This invention involves machines and methods for forming a multi-layer, die-molded, pulp article, such as a plate, dish or other container, and is distinguished from prior multi-layer formation machines and methods in that in my present invention the formation process is an intermittent rather than a continuously rotary forming process.

Broadly, my present invention contemplates an intermittent formation method and machine whereby multi-layer articles having the desired characteristics may be economically produced in commercial quantities.

More specifically, my present invention involves an intermittent formation method and machine whereby multi-layer articles having the desired characteristics may be produced under such positively controlled conditions of pulp deposit as to cause the successive pulp deposits constituting the article to be interlabeled and interlocked with each other as a practically homogeneous integrated article, the relative depths and penetrative interlock of such successive deposits constituting the interlocked layers of the integral article being so controlled as to permit the article structure to be varied as required by changing commercial specifications or other conditions.

These and various other features of advantages which will appear more fully hereinafter, are attained by the machine and method constituting the subject matter of my present invention. The construction and operation of such machine and the manner of practicing my method are described and illustrated in the accompanying specification and drawings and the characteristic features of novelty are particularly pointed out in the appended claims.

In the drawings I have shown rather diagrammatically a form of apparatus for the practice of my method which I have found highly satisfactory under actual service conditions. Such apparatus is purposely shown schematic in order to avoid obscuring the underlying broad principles of my invention by details of machine construction not really necessary to a complete understanding of the fundamentals of my invention.

In such drawings:

Fig. 1 is a vertical section through a forming die and associated parts and showing the relative positions of the parts at which may be regarded as an intermediate stage of the molding cycle.

Fig. 2 is a similar view showing a modification, and

Figs. 3 to 10 inclusive are vertical sections showing the relative positions of the apparatus illustrated in Fig. 1 at successive stages in the molding cycle.

I have indicated at 1 a forming die and at 2 a receiving die onto which the article formed on the forming die is adapted to be transferred for subsequent treatment. For the purposes of this application, however, the die 2 may be regarded simply as a holding or receiving die to take the formed article from the forming die.

The dies 1 and 2 are adapted to be moved in properly timed relation to each other by means of any suitable motion transmitting connections (not shown). As contemplated herein, such movement is an intermittent movement, the forming die 1 reciprocating in the cylinder 3 during the forming process and the receiving die 2 at the proper time moving towards and pausing opposite the die 1 in order to permit the formed article on said forming die to be transferred therefrom.

Thus the movement of the die 2 is also an intermittent movement, but in so far as the fundamental principles of molding are concerned, such intermittent movement of the die 2 may be either a sliding rectilinear motion or such die may rotate intermittently through an orbit which is intersected by the line of reciprocation of the forming die 1, the transfer die 2 pausing when aligned with the die 1 for the purpose of permitting transfer of the formed article from the die 1 to the die 2, and after such transfer has taken place, continuing its travel whereby to carry the formed article to some other station where it is subjected to further treatment, as for example, a drying treatment.

The forming die 1 is of usual construction in so far as its pulp molding surface is con-
cerned, that is to say, such surface is foraminous, being either a perforated surface as shown in Fig. 1, or a simple wire screen of suitable mesh.

The forming die 1 fits within the cylinder 3 as a piston, being provided with a hollow plunger or stem 4 by means of which it may be reciprocated in said cylinder and through which suction is maintained in any suitable manner.

The cylinder is stationarily mounted on a suitable base 5 which also constitutes a support for a fixed pulp tank 6 enclosing said cylinder and having intermittent communication therewith through an annular series of inlet ports 7 formed in the cylinder wall and controlled by the position of the forming die 1 which thus acts as a slide valve to open or close said ports.

The materials which are to constitute the several deposits or layers of the composite article are admitted under conditions of proper control through inlet pipes 8 and 9 discharging, respectively, into the pulp tank and cylinder.

The tank 6 is formed as at 10 to permit overflow into an overflow pipe 12 controlled by a manually adjustable gate 11 which may conveniently be a simple slide valve adjustable within the tank to open or close said overflow outlet 10. The inlet of stock into the tank through pipe 8 is continuous and in sufficient volume to maintain an overflow at 12 irrespective of the position or timing of the forming die 1, and the overflow outlet 10 is of such dimension relative to the rate of inlet as to maintain a substantially constant pulp level in the tank 6 at all times and in all positions of the forming die.

For the purposes of this application, the material inlet pipe 8 to the tank 6 may be considered as supplying a relatively inexpensive stock, such as ground wood pulp, which constitutes the main body portion of the article, and the inlet pipe 9 into the cylinder 3 may be considered as supplying a higher grade lining stock, such as chemical pulp, which may or may not be bleached, and which forms the lining for the body stock introduced through the pipe 8.

The admission of the lining stock into the cylinder through pipe 9 is controlled by any suitable valve 13 operating in properly timed relation to the movement of the forming die through any suitable motion transmitting connections, of which a portion thereof is indicated at 14.

The tank 6 is adapted continuously to be supplied with the low grade body-forming material B through pipe 8, such material as is not needed for the forming operation overflowing through port 10 into the overflow pipe 12, and the valve 13 controlling the admission of the high grade lining stock L through pipe 9 to the cylinder 3 is adapted periodically to be opened to admit a predetermined charge of such lining stock to the cylinder.

The formation cycle is detailed in Figs. 3 to 10 and is as follows:

Referring first to Fig. 3, I have simply shown a starting position which for the purposes of illustration may be considered as largely theoretical.

In this figure, therefore, the tank and cylinder are empty and the forming die is bare.

The forming die 1 first moves to the position of Fig. 4, in which position it blocks the ports 7 which connect cylinder 3 with tank 6 and thus prevents the low-grade body stock B from pipe 8 which is continuously being supplied to the tank from entering said cylinder. At this time, the valve 13 is automatically opened and a predetermined charge of the high grade lining stock L is admitted through pipe 9 into cylinder 3, depositing as a layer of predetermined depth on the forming face of the die 1 whereupon said valve immediately closes.

The die 1 remains in the position of Fig. 4 for a sufficient time to allow the lining stock L either partially or wholly, as desired, to drain and form such layer on the die (Fig. 5). Where intereting of such lining layer with the body layer is wanted, drainage is not completed before the body stock is admitted, the die 1 moving to the position of Fig. 6, in which position the ports 7 are uncovered, to admit a charge of the low-grade body stock B into the cylinder 3 from the tank 6 while the lining layer is still draining. Such body stock therefore merges or interterls with the lining stock left in the cylinder and not yet completely deposited on the die 1. Under such circumstances, the formation process is continuous, starting immediately after the admission of the lining stock and continuing until all of the body stock is deposited on the forming die, so that at the time that the ground wood body stock is admitted and while it is merging with the undeposited lining stock, the formation process is going on, thus insuring good interfeting of the two deposits. Where it is not necessary to have interfeting the lining stock may be allowed entirely to drain before the body stock is admitted, the layers being simply secured together by adhesion, which adhesion may be augmented if desired by subsequent treatment, as by pressure and heat.

In either case the forming die thereafter moves to the position of Fig. 7. This is a completely draining position, the body stock draining through the die while the die is in this position until draining is completed so that the layer of body stock, of the desired thickness, is merged with the lining layer on the die (Fig. 8). The degree of thickness is accurately controllable by simply varying
the time in which the ports 7 are uncovered and by varying the level of the stock in the tank 6, through adjustment of the gate 11.

The forming die then moves to the position of Fig. 9 which is the transfer position for the now formed article. At this time the receiving die 2 has moved into alignment with the forming die in order to receive the formed article and has paused in such position to permit the transfer of the formed article thereto.

As the dies 1 and 2 separate (Fig. 10) the formed article A is deposited on the receiving die for subsequent treatment, as a drying treatment in the further travel of the receiving die, and the forming die repeats its cycle.

The low grade body stock B admitted into the cylinder 3 below the die 1 through the ports 7 while said die is in the positions of Figs. 7, 8, 9 and 10 is circulated through ports 6' near the bottom of the cylinder as the die 1 is raised or lowered.

When the body stock is admitted into the cylinder, an agitation and mixing of the same occurs with the undeposited lining stock therein, resulting in a desirable interfacing or interlacing action between the two kinds of stock so that they are interlocked with each other as a practically homogeneous article.

The actual transfer of the formed article from the forming die to the transfer die may be accomplished by shutting off the suction to the forming die 1 at substantially the moment that the two dies are in contact with each other and sending a blast of compressed air against the under surface of the forming die 1 whereby to dislodge the formed article therefrom.

In order to remove any air which may be entrained with the water of suspension on the forming die, I may arrange an air pipe 17 within the lower stem 4 of the forming die. In operation, the drain pipe 4 is emptied of the water therein between each formation cycle. At the start of a formation cycle, vacuum is applied to the pipe 17. Such vacuum immediately withdraws the air from underneath the forming die and also all air in pipe 4 above the check valve 4', said check valve being held securely closed by said vacuum.

During the formation period, all entrapped air in the pulp stock or which may be underneath the die is removed through pipe 17, the upper open end of said pipe having a cap 18 thereon which so shields it as to prevent any water from entering said pipe and being withdrawn with the air.

The water of formation discharges by gravity down the pipe 4 and lays against the trap at the check valve 4'. This condition continues until the time of transfer of the article from the die 1 to the die 2 at which time the vacuum is cut from the pipe 17 and a blast of air sent through said pipe. This blast of air performs the double function of transferring the article to the receiving die 9 and adding pressure to the water in the pipe 4 so as to blow it out through the check valve 4' and free the pipe of water.

The transfer die 2 may also be provided with a suction connection indicated at 16 by means of which the transferred article will be held thereon after the dies separate.

In the modification shown in Fig. 2 the inlet pipes 19 and 20 are both provided with control valves 21 and 22 respectively, which through suitable operating connections, a portion of which is indicated at 23 and 24 are opened and closed in properly-timed relation to each other so as to admit into the cylinder 3 predetermined charges of body and lining stocks.

The formation cycle in this embodiment of my invention is generally similar to that detailed in Figs. 3 et seq., the lining stock being first admitted through pipe 20 and draining as a layer on the forming die, after which the body layer is admitted through pipe 19 onto said lining layer and allowed to drain and merge therewith.

The forming die is then moved up to the receiving die 2 which is now aligned with and paused opposite to the forming die and the formed article transferred thereto.

In the embodiment of Fig. 2, however, the tank 6, ports 7 and overflow 12 have been replaced by the valve 21 controlling pipe 19.

While I have described the article as composed of a body stock and a lining stock of different grades, it will be understood that this treatment is purely for purposes of disclosure, and that I may admit through the pipes 8 and 9 or 19 and 20 any materials which are capable of being united to form a composite article. Such union of the several deposits may be obtained by interfacing or by adhesion, due to subsequent processing, as by drying under pressure and high temperatures.

Similarly it will be understood that while I have referred to the article so formed as a multi-layer article, such term is to be construed in its looser sense, since the several pulp deposits may not be separate and distinct layers, but may be so merged with each other as to show no definite line of demarcation between successive deposits.

In other words, the resultant article may not be a layered article at all, except in so far as differences in color or fibre characteristics may be detected in the different depths of the interlocked fibre deposits constituting the article.

Various other modifications in the machine and method may obviously be made within the spirit and scope of my invention as defined by the appended claims.
What I therefore claim and desire to secure by Letters Patent is:—

1. The die and cylinder formation method which consists in successively depositing upon a foraminous forming die intermittently movable within said cylinder aqueous pulp solutions of different characteristics and in such relation to each other and to the movement of the die that during the movement of said die in said cylinder the second pulp solution is imposed upon said first solution before said first solution is completely deposited whereby to form a substantially integral article on said die, and in finally moving said forming die into a position in which the formed article may be removed therefrom.

2. The tank, die and cylinder formation method which consists in successively depositing upon a foraminous forming die intermittently movable within said cylinder aqueous pulp solutions of different characteristic and in such relation to each other and to the movement of the die that said second solution is interfelted with said first solution before said first solution is completely deposited whereby to form a substantially integral article on said die, in controlling the admission of said second solution into said cylinder from said tank by the movement of said die in said cylinder, and in finally moving said forming die into a position in which the formed article may be removed therefrom.

3. The tank, die and cylinder formation method which consists in depositing upon a foraminous die intermittently movable within said cylinder an aqueous pulp solution while admitting into a tank enclosing such cylinder a second solution of different fibre characteristic, in moving said die in said cylinder to admit said second solution into said cylinder for deposit on said die before said first solution is completely deposited whereby to interfelt the two solutions as a substantially integral article, and in finally moving said forming die into a position in which the formed article may be removed therefrom.

4. In pulp molding apparatus, a tank having a supply and an overflow for an aqueous pulp solution, a cylinder within said tank having a port opening into said tank, a timed supply for delivering an aqueous pulp solution of different characteristic to said cylinder, a forming die movable in said cylinder and acting as a slide valve to close and open said port and receiving a predetermined charge from said pulp supply to said cylinder and in another position uncovering said port to permit a predetermined charge of pulp solution from said tank to be imposed upon said first deposit and interfelt thereupon closing said port and receiving a predetermined charge from said pulp supply to said cylinder in another position uncovering said port and receiving a predetermined charge from said pulp supply to said cylinder and in another position uncovering said port to permit a predetermined charge of pulp solution from said tank to be imposed upon said first deposit and interfelt

5. In pulp molding apparatus, a tank having a supply and an overflow for an aqueous pulp solution, a cylinder within said tank having a port opening into said tank, a timed supply for delivering an aqueous pulp solution of different characteristic to said cylinder, a forming die movable in said cylinder and acting as a slide valve to close and open said port, said die in one position closing said port and receiving a predetermined charge from said pulp supply to said cylinder and in another position uncovering said port to permit a predetermined charge of pulp solution from said tank to be imposed upon said first deposit and interfelt
ent connection whereby suction may be maintained on said die during the formation process and whereby entrapped air beneath said die may be partially withdrawn during the formation process, said withdrawing means also constituting an air blast connection whereby the formed article may be dislodged from said forming die at the end of the formation process.

8. In pulp molding apparatus, a base, a tank mounted on said base, a pipe for continuously supplying an aqueous pulp solution to said tank, a cylinder within said tank having a port opening into said tank, a timed supply for delivering an aqueous pulp solution of different characteristic into the upper end of said cylinder, and a forming die movable in said cylinder and acting as a slide valve to close and open said port, said die in one position closing said port and receiving a predetermined charge from said pulp supply to said cylinder and in another position uncovering said port to permit a predetermined charge of pulp solution from said tank to be imposed upon said first deposit and interlaid therewith before said first solution is completely deposited upon said die.

9. In pulp molding apparatus, a cylinder, a forming die movable therein, and means whereby independent aqueous pulp solutions may be introduced into said cylinder in such relation to each other that the second solution interlaid with the first solution on said die before said first solution is completely deposited.

10. In pulp molding apparatus, a tank, a cylinder therein, and having a port adapted to communicate with said tank, a forming die movable in said cylinder and acting as a slide valve to cover and uncover said port, and means whereby independent aqueous pulp solutions may be introduced into said tank and cylinder in such relation to each other that the second solution interlaid with the first solution on said die before said first solution is completely deposited.

11. In pulp molding apparatus, a tank, a cylinder therein and having a port adapted to communicate with said tank, a forming die movable within said cylinder and acting as a slide valve to cover and uncover said port, and independent deliveries to said tank and cylinder for supplying independent aqueous pulp solutions thereto in such relation to each other that the second solution interlaid with the first solution on said die before said first solution is completely deposited.

12. In pulp molding apparatus, a cylinder, a forming die movable therein, means for independently admitting into said cylinder for deposit on said die aqueous pulp solutions of different characteristics in such relation to each other that the second solution interlaid with the first solution on said die before said first solution is completely deposited, means whereby said forming die may be moved into a position in which the formed article may be removed therefrom, and means whereby suction may be maintained on said die while said deposits are forming thereon.

13. In pulp molding apparatus, a cylinder, a forming die movable therein, means for independently admitting into said cylinder for deposit on said die successive aqueous pulp solutions of different characteristics in such relation to each other that the second solution interlaid with the first solution on said die before said first solution is completely deposited, means whereby said forming die may be moved into a position in which the formed article may be removed therefrom, and means whereby suction may be maintained on said die while said deposits are forming thereon and the entrapped air beneath said die partially withdrawn during the formation process.

14. In pulp molding apparatus, a cylinder, a forming die movable therein, means for independently admitting into said cylinder for deposit on said die successive aqueous pulp solutions of different characteristics in such relation to each other that the second solution interlaid with the first solution on said die before said first solution is completely deposited, means whereby said forming die may be moved into a position in which the formed article may be removed therefrom, means whereby said die may be drained of the water of suspension, and means independent of said drainage means whereby suction may be maintained in said die while said deposits are forming thereon and the entrapped air beneath said die partially withdrawn during formation process.

15. In pulp molding apparatus, a cylinder, a forming die movable therein, means for independently admitting into said cylinder for deposit on said die successive aqueous pulp solutions of different characteristics in such relation to each other that the second solution interlaid with the first solution on said die before said first solution is completely deposited, means whereby said forming die may be moved into a position in which the formed article may be removed therefrom, and the entrapped air beneath said die partially withdrawn during the formation process, said last-named means also constituting an air blast connection whereby the formed article may be dislodged by air blast.
from said forming die at the end of the formation process.

16. In pulp molding apparatus, a tank, a cylinder within said tank, said tank and cylinder having a port connecting the same, a piston movable within said cylinder and covering and uncovering said port, a supply pipe to said tank and a supply pipe to said cylinder, said pipes supplying independent aqueous pulp solutions of different characteristics, and a valve controlling said supply pipe to the cylinder and operating in timed relation to the movement of the die in said cylinder.

17. In pulp molding apparatus, a cylinder, a die moving therein, a pulp supply for delivering an aqueous pulp solution into said cylinder in one position of said die, a pulp supply for delivering a second aqueous pulp solution of different characteristic into said cylinder and onto said first deposit in another position of said die whereby ultimately to form with said first deposit a substantially integral article on said die, and means for subsequently removing the article thus formed from said die.

18. In the intermittent formation method of producing an integral molded pulp article from successive deposits of aqueous pulp solutions of different fibre characteristic which utilizes as the formation apparatus a tank, a cylinder adapted to communicate therewith, and a foraminous forming or suction die intermittently movable in said cylinder and controlling the communication between said tank and cylinder, those steps which consist in admitting into the tank a first pulp solution, in moving the forming die into position to prevent entry of such solution from the tank into the cylinder, in depositing upon the forming die while in said blocking position a second pulp solution, in thereafter moving the die to a non-blocking position whereby to admit a charge of the first solution from said tank to said cylinder for deposit on top of said second solution, and in finally moving said die to a transfer position wherein the now formed article may be removed from the die.

19. In the intermittent formation method of producing an integral molded pulp article from successive deposits of aqueous pulp solutions of different fibre characteristic which utilizes as the formation apparatus a tank, a cylinder adapted to communicate therewith, and a foraminous forming or suction die intermittently movable in said cylinder and controlling the communication between said tank and cylinder, those steps which consist in admitting into the tank a first pulp solution, in moving the forming die into position to block entry of such solution from the tank into the cylinder, in depositing upon the forming die while in said blocking position a second pulp solution, in maintaining the die in such blocking position for a time sufficient to allow said second solution to partially or wholly drain, in thereafter moving the die to a non-blocking position whereby to admit a charge of the first solution from said tank to said cylinder for deposit on said second solution, in thereafter moving the die to a position wherein said first solution will drain and be merged with the second solution already deposited upon the die, and in finally moving said die to a transfer position wherein the now formed article may be removed from the die.

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