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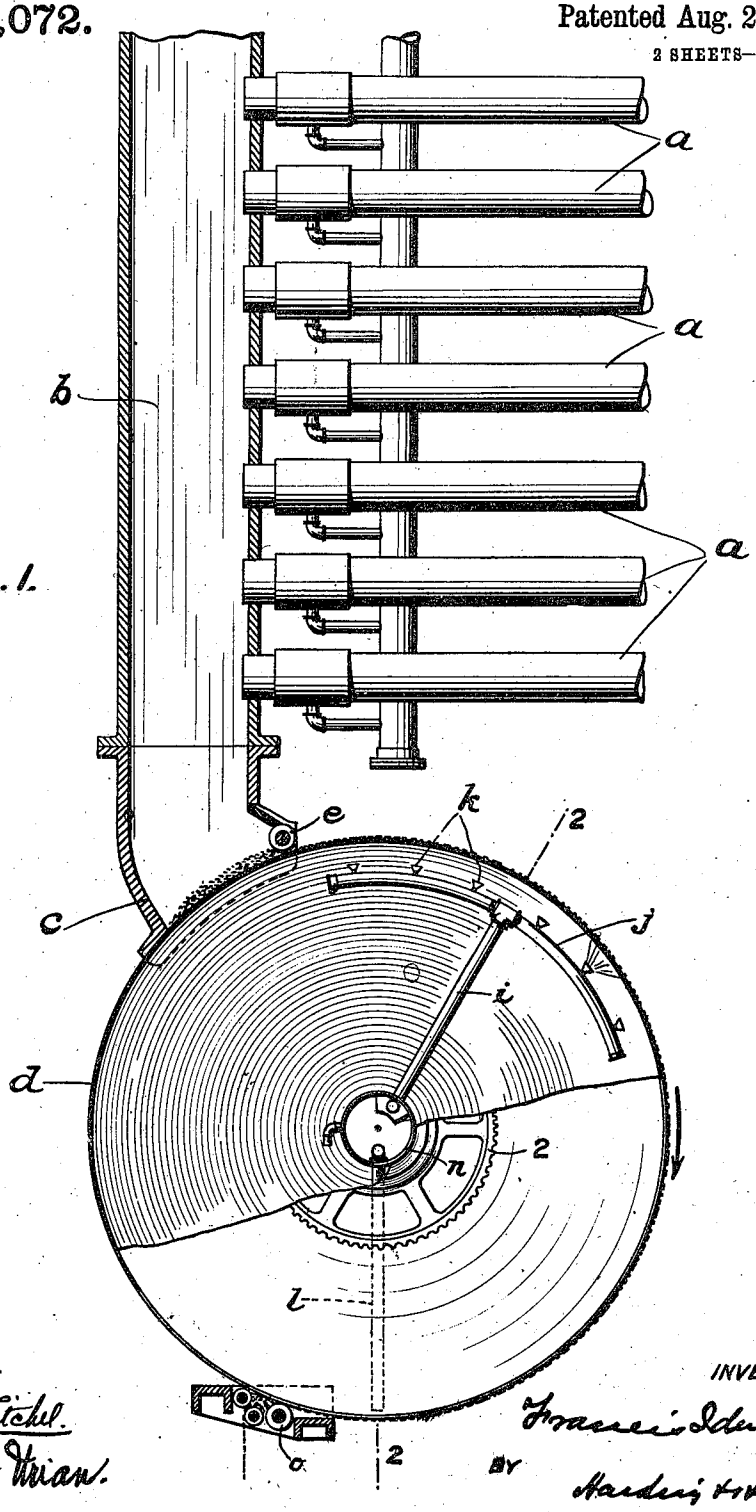
APPARATUS FOR SOLIDIFYING CRYSTALLIZABLE MIXTURES WITHOUT SUBSTANTIAL CRYSTALLIZATION AND FORMING STRIPS THEREOF.

APPLICATION FILED SEPT. 24, 1909.

1,001,072. Patented Aug. 22, 1911.

2 SHEETS—SHEET 1.

FIG. 1.



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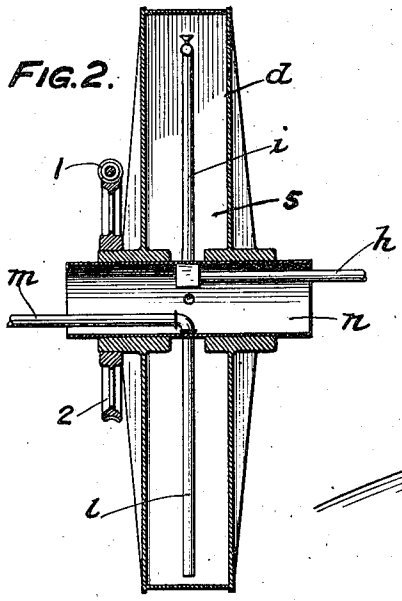
2 SHEETS—SHEET 2.

FIG. 2.



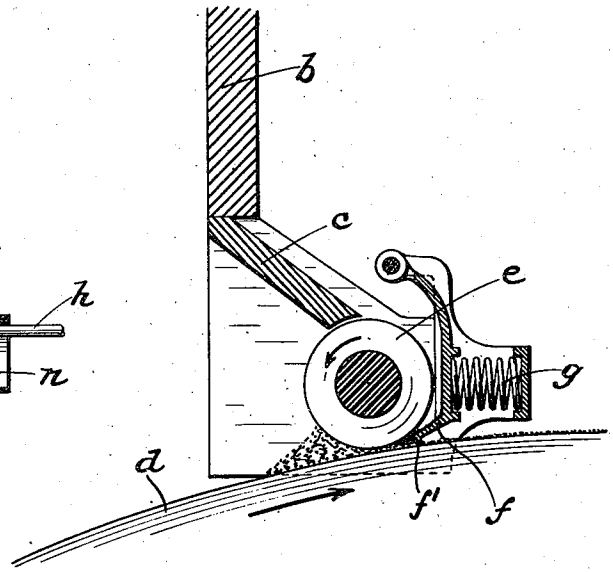


FIG. 3.

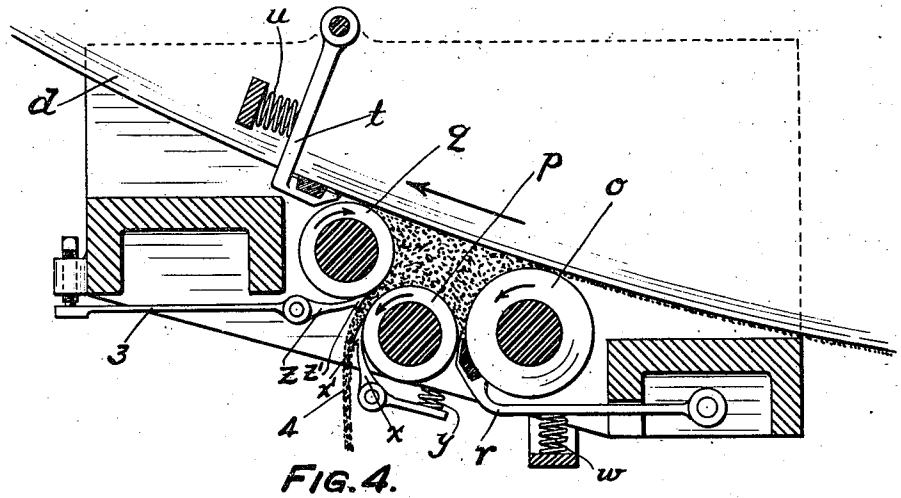


FIG. 4.

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR SOLIDIFYING CRYSTALLIZABLE MIXTURES WITHOUT SUBSTANTIAL CRYSTALLIZATION AND FORMING STRIPS THEREOF.

1,001,072. Specification of Letters Patent. Patented Aug. 22, 1911.

Application filed September 24, 1909. Serial No. 519,318.

To all whom it may concern:

Be it known that I, FRANCIS I. DU PONT, a citizen of the United States, residing at Wilmington, county of Newcastle, and State of Delaware, have invented a new and useful Improvement in Apparatus for Solidifying Crystallizable Mixtures Without Substantial Crystallization and Forming Strips Thereof, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

In the manufacture of "black powder" from an initial mixture of the ingredients when in a dissolved, liquid or semiliquid condition produced by solvents or heat or both, it is necessary to return the material to a solid condition without substantial crystallization. So far as the ingredients which are made liquid or semiliquid by solvents are concerned, they may be brought to a certain extent to a solid condition without substantial crystallization by means of applied heat and working the mass during such heat application. Such an apparatus is described, illustrated and claimed in an application filed by me November 18, 1909, Serial No. 463,248, and in an application filed by me July 28th, 1909, Serial No. 510,070. This action will not, however, even as to those ingredients above specified, bring them to a completely solidified condition, and will have substantially no effect upon those ingredients which are rendered liquid or semiliquid by heat.

The object of my invention is to bring both characters of such ingredients to a completely solidified condition without allowing any recrystallization of the crystallizable ingredients.

The mass after admixture in a fluid or semifluid condition is subjected to heat, while working such mass during said treatment. This should practically, although not completely, as described herein, solidify the ingredients which are rendered liquid or semiliquid by a solvent. It has, however, no such effect upon the ingredients rendered liquid or semiliquid by heat. For instance, taking "black powder", an example of the ingredients of which is 73 parts nitrate of soda, 16 parts charcoal, and 11 parts sulfur, in such composition the liquid or semiliquid sulfur will not be solidified by this treatment. The treatment of heat and working just described may be carried on in the application before mentioned.

The present invention relates to an apparatus for completing the solidification without crystallization of such ingredients, and solidifying, without crystallization, the ingredients rendered liquid or semiliquid by heat.

I have discovered that if I take the mixture after it has passed through the evaporator and form it into a thin sheet, which sheet must be practically as thin as it can be formed, and when in such thin sheet subjected to cooling action, the material is rapidly cooled and solidified and all the material practically simultaneously so chilled, and solidified, and the solidification of the ingredients of the previous treatment completed, and the solidification of the other ingredients obtained, all without crystallization. The material thus solidified, may then be broken up and if grains are desired to be produced, formed into a sheet of the desired thickness and the grains cut therefrom.

I will now describe an apparatus for carrying out my process or method, said apparatus forming the subject matter of the present application, and said process or method forming the subject matter of an application, a division of this application, filed January 31, 1910, Serial No. 540,951.

In the drawings: Figure 1 is a general view of my invention, with some of the parts in elevation and others in section. Fig. 2 is a section on the line 2—2, Fig. 1. Fig. 3 is a detailed view of a portion of the apparatus adjacent to the point of reception of the material upon the roller. Fig. 4 is an enlarged section of the mechanism for removing the powder from the carrying roller and forming it into the ultimate sheet or strip.

a—a are the evaporating tubes of the evaporator, as described in my application before mentioned, and also described in an application filed by me July 28th, 1909, Serial No. 510,070. The material passes from these evaporators into a stack *b*, having the chamber *c*. The carrying roller *d*, which is

revolved by appropriate mechanism in the direction indicated by the arrow, forms the bottom of this chamber *c*. The forward wall of chamber *c* is cut away to admit the pressing roller *e*, which is revolved in the direction of the arrow. The peripheral speed of the rollers *d* and *e* is the same. The tendency of this roller *e* is to press the material in the chamber *c* onto the face of the roller *d*. On the other hand, the material is of such character that its tendency is to follow the roller *e* as well as the roller *d*. In order to obviate this last mentioned condition I use what I term a spreader and scraper *f*. This scraper and spreader *f* is pivoted and backed up by the spring *g*. This combined scraper and spreader *f* has a portion contacting with the surface of the roller *e* to prevent the material following the roller *e*. As shown, this has a knife edge. It is also provided with a projecting lip *f'* which is spaced a distance from the surface of the roller *d* equal to the distance between the surfaces of rollers *d* and *e* at their nearest point.

By this arrangement the material is, by the action of the roller *e*, spread upon the roller *d*, and the thickness of the sheet determined by the distance between the rollers *d* and *e*. Further, the scraper and spreader prevent the material following the roller *e* and also maintain the thickness of the sheet the same as that of the distance between the rollers. As stated, the roller *d* is a skeleton roller, having the internal chamber 5.

h is a pipe leading from a source of water supply or cooling fluid, not shown. The pipe *h* passes through the hollow hub of the roller *d* and connects with the pipe *i*, which passes up vertically in the chamber 5, and terminates in the branch *j*, having the nozzles or sprayers *k*.

l is a pipe leading from the lower portion of the chamber 5, connecting with the pipe *m*. The pipe *m* also passes through the hub of roller *d* and is connected with a suction pump. When water passes from the pipe *h*, under pressure, it is forced out through nozzles *k* and sprayed against the inner surface of the roller *d*, thus chilling the surface of the roller *d* and chilling the powder strip as it passes around with the wheel. The roller *d* is driven by the worm 1 and worm wheel 2. The water will flow by gravity to the bottom of the chamber 5, and is withdrawn by the pump, acting through pipes *m* and *l*.

As stated before, the strip from the roller *d* is too thin to be used in the subsequent steps in the manufacture of the powder into grains. I therefore have provided, as is necessary in this apparatus, mechanism for the purpose of forming this thin strip into a strip of proper thickness to be cut into powder grains. Near the lower surface of the roller *d* I provide the rollers *o*, *p* and *q*. The roller *o* revolves in the same surface direction and at the same surface speed as the roller *d*. The roller *q* revolves in the opposite direction and at a surface speed to be determined by the desired thickness of the ultimate powder strip, as will hereinafter be more fully described. As these two rollers *q* and *o* revolve in opposite directions the powder strip upon the roller *d* will, when it reaches those rollers, be, by their reverse action, crowded between them into the space as shown. The scraper *t*, backed up by the spring *u*, prevents any powder passing beyond the roller *q*. Between the rollers *o* and *q* is the roller *p* revolving in a direction opposite to the roller *q*. The material crowded between the rollers *o* and *q* is prevented from passing out between the rollers *o* and *p* by means of the scraper and cleaner *r*, backed up by the spring *w*. As the drawings show, the scraper and cleaner *r* contacts with the roller *o*, as that is the roller which will tend to carry the material around in the direction between the rollers *o* and *p*. In like manner, the scraper and cleaner *t* contacts with the surface of the roller *d*, as that roller is the one which will tend to carry off and prevent the material being brought into the space between the rollers *q* and *o*. The rollers *p* and *q* are separated from each other at a distance equal to the thickness of the desired powder strip and their peripheral velocities are determined upon the basis of the thickness of the powder strip desired and the quantity acted on.

Contacting with the roller *q* is a scraper and spreader *z*, quite similar to the scraper and spreader *f*, before described. It, like the scraper *f*, has the scraping surface or edge, which contacts with the roller *q*, and the projecting lip *z'* which is spaced from the roller *p* a distance equal to the distance between the rollers *p* and *q* at the active point. By this construction the powder mass in the space between the rollers *o* and *q* will pass out between the rollers *p* and *q* and will be prevented from following the roller *q* by the scraping surface of the scraper and spreader *z*, and be maintained by the lip *z'* at the proper thickness. The action is thus a formative one between the rollers *p* and *q*, these forming a spreading and holding action between the lip *z'* and the roller *p*. Finally, the powder strip is released from the roller *p* by means of the scraper *x*, the scraping surface of which contacts with the roller *p* beyond the point of action of the lip *z'*. This scraper *x* is also provided with a projecting lip *x'* to carry the powder fully clear of the scraper itself so that it will move or pass free from said scraper. The scraper *x* is held in operative position by the spring *y*.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:—

1. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, an open-ended receptacle for the material, a rotating carrying roller at the mouth of said receptacle, a rotating pressing roller mounted at the end of said receptacle, the material passing from said receptacle between said rollers, and a scraper and spreader, the scraper coacting with the pressing roller and the spreader extending beyond the pressing roller and coacting with the carrying roller.

2. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, mechanism adapted to take off the layer of material from said carrying roller and break it up, and pressure rollers, spaced apart the distance for the desired thickness of strip, between which said material, when removed from the carrying roller, is adapted to pass.

3. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, mechanism adapted to take off the material from said carrying roller, and pressure rollers, spaced apart the distance for the desired thickness of strip, between which said material, when removed from the carrying roller, is adapted to pass, and a spreading and scraping device in proximity to one pressure roller and a scraping device in proximity to the other pressure roller.

4. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, mechanism adapted to take off the material from said carrying roller, and pressure rollers, spaced apart the distance for the desired thickness of strip, between which said material, when removed from the carrying roller, is adapted to pass, and a scraping and pressing device in proximity to one pressure roller, the scraping portion thereof coacting with said roller and the spreading portion thereof coacting with the other pressure roller, and a scraping device coacting with the last mentioned roller beyond said spreader.

5. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, mechanism adapted to take off the material from said carrying roller, and pressure rollers, spaced apart the distance for the desired thickness of strip, between which said material, when removed from the carrying roller, is adapted to pass, and a scraping and pressing device in proximity to one pressure roller, the scraping portion thereof coacting with said roller and the spreading portion thereof coacting with the other pressure roller, and a scraping device coacting with the last mentioned roller beyond said spreader, said scraper having a projecting lip.

6. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, means to chill said layer while on said roller, mechanism adapted to take off the layer of material from said carrying roller and break it up, and pressure rollers, spaced apart the distance for the desired thickness of strip, between which said material, when removed from the carrying roller, is adapted to pass.

7. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, means to chill said layer while on said roller, mechanism adapted to take off the material from said carrying roller, and pressure rollers, spaced apart the distance for the desired thickness of strip, between which said material, when removed from the carrying roller, is adapted to pass, and a spreading and scraping device in proximity to one pressure roller and a scraping device in proximity to the other pressure roller

8. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, means to chill said layer while on said roller, mechanism adapted to take off the material from said carrying roller, and pressure rollers, spaced apart the distance for the desired thickness of strip, between which said material, when removed from the carrying roller, is adapted to pass, a scraping and pressing device in proximity to one pressure roller, the scraping portion thereof coacting with said roller and the spreading portion thereof coacting with the other pressure roller, and a scraping device coacting with the last mentioned roller beyond said spreader.

9. In an apparatus for solidifying crystallizable mixtures without substantial crystallization, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, means to chill said layer while on said roller, mechanism adapted to take off the material from

said carrying roller, and pressure rollers, spaced apart the distance for the desired thickness of strip, between which said material, when removed from the carrying roller, is adapted to pass, a scraping and pressing device in proximity to one pressure roller, the scraping portion thereof coacting with said roller and the spreading portion thereof coacting with the other pressure roller, and a scraping device coacting with the last mentioned roller beyond said spreader, said scraper having a projecting lip.

10. In an apparatus for forming powder strips, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, a pair of rollers revolving in opposite directions in proximity to said carrying roller for removing and breaking up the layer from said carrying roller, and a third roller coacting with the just mentioned rollers to compress the mass and form it into a sheet of the desired thickness.

11. In an apparatus for forming powder strips, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, means to cool the material on said carrying roller, a pair of rollers revolving in opposite directions in proximity to said carrying roller for removing and breaking up the layer from said carrying roller, and a third roller coacting with the first mentioned rollers to compress the mass and form it into a sheet of the desired thickness.

12. In an apparatus for forming powder strips, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, a roller, *o*, in proximity to the carrying roller and rotating in a direction opposite to that of the carrying roller, a roller, *q*, in proximity to the carrying roller and rotating in the same direction as the carrying roller, and a roller, *p*, interposed between the rollers *o* and *q* and revolving in a direction opposite to that of roller *q*, the said rollers *p* and *q* being spaced apart the desired thickness of the strip.

13. In an apparatus for forming powder strips, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, a roller, *o*, in proximity to the carrying roller and rotating in a direction opposite to that of the carrying roller, a roller, *q*, in proximity to the carrying roller and rotating in the same direction as the carrying roller, a roller, *p*, interposed between the rollers *o* and *p* and revolving in a direction opposite to that of roller *q*, the said rollers *p* and *q* being spaced apart the desired thickness of the strip, means to prevent the material on the carrying roller passing beyond roller *q*, means to prevent the material passing between rollers *o* and *p*, a scraper and spreader in proximity to roller *q*, a scraper in proximity to roller *p*, the scraper of the scraper and spreader coacting with roller *q* and the spreader of said device coacting with roller *p*, the scraper in proximity to roller *p* coacting with said roller *p* beyond the point of coaction of the spreader.

14. In an apparatus for forming powder strips, in combination, a rotating carrying roller, means to apply a layer of material to the surface of said roller, means to chill the material on said carrying roller, a roller, *o*, in proximity to the carrying roller and rotating in a direction opposite to that of the carrying roller, a roller, *q*, in proximity to the carrying roller and rotating in the same direction as the carrying roller, a roller, *p*, interposed between the rollers *o* and *q* and revolving in a direction opposite to that of roller *q*, the said rollers *p* and *q* being spaced apart the desired thickness of the strip, means to prevent the material on the carrying roller passing beyond roller *q*, means to prevent the material passing between rollers *o* and *p*, a scraper and spreader in proximity to roller *q*, a scraper in proximity to roller *p*, the scraper of the scraper and spreader coacting with roller *q* and the spreader of said device coacting with roller *p*, the scraper in proximity to roller *p* coacting with said roller *p* beyond the point of coaction of the spreader.

In testimony of which invention, I have hereunto set my hand, at Philadelphia, on this 23rd day of September, 1909.

FRANCIS I. DU PONT.

Witnesses:
M. M. HAMILTON,
A. M. URIAN.