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APPARATUS FOR ELECTROPHORETIC DEPOSITION OF LAMELLAR FLUORPHLOGOPITE MICA SHEETS

Original Filed May 5, 1961

Fig. 1

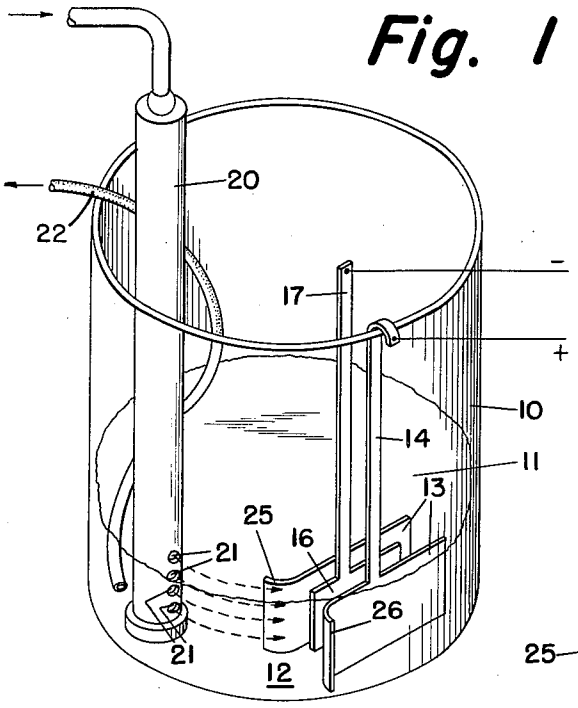


Fig. 2

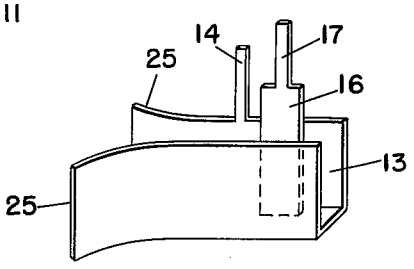
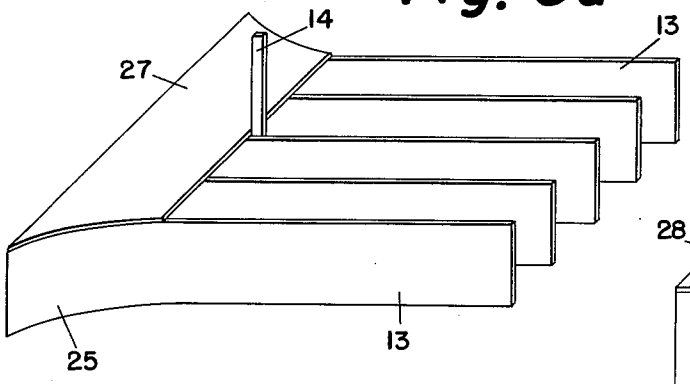


Fig. 3a



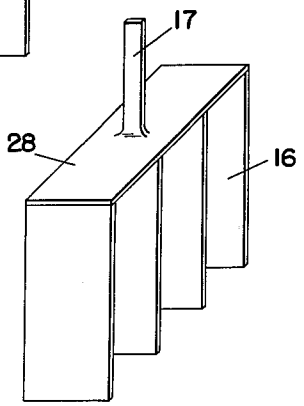


Fig. 3b

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APPARATUS FOR ELECTROPHORETIC DEPOSITION OF LAMELLAR FLUORPHLOGOPITE MICA SHEETS

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Continuation of application Ser. No. 108,209, May 5, 1961. This application Mar. 27, 1964, Ser. No. 356,018
4 Claims. (Cl. 204—299)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to us of any royalty thereon.

This invention is a continuation of our copending patent application, Serial Number 108,209. filed May 5, 1961, now abondoned entitled "Apparatus for Electrophoretic Deposition of Lamellar Fluorphlogopite Mica Sheets" and assigned to the same assignee hereof, and relates to the deposition of flat, plate-like particles such as mica and the like and more particularly concerns novel apparatus for the electrophoretic depositing of such particles into large lamellar sheets.

Mica is one of the strategic materials of this country. They define a group of hydrated alumino silicate materials possessing high dielectric strength, and have mechanical and thermal properties which make them especially suited for various electronic applications.

At the present time, a major proportion of high quality natural mica used in this country is obtained from foreign sources. A process for the production of synthetic micas has been developed by the Electrotechnical Laboratory, U.S. Bureau of Mines, Norris, Tennessee, but the yield of crystals of sufficiently large dimensions for electronic applications has been wholly inadequate.

Consequently, attempts have been made to reconstitute synthetic mica into large sheet-like structures which would be adequate for such applications. For example, one of the earliest and most extensively used approaches to mica reconstitution employed the well-known paper making technique. There, the synthetic mica was broken down into flakes by grinding in an aqueous medium and then permitted to settle out of such medium onto a suitable surface or screen in the form of a reconstituted mica sheet or mat. The sheet or mat was then dried and treated to obtain specific desired properties. The orientation of particles in such "mica papers" was not sufficiently lamellar to allow them to be recrystallized into transparent pure mica sheets. In a copending application of McNeill et al., Method of Making Lamellar Sheets of Fluorophlogopite Mica, Serial No. 38,673, filed June 24, 1960, now U.S. Patent No. 3,100,186, a solution to this problem was provided.

A principal object of the invention is to provide apparatus for electrophoretically depositiong flat, plate-like particles into large lamellar sheets.

A further object of the invention resides in the provision of apparatus for the reconstitution of synthetic mica particles into large lamellar sheets.

The exact nature of this invention as well as other objects and advantages thereof will be readily apparent from consideration of the following description and drawings wherein:

FIG. 1 is a perspective view of an embodiment of the invention;

FIG. 2 is a modification of the electrode assembly of FIG. 1 showing a typical anode configuration with its cooperating cathode; and

FIGS. 3*a* and 3*b* comprise another modification of the electrode assembly showing the anode and cathode in displaced relation.

Briefly, the aforementioned objects are attained in accordance with the present invention by configurating the electrode assembly to enable the hydrodynamic flow of the particle suspension, and circulated by an impeller, to be directed through the electrode assembly, wherein the electrostatic forces therearound, and supplied by an applied potential thereto, result in the flat, overleafing, lamellar depositing of the particles.

More specifically, the impeller is caused to circulate the particle suspension under conditions of maximum viscous flow through the configurated electrode assembly, thus favorably pre-aligning the plate-like particles when subjected to the nearly uniform electrical field of the cathode surfaces. While reference hereinafter will be made to mica particles, it is to be understood that the invention is not intended to be so limited, and other flat, plate-like materials may be satisfactorily deposited in lamellar formations.

Referring now to FIG. 1 of the drawings, there is shown an electrophoretic cell or container **10**, preferably of an electrical non-conducting material and containing a liquid **11** for suspending the mica particles to be deposited.

An electrode assembly is shown generally at **12** and consists of spaced-apart interconnected multi-segmented anode plates **13**—**13** providing a generally vertical extension **14** adapted to connect to a positive terminal of a suitable direct current source. A cathode **16** is positioned mid-way between the multi-segmented anode plates and has an extension **17** for connection to the negative terminal of the power source. The surfaces of the anode and cathode are disposed in parallel relation with each other and are rigidly mounted within the container adjacent its bottom in order to prevent any displacement during deposition. The material used for the cathode is preferably nickel, although other suitable conductors such as platinum, palladium, palladium-10% ruthenium, silver, copper, gold plated on copper, mercury plated on silver or copper, lead, tin, magnesium, aluminum, niobium, stainless steel, mild steel, titanium, molybdenum and graphite may be used advantageously. The anode may suitably be platinum, palladium or nickel.

An upright inlet pipe **20** having a plurality of vertically disposed orifices **21** adjacent its bottom rests within the cell **10** and communicates with a centrifugal pump or impeller, not shown, to provide uniform circulation of the suspension. To this end, an outlet or return tube **22** is similarly disposed within the cell and communicates with the same impeller.

The anodes in each of the drawings have at least one of their plates flaring outwardly as shown at **25** in order to direct the flow of suspension from orifices **21** past the cathode **16**. In the anode assembly of FIG. 1, however, the wall of the container is utilized in directing the flow of the suspension toward the cathode and hence, the outwardly curved portion **26** of the other anode plate may be shaped as shown.

In the modifications depicted in FIGS. 2 and 3*a*, the flaring portions **25** of the anode plates are generally similar, it being understood that these modifications are usable irrespective of their positioning against the container wall. The anode of FIG. 3*a* is provided with a roof member **27** over the flaring portions **25** in order to additionally direct the suspension past the cathode and to electrically interconnect each plate. Obviously, such a roof member may be used to advantage in the modification of FIG. 2. The cathode assembly of FIG. 3*b* is shown provided with an upper connecting member **28** and, in operation, its plates are placed in spaced alternate relationship with the anode plates.

In all cases, the cathode will be centered with respect to the anode plates, and all electrode surfaces are disposed in

general parallel relation. The dimensions of the electrodes are selected to permit the maximum rate of viscous flow of suspension parallel to the cathode surfaces and are dependent upon the physical and chemical properties of the individual suspension used.

In the practice of the invention, the level of the mica particle suspending medium **11** will be determined by the height of the cathode if the entire cathode surface is to be coated. Where deposition is desired over a portion of the cathode only, the suspension level may be lowered accordingly.

From the foregoing description, it is apparent that novel apparatus has been provided wherein the mica suspension is maintained in viscous flow, thus preventing random orientation of the suspended particles, and insuring the good, flat, overleafing, lamellar desposition thereof.

We claim:

1. Apparatus for the electrophoretic deposition of large lamellar sheets of mica and the like from a suspension of particles thereof having flat, plate-like characteristics, said apparatus comprising a container, an electrode assembly within said container at the bottom thereof including an anode and a cathode, said anode comprising a plurality of spaced-apart, interconnected plates of a metal selected from the group consisting of platinum, palladium, and nickel, disposed in vertical parallel relation to each other and connected to the positive terminal of a D.C. source, and said cathode comprising at least one vertically disposed plate positioned in spaced-apart relation midway between each adjacent pair of anode plates and connected to the negative terminal of said D.C. source, an inlet tube

communicating with impeller means and leading from a source of said suspension outside said container to a point within said container in proximate relation to the anterior portion of said electrode assembly, said inlet tube being provided with orifices each of which is horizontally aligned with said anterior portion of said electrode assembly for horizontally directing said suspension through the spaces therebetween, and a return tube communicating with said impeller and leading to said source of suspension from a point within said container other than in the area between said orifices and said electrode assembly.

2. Apparatus according to claim **1** wherein said anode comprises two plates, each of said plates flaring anteriorly outwardly for directing said suspension therebetween.

3. Apparatus according to claim **1** wherein roofing means are mounted anteriorly on said anode plates for directing said suspension therebetween.

4. Apparatus according to claim **1** wherein said cathode comprises interconnected multi-segmented depending plates, the number of said cathode plates being one less than the number of anode plates.

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