Aug. 25, 1925. 1,551,257

A. D. LITTLE

METHOD OF AND APPARATUS FOR MOLDING PULP ARTICLES

Filed June 11, 1919 2 Sheets-Sheet 1

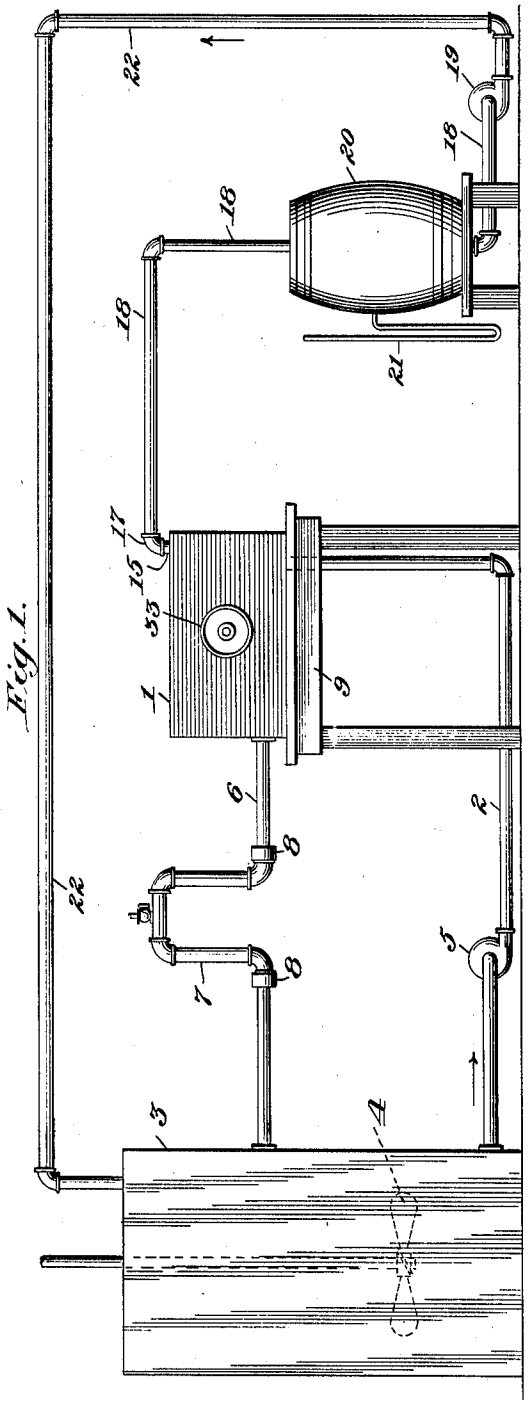

Fig. 1.

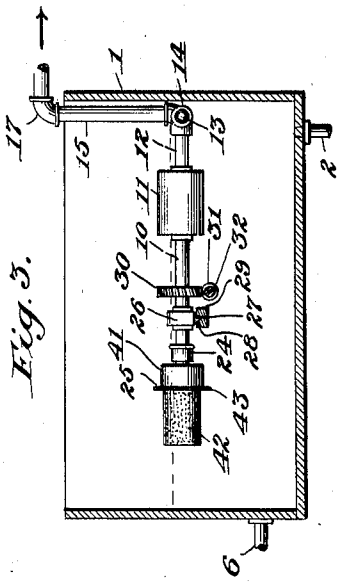

Fig. 3.

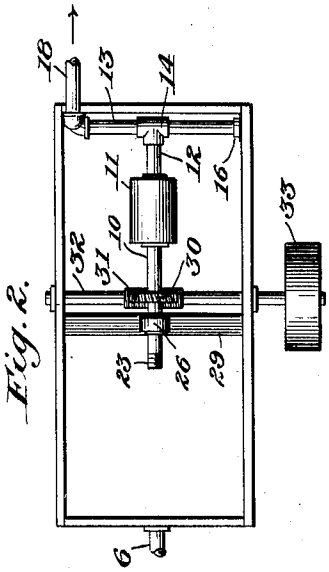

Fig. 2.

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Fig. 4.

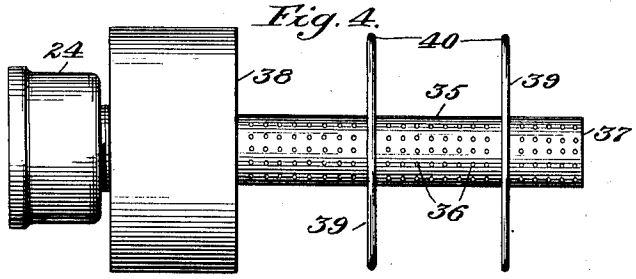


Fig. 5.

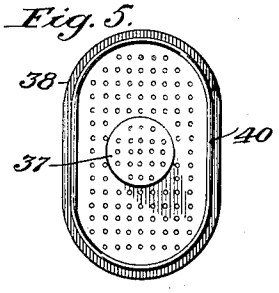


Fig. 6.

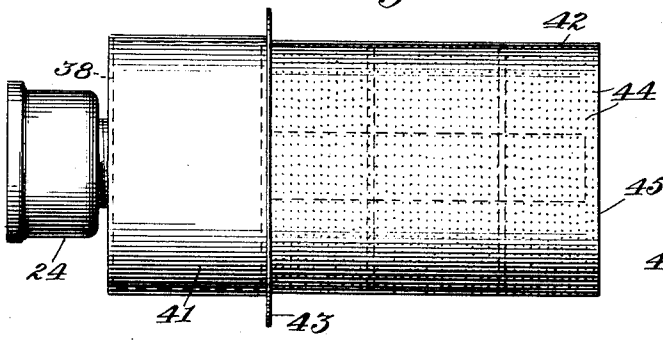


Fig. 7.

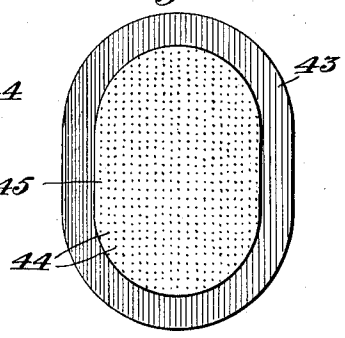


Fig. 8.

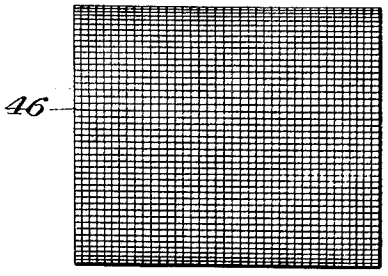


Fig. 9.

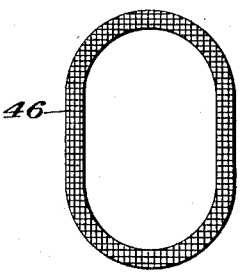
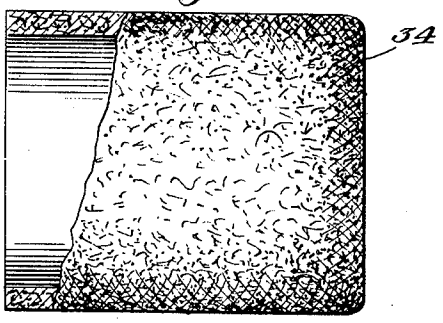


Fig. 10.



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Patented Aug. 25, 1925. 1,551,257

UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR MOLDING PULP ARTICLES.

Application filed June 11, 1919. Serial No. 303,291.

To all whom it may concern:

Be it known that I, ARTHUR D. LITTLE, a citizen of the United States, residing at Brookline, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Methods of and Apparatus for Molding Pulp Articles, of which the following is a specification.

This invention relates to methods of and apparatus for forming pulp articles and especially to the molding of articles from pulp-stock by a gradual building-up of the particles from a body of pulp onto a suitable form submerged in the pulp, to produce firm and dense articles suitable for many uses, such as pails, jars, mailing-tubes and containers for various commodities; in other words, fibre articles in general.

Briefly the invention contemplates a method of forming pulp articles by causing the particles from a body of stock of relatively low concentration to be forced onto a perforated form or mandrel submerged in the pulp, by suction applied within the form, alternately immersing the article in the course of molding in the pulp and exposing it above the same for predetermined intervals, without, however, admitting air into the article, and so regulating the suction applied on the interior of the mandrel, the concentration of the pulp, the speed of rotation of the form and article and the amount of surface of the latter exposed, that a gradual building-up and compacting of the particles over the form will occur and a pulp article of maximum density will be produced.

A preferred embodiment of apparatus suitable for carrying out the method comprises in general a vat for containing the fibre and water mixture a hollow, perforated mandrel capable of being submerged to any desired extent in the mixture (hereinafter designated as pulp), means for regulably applying suction to the inside of the mandrel or form, means for regulating the level of pulp and thereby the amount of surface of the article exposed, and means for replenishing the system with pulp to compensate for the fibre used up in the formation of the article.

Such an apparatus is illustrated in the accompanying drawings, wherein:

Fig. 1 is a diagrammatical side elevation of the system;

Fig. 2 is a plan view of the vat and its contained elements;

Fig. 3 is a vertical section of the vat and contained parts, portions of the same being shown in side elevation;

Fig. 4 is an elevation of the hollow perforated mandrel;

Fig. 5 is an end view of the mandrel;

Fig. 6 is an elevation of the perforated form into which the mandrel fits;

Fig. 7 is an end view of the form;

Fig. 8 is an elevation of a fine wire-cloth covering which in some cases may be employed with the perforated form shown in Figs. 6 and 7;

Fig. 9 is an end view of the wire-cloth covering; and

Fig. 10 is a side view, partly in section, of one style of article which may be molded according to my invention.

In the drawings, the numeral 1 indicates a vat of any suitable size or shape, connected by supply-pipe 2 with a stuff-chest or other pulp-reservoir 3, the latter being preferably equipped with agitating means 4 to insure uniformity in the consistency of the pulp. In the pipe-line 2, is inserted a pump 5 of any desired construction.

The vat 1 is also connected with the pulp-chest 3 by a second pipe 6 for return of pulp to the pulp-chest 3 as desired, and in order to regulate and maintain the level of the pulp in the vat, a U-bend 7 is provided in the pipe-line 6, such U-bend being revolubly connected to the sections of the pipe 6 by flexible couplings 8 of any suitable form. Thus by swinging the U-bend 7 about the pipe-sections 6 through the couplings 8, any desired height of pulp may be procured and maintained in the vat 1. The rotary joints 8 may be stiff enough to hold the bend 7 at any angle. The vat may rest of course on any convenient support 9.

Within the vat 1 and disposed lengthwise thereof is a pipe 10 rotatably connected through a suitable stuffing-box 11 and a short pipe-section 12 with a cross-pipe 13 at one end of the vat. By means of a

rotatable T-joint or the like, 14, the pipe 12 is so connected to the cross-pipe 13 that the former, and with it the stuffing-box 11 and pipe 10, can be swung upward about the pipe 13. A vertical pipe 15 leading to the top of the vat is connected to an open end of the cross-pipe 13 while the other end of said cross-pipe is mounted in a supporting bracket 16.

Through an elbow or other suitable coupling 17, the vertical pipe 15 is connected with a pipe-line 18 leading to a suction-pump or other vacuum-producing device 19, and a receiver 20, shown as a barrel, is interposed in the suction-line between the pump 19 and the vat 1. For measuring the degree of vacuum in the line, a suitable manometer 21 which may comprise the customary mercury-column is connected to the suction-line, conveniently at the receiver 20. A pipe-line 22 serves to return the water and any exhausted fiber to the pulp reservoir 3.

The end of the rotatable pipe 10 remote from the stuffing-box is provided with suitable means for receiving and holding a mandrel or form hereinafter referred to. As illustrated, this means comprises threads 23 upon which the screw-threaded female member 24 (Figs. 3, 4) of the mandrel 25 turns. The pipe or shaft 10 is supported near the mandrel in a bearing-sleeve 26, the under side whereof is provided with a point or the like 27 adapted to rest in a conical seat 28 of a cross-bar 29 secured athwart the vat preferably somewhat below its central horizontal plane.

To effect rotation of the mandrel, the pipe-shaft 10 is provided with a gear 30 adapted, when the parts are in operating position, as shown in Figs. 2 and 3, to engage with a worm 31 mounted on a cross-shaft 32 to which rotation is imparted by any suitable means through, for instance, a pulley 33.

The mandrel 25 may be made of any suitable material, preferably of tin-plate or similar metal, and its size and shape will depend upon the size and shape of the article to be molded. As shown in Figs. 4 and 5 by way of example, the mandrel is designed for the production of cylindroidal cups or receptacles 34, illustrated in Fig. 10. The hollow core or center 35 of the mandrel is provided with numerous small perforations 36, of say, $\frac{3}{32}$ in. diameter, along such length thereof as will be required by the length or depth of the article to be molded. Its outer end 37 is preferably likewise perforated. Near the opposite end the mandrel is formed or provided with an imperforate portion 38 and beyond this is affixed the coupling or connecting female member 24 hereinbefore described. Two or more encircling perforated supporting-plates 39, which may be reinforced peripherally by wire beadings 40, are fixed to the core 35 in parallel spaced relation.

As shown in Fig. 6, the portions of the mandrel except the coupling fit within an outer structure comprising an imperforate casing 41 which receives and envelopes the portion 38 of the mandrel, a perforated form 42 of the exact size and shape of the interior surface of the article to be molded, and an end-plate 43, in depth at least equal to the thickness of the article, fixed to the structure at the junction of the form 42 and the housing 41. The perforations 44 of the form depend somewhat for size upon the fiber being used, since they are intended to permit free passage of the liquid without allowing the fiber to be drawn through them when suction is applied to the interior of the mandrel. I have found that perforations having a diameter of approximately $\frac{1}{32}$ of an inch give satisfactory results with the usual fibers. When the article to be produced is to have a bottom, the end 45 of the form is also perforated, but if the article is to be open at both ends the outer end of the form 42 will be imperforate, of course. The structure shown in Figs. 6 and 7 is also preferably made of sheet tin or similar metal.

While in most cases its use is preferred, it is obvious that the mandrel may be dispensed with and the perforated form alone used. In such case the form must be made strong enough to withstand the pressure and the attaching end of the form will be supplied directly with the coupling for engagement with the end 23 of the pipe-shaft 10.

In some cases it has been found desirable to encase the perforated form with a fine-mesh wire-cloth cage upon which the fiber is sucked. Such a cage is illustrated at 46 in Figs. 8 and 9. It is adapted to slip lengthwise over the form 42 so that its inner end abuts against the flange 43. Since if this wire cage is used it determines the shape of the article being molded, it is virtually a part of the form and may be considered if used as included in the term "form" which is herein employed in its broad sense to cover any reticulated or perforated structure upon which the fibers are sucked to produce an article taking the shape of the perforated structure.

In carrying out the method with the apparatus described, a form is chosen according to the size and shape of the article which it is desired to mold and such form is attached, as through the instrumentality of the mandrel, to the pipe-shaft 10 which may be conveniently swung up for this purpose out of the vat 1 about the cross-pipe 13. The form is then let down into the vat so that the gear 30 meshes with the worm 31 and the point 27 beneath the bearing-collar 26

rests in the recess 28. Pulp is then run into the vat from the stock-chest 3 through pipe 2, by starting the pump 5, until the form is completely submerged. The height of the mixture in the vat is regulated by adjusting the U-bend 7 on the joints 8. Suction-pump 19 is then started and preferably, though not necessarily at this time, rotation is imparted to the shaft 32 and worm 31 to effect rotation of the form. The particles of fiber are thus sucked onto the form, the liquid passing through the perforations thereof and on through the suction line to the receiver 20 from which it is ultimately transferred by the circulating-pump 19 back to the reservoir 3. In this way a base or nucleus of fibre is soon deposited on the form. When this initial structure has been produced, the level of the pulp is lowered by manipulation of the bend 7 to such a degree that a portion of the surface of the article is exposed above the pulp. The exact amount of exposed surface depends upon several factors, including the size and shape of the mold, the density of the pulp-mixture, the speed of rotation and the degree of suction; but in every case these factors are so balanced that although every portion of the surface of the article passes out of the body of pulp during a portion of each revolution, an unbroken film of liquid persists entirely over such surface during exposure. By maintaining this unbroken film of liquid advantage is taken of the atmospheric pressure against the portion of the form exposed to the air to produce an exceedingly compact fibre structure without however permitting penetration by the air, which penetration if permitted to occur would lower the density of the article and render it less compact. Preferably at no state of the process does air enter the pores of the article.

While in the apparatus illustrated, the alternate immersion and exposure of successive portions of the article in the course of molding is shown by preference as effected through rotation of the partially submerged form in a regulated amount of pulp, it will be apparent that such alternate immersion and exposure may be brought about by other media, for instance by vertical reciprocation of the form.

The operation is continued until an article of the desired thickness is produced, whereupon the form is raised from the pulp and the article removed by hand or by any of the well-known automatic devices constructed for such purposes. If the article is automatically removed from the form, the immersing of the form may also be automatically effected.

When removed, the article is preferably subjected to compression to insure a more uniform density in the outer layers, and this may be effected by placing the article in a mold of rubber, for example, and applying a pressure of, say, twenty-five pounds to the outside of the mold.

The described conditions may vary considerably. In general, however, it is better to operate with pulp of low concentration, a relatively low speed of rotation and with from one-third to one-half of the article being molded exposed above the level of the body of pulp in the vat. In operations which I have conducted, I have found, for example, that pulp-concentrations of from 0.005% to 0.2% with a speed of revolution of approximately thirty R. P. M. gave articles of very uniform density.

In the course of the formation of the article, the suction varies; in the operation referred to above, merely by way of example, the suction at the start is about eight inches of mercury and increases by degrees as molding proceeds to about twenty.

Obviously the specific conditions of operation will vary somewhat according to the material used, the character of article to be molded and possibly other factors, so it is to be understood that I do not intend to limit the scope of my invention by the special conditions given above merely by way of illustration. Almost any fiber may be built up into articles by the use of the process and apparatus described, and the concentration of the pulp may vary within fairly wide limits. As the fiber is removed from the pulp by the formation of the article, more fiber is supplied to the system to compensate therefor.

It will also be obvious that articles of almost any shape may be produced, whether cylindrical, cylindroidal, parallelepipedal, etc., and even flat or curved plates can thus be molded.

I claim:

1. The process of forming articles from pulp or similar material, which consists in immersing a perforated form in a mass of pulp mixture of relatively low concentration and applying negative pressure to the interior of the form to cause an initial deposit to be formed, then alternately immersing and exposing the surface of the body formed and regulating the extent of exposure and the density of the pulp mixture while maintaining the negative pressure.

2. The process of forming articles from pulp or similar material, which consists in immersing a perforated form in a mass of pulp mixture of relatively low concentration and applying negative pressure to the interior of the form to cause an initial deposit to be formed, revolving the form and the deposit thereon while maintaining the negative pressure and regulating the level of the pulp mixture to expose a predetermined portion of the surface of the body formed.

3. The process of forming articles from pulp or similar material, which consists in immersing a perforated form in a mass of pulp mixture of relatively low concentration and applying negative pressure to the interior of the form to cause an initial deposit to be formed, revolving the form and the deposit thereon while maintaining the negative pressure, regulating the level of the pulp mixture to expose a predetermined portion of the surface of the body formed and maintaining the pulp mixture at a substantially uniform density.

4. Apparatus for forming articles from pulp or similar material, comprising a receptacle for the pulp mixture, a hollow perforated form, means for maintaining negative pressure in the interior of the form, means operative to cause an alternate immersion and exposure of successive portions of the surface of the form and the body deposited thereon, and means for controlling the relative extent of immersion and exposure.

5. Apparatus for forming articles from pulp or similar material, comprising a receptacle for the pulp mixture, a hollow perforated form, means for maintaining negative pressure in the interior of the form, means operative to cause an alternate immersion and exposure of successive portions of the surface of the form and the body deposited thereon, and means for controlling the level of the pulp mixture.

6. Apparatus for forming articles from pulp or similar material, comprising a receptacle for the pulp, a hollow perforated form adapted to be immersed in the pulp, means for applying suction to the form to cause the solid material of the pulp to build up on said form to produce an article, means for regulating the depth of immersion of the article in the pulp to expose a predetermined amount of surface of the article above the pulp, and means for rotating the article to alternately immerse and expose successive portions of the surface of the article being formed.

7. Apparatus for forming articles from pulp or similar material, comprising a vat for the pulp, a hollow perforated form adapted to be immersed in the pulp, means for applying suction to the form to cause the solid material of the pulp to build up on said form to produce an article, means for varying the level of pulp in said vat to completely or partially submerge the article being formed, and means for rotating the article when the same is partially submerged to alternately immerse and expose successive portions of the surface of the article.

8. Apparatus for forming articles from pulp or similar material, comprising a vat for the pulp, a rotatable perforated mandrel horizontally disposed in said vat, a perforated form on said mandrel, means for applying suction to the inside of said mandrel to cause the solid material of the pulp to build up on said form to produce an article, means for regulating the depth of immersion of the article in the pulp to expose a predetermined amount of surface of the article above the pulp, and means for rotating said mandrel and therefore the article being formed to alternately immerse and expose successive portions of the surface of the article.

9. Apparatus for forming articles from pulp or similar material, comprising a vat for the pulp, a rotatable perforated mandrel horizontally disposed in said vat, a perforated form on said mandrel, means for applying suction to the inside of said mandrel to cause the solid material of the pulp to build up on said form to produce an article, means for varying the level of pulp in said vat to completely or partially submerge the article being formed, and means for rotating said mandrel and therefore the article being formed when the same is partially submerged to alternately immerse and expose successive portions of the surface of such article.

In testimony whereof, I affix my signature.

ARTHUR D. LITTLE.