet. The mica sheet on the teflon glass cover is then placed in a rack and allowed to dry overnight.

The teflon glass cover is removed and the mica layers are then pressed in a steam heated hydraulic press at 270°F., 15 minutes at touching pressure followed by 30 minutes at 200 psi.

The pressed sheets are then cured in an oven for 18 hours at 600°F. to yield a finished mica plate.

EXAMPLE 3

To produce a 39 inch by 39 inch 20 mil thick sheet, 890 grams of mica which is ground and graded to yield particles which range in size between 6 mesh and 30 mesh, are added to a rotating drum.

The mica charge is slowly tumbled in the rotating drum while being sprayed slowly with a 30 percent solution of Dow-Corming 2,106 silicone resin in equal parts of alcohol and toluene. The amount added is such that the final mica product contains 15 percent by weight of the resin binder. The tumbling is stopped when mica particles no longer cling to the sides of the drum.

The coated mica platelets are then added to 20 gallons of water containing ⅛ percent by weight of the xanthan gum thixotropic colloid agent and stirred gently to prevent settling.

This **20** gallon charge is dropped into tub **14** through baffle tray **26.** The water is then drained through a 60 mesh screen **20** situated in the bottom of the tub. When all the surface water has been removed, a sheet of teflon coated glass is laid over the mica. This cover is cut to fit smugly inside mold **16.**

Vacuum at **14** inches is then applied through the drain line to remove most of the residual water and densify the mica sheet through the pressing action of the teflon glass cover.

The combination of screen **20,** mica sheet and teflon glass is then removed from the tub and placed between two pieces of cardboard, turned upside down, and the screen **20** is stripped from the mica sheet. The mica sheet on the teflon glass cover is then placed in a rack and allowed to dry overnight.

The teflon glass cover is removed, and the mica layers are then pressed in a steam heated hydraulic press at 270°F., 15 minutes at touching pressure followed by 30 minutes at 200 psi.

The pressed sheets are then cured in an oven for **18** hours at 600°F. to yield a finished mica plate.

EXAMPLE 4

To produce a 39 inch by 39 inch 20 mil thick sheet, 890 grams of mica, which is ground and graded to yield particles which range in size between 6 mesh and 30 mesh, are added to a rotating drum.

The mica charge is slowly tumbled in the rotating drum while being sprayed with water. Spraying is continued until the mica starts clinging to the side of the drum (approximately 20 percent moisture content). An amount of silicone resin powder, previously ball milled and passed through 60 mesh screen, is slowly added such that the final mica product contains **15** percent by weight of binder. Additional spraying with water is necessary to keep the platelets damp and the resin clinging to the mica platelets. The total tumbling time is approximately 15 minutes.

The coated mica is then added to 20 gallons of water containing ⅛ percent by weight of the xantham gum thixotropic colloid agent and stirred gently to prevent settling.

This 20 gallon charge is dropped into tub **14** through baffle tray **26.** The water is then drained through a 60 mesh screen **20** situated in the bottom of the tub. When all the surface water has been removed, a sheet of teflon coated glass is laid over the mica. This cover is cut to fit smugly inside mold **16.**

Vacuum at 14 inches is then applied through the drain line to remove most of the residual water and densify the mica sheet through the pressing action of the teflon glass cover.

The combination of screen **20,** mica sheet and teflon glass is then removed from the tub and placed between two pieces of cardboard, turned upside down, and the screen **20** is stripped from the mica sheet. The mica sheet on the teflon glass cover is then placed in a rack and allowed to dry overnight.

The teflon glass cover is removed and the mica layers are then pressed in a steam heated hydraulic press at 270°F., 15 minutes at touching pressure followed by 30 minutes at 200 psi.

The pressed sheets are then cured in an oven for 18 hours at 600°F. to yield a finished mica plate.

EXAMPLE 5

The procedure set forth in Example 1 is followed but with the 890 grams of mica being charged into 20 gallons of water containing ⅛ percent by weight of the hydroxyalkyl guar colloidial agent.

EXAMPLE 6

The procedure set forth in Example 5 is followed but with the air-dried mica being coated with a shellac solution containing two to three pounds of shellac per gallon of methyl alcohol.

EXAMPLE 7

The procedure set forth in Example 3 is followed except that the 890 grams of coated mica starting material is added to 20 gallons of water containing ⅛ percent by weight of the hydroxyalkyl guar colloid agent.

EXAMPLE 8

The procedure set forth in Example 7 is followed except that the mica is coated with a shellac solution containing two to three pounds of shellac per gallon of methyl alcohol.

EXAMPLES 9–11

The procedure set forth in Example 1 is followed but with the 890 grams of mica being charged into **20** gallons of water containing ⅛ percent by weight of sodium silicate, potassium silicate or calcium sulfate.

EXAMPLES 12–14

The procedure set forth in Examples 9–11 is followed but with the air-dried mica being coated with a shellac solution containing two to three pounds of shellac per gallon of methyl alcohol.

EXAMPLES 15–17

The procedure set forth in Example **3** is followed except that the 890 grams of coated mica starting material is added to 20 gallons of water containing ⅛ percent by weight of sodium silicate, potassium silicate or calcium sulfate.

EXAMPLES 18–20

The procedure set forth in Examples 15–17 is followed except that the mica is coated with a shellac solution containing two to three pounds of shellac per gallon of methyl alcohol.

EXAMPLES 21–23

The procedure set forth in Examples 9–11 is followed but with the air-dried mica being coated with an epoxy resin. The epoxy resin is Sterling Varnish Company's epoxy Y–20.

EXAMPLES 24–26

The procedure set forth in Examples 9–11 is followed but with the air-dried mica being coated with an alkyd. The alkyd is General Electric's alkyd vinyl 7002.

In addition to the foregoing examples, the procedures set forth in Examples 1, 3, 5, 7, 9–11 and 15–17 may be carried out with solutions of other epoxies, alkyds, polyurethanes and phenolics as the binder. Additionally, inorganic binders may be used in place of the silicone solution.

The procedure set forth in Example 2 may be carried out with latexes of other solid resins such as shellac, epoxies, alkyds, and polyurethanes as well as with inorganic binders in place of the silicone latex.

The procedure set forth in Example 4 may be carried out with solid resins such as shellac, epoxies, alkyds, polyurethanes and inorganic binders in place of the silicone solid resin.

Accordingly, by following the procedures set forth above, a new and improved method for manufacturing mica sheet composites results. With the present invention, the mica platelets, after being ground, can be stored indefinitely in a dry condition. Once resin is added to the sheet, a sheet results with excellent properties.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

We claim:

1. A method for manufacturing a mica sheet of uniform thickness comprising:

a. mixing a quantity of mica platelets with a liquid carrier and a thixotropic colloid agent;

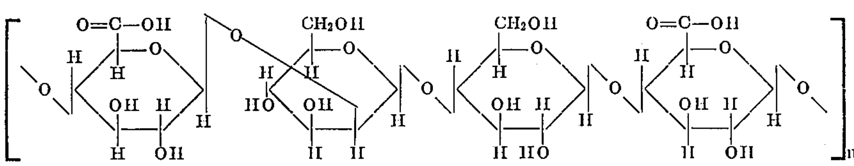
b. delivering the mixture of carrier, thixotropic colloid agent and mica platelets to a sheet forming mold having a drain with a screen over the drain to prevent the mica platelets from passing through the drain;

c. removing the liquid carrier from the mold through the drain to yield a mica sheet on the screen; and

d. applying a binder resin to the mica sheet to strengthen the sheet; said thixotropic colloid agent causing said mica platelets to remain in suspension after said mixture of carrier, thixotropic colloid agent, and mica platelets are delivered to said mold, reducing lateral movement of said platelets toward said drain while liquid carrier is being removed through said drain, and enabling the formation of a mica sheet of uniform thickness by preventing the channeling of platelets toward the drain.

2. The method as set forth in claim **1** wherein in step (a) a thixotropic colloid agent selected from the group consisting of xanthan gum, hydroxyalkyl guar, sodium silicate, potassium silicate and calcium sulfate is mixed with water and the platelets.

3. The method as set forth in claim **1** wherein in step (a) a thixotropic colloid agent which is a xanthan gum having the formula



is mixed with water and the platelets.

4. The method as set forth in claim **1** including the steps of drying and pressing the mica sheet.

5. In method for manufacturing a mica sheet of uniform thickness in which a resin is applied to mica platelets as a binder which strengthens the sheet wherein the improvement comprises:

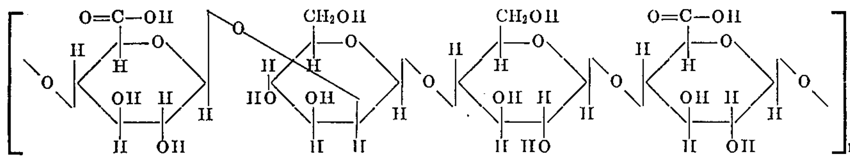
a. grinding a dry mica starting material to yield mica platelets;

b. mixing a quantity of the mica platelets with water and a thixotropic colloid agent;

c. delivering the mixture of water, thixotropic colloid agent and mica platelets to a sheet forming mold having a drain on the bottom thereof and a screen for passing water and retaining platelets positioned between the mixture and the drain; and

d. removing the water from the mold through the drain to yield a mica sheet on said screen; said thixotropic colloid agent causing said mica platelets to remain in suspension after said mixture of water, thixotropic colloid agent, and mica platelets are delivered to said mold, reducing lateral movement of said platelets toward said drain while water is being removed, and enabling the formation of a mica sheet of uniform thickness by preventing the channeling of platelets toward the drain.

6. The method as set forth in claim **5** wherein in step (b) the thixotropic colloid agent that is mixed with the water and platelets is xanthan gum having the formula



7. The method as set forth in claim **5** wherein a suction is applied to said drain to withdraw water from said sheet forming mold.

8. The method as set forth in claim **7** including the step of covering the mica platelets in said sheet forming mold with a waterproof cover to facilitate removal of water and applying a suction to said drain while said mica platelets are covered with said cover.

9. The method as set forth in claim **7** including the step of applying a binder resin to said mica platelets prior to mixing said mica platelets with water and a thixotropic colloid agent in step (b).

10. The method as set forth in claim **7** including the step of applying a binder resin to the mica sheet after a sheet is formed in the sheet forming mold.

11. The method as set forth in claim **9** also including the steps of drying and pressing the mica sheet formed in said sheet forming mold.

12. The method as set forth in claim **10** also including the steps of drying and pressing the mica sheet formed in said sheet forming mold.

13. A method for manufacturing a mica sheet of uniform thickness comprising:

a. coating a binder resin on a quantity of mica platelets to strengthen the mica sheet;

b. mixing the coated mica platelets with a liquid carrier and a thixotropic colloid agent;

c. delivering the mixture of carrier thixotropic colloid agent and coated mica platelets to a sheet forming mold having a drain with a screen over the drain to prevent the mica platelets from passing through the drain; and,

d. removing the liquid carrier from the mold through the drain to yield a mica sheet on the screen; said thixotropic colloid agent:

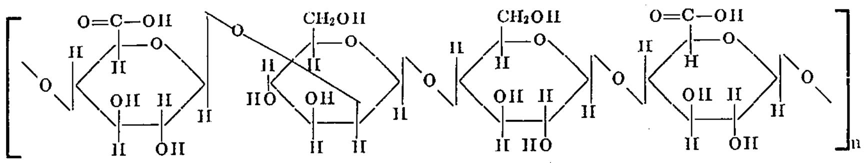
1. causing said mica platelets to remain in suspension after said mixture of carrier, thixotropic colloid agent, and mica platelets are delivered to said mold;

2. reducing lateral movement of said platelets to-

ward said drain while liquid carrier is being removed through said drain, and

3. enabling the formation of a mica sheet of uniform thickness by preventing the channeling of platelets toward the drain.

14. The method as set forth in claim 13 wherein in step (b) a xanthan gum having the formula



is mixed with water and the coated platelets.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,880,972 Dated April 29, 1975

Inventor(s) Allen N. Towne et al Page 1 of 2

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Figure 1 of the drawings should appear and apply to the grant only per attachment.

Signed and Sealed this

first Day of *June 1976*

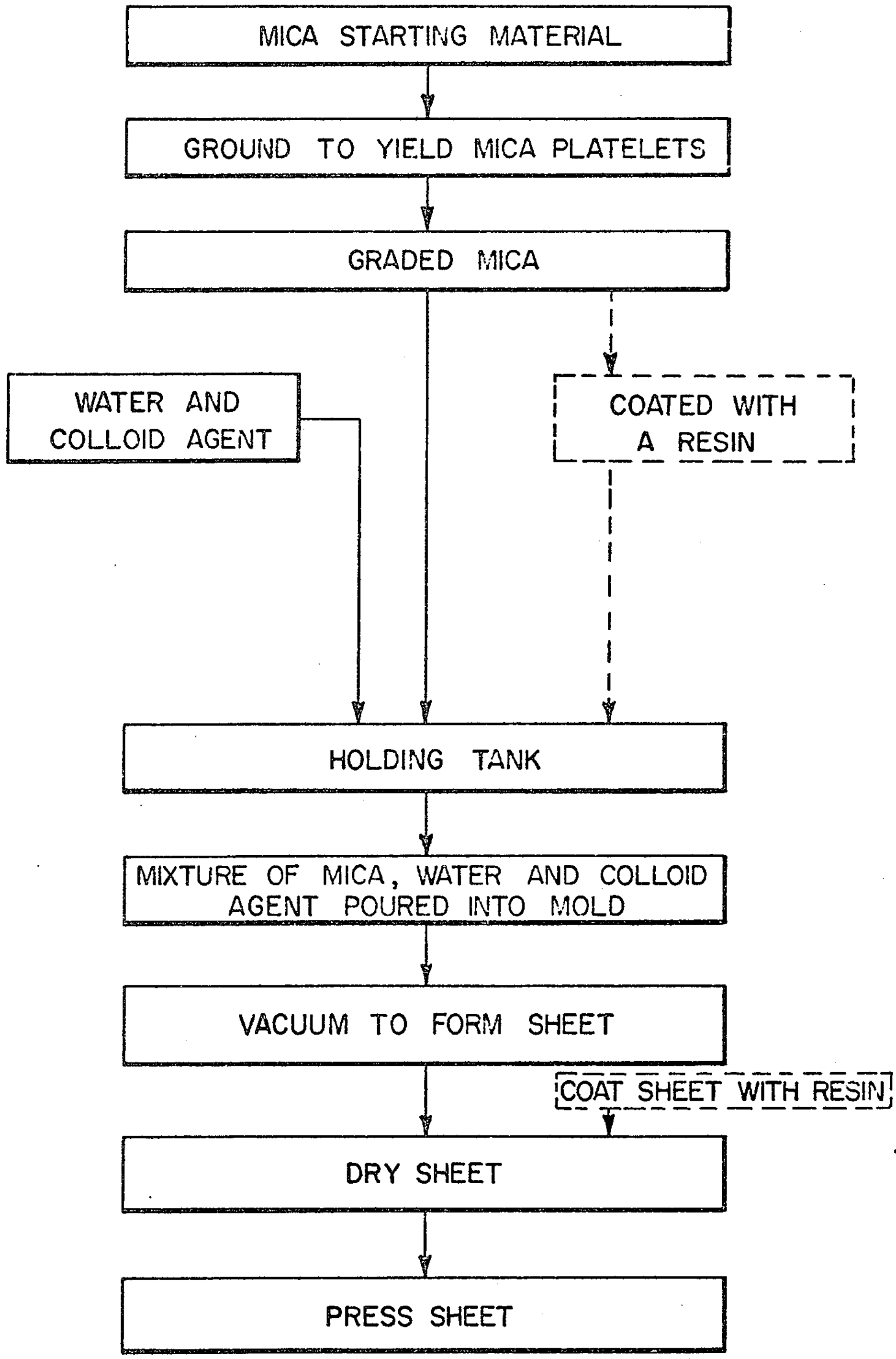
[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

FIG. 1.


MICA STARTING MATERIAL
GROUND TO YIELD MICA PLATELETS
GRADED MICA
WATER AND COLLOID AGENT
COATED WITH A RESIN
HOLDING TANK
MIXTURE OF MICA, WATER AND COLLOID AGENT POURED INTO MOLD
VACUUM TO FORM SHEET
COAT SHEET WITH RESIN
DRY SHEET
PRESS SHEET

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,880,972
DATED : April 29, 1975
INVENTOR(S) : Allen N. Towne et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 40, add --poured into a sheet forming mold.--.

Relocate Column 5 and Column 6 to be in correct order.

Column 5, line 8, change "presence" to --present--.

Column 7, line 21, third occurance of CH reading CH_1, change to CH_2.

Column 9, line 15, change "thixotripic" to --thixotropic--.

Column 9, line 27, change "combustion" to --combination--.

Column 9, line 60, change "5/8" to --1/8--.

Claim 13, Column 15, line 13 change "form thickness by preventing the channeling of platelets toward the drain. 3. enabling the formation of a mica sheet of uni." to --3. enabling the formation of a mica sheet of uniform thickness by preventing the channeling of platelets toward the drain.--.

Signed and Sealed this

first **Day of** *June 1976*

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