Dec. 17, 1946. P. H. GOLDSMITH 2,412,771

METHOD OF MAKING PAPER ON CYLINDER MOLD TYPE PAPER MACHINES

Filed Sept. 27, 1938 2 Sheets-Sheet 1

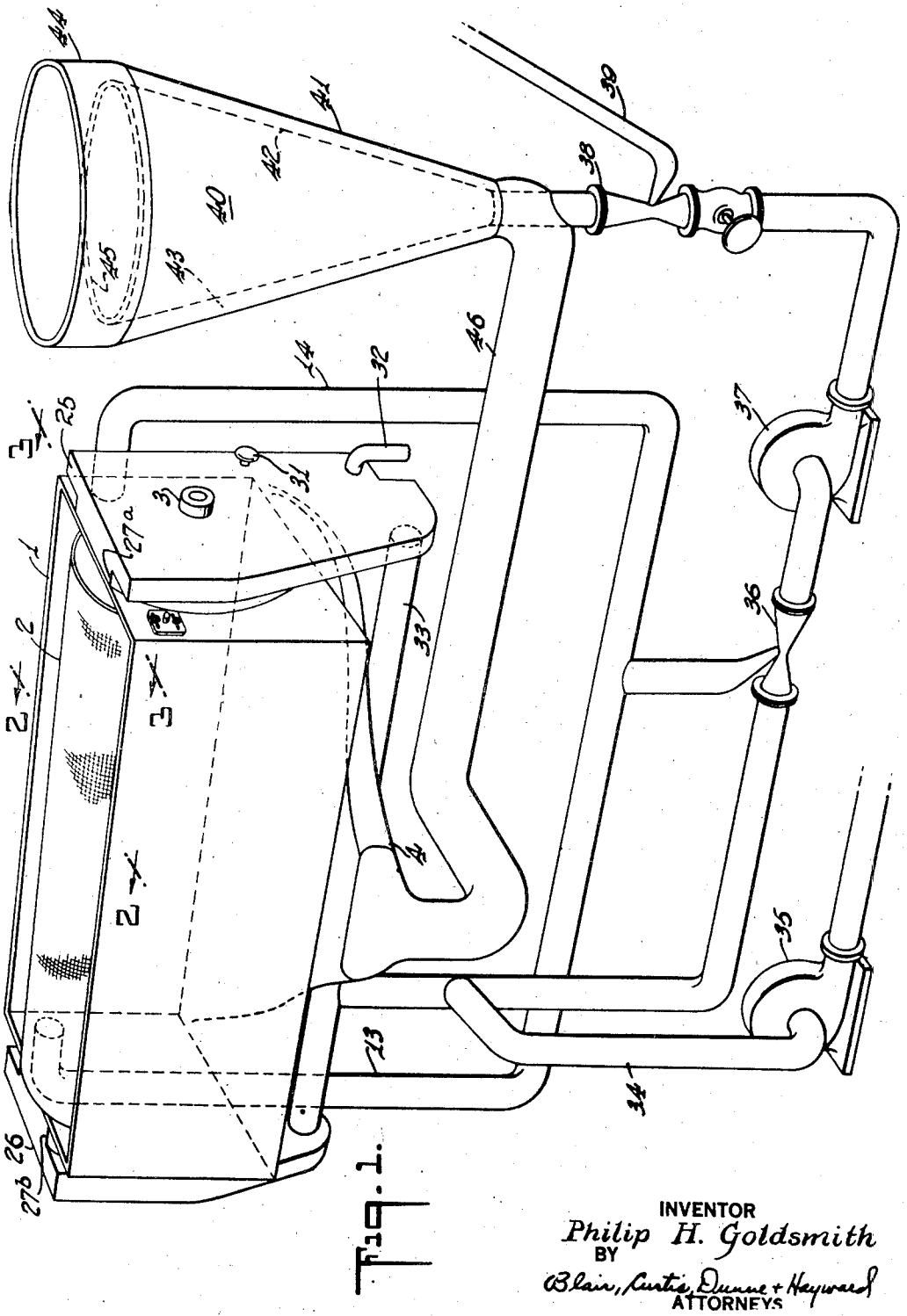


Fig. 1.

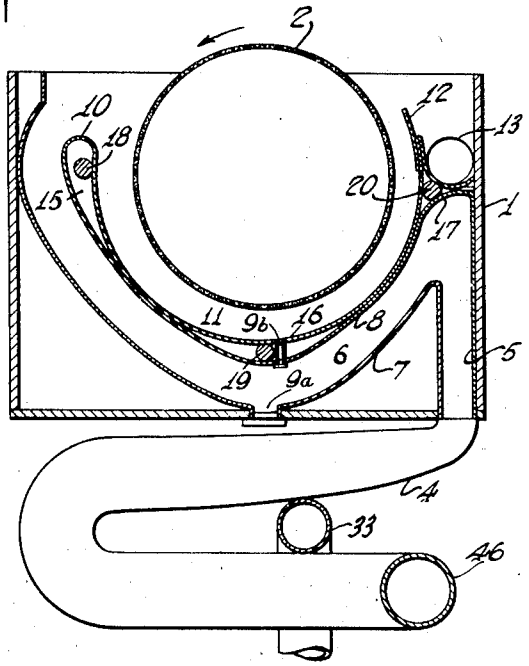
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Fig. 2.



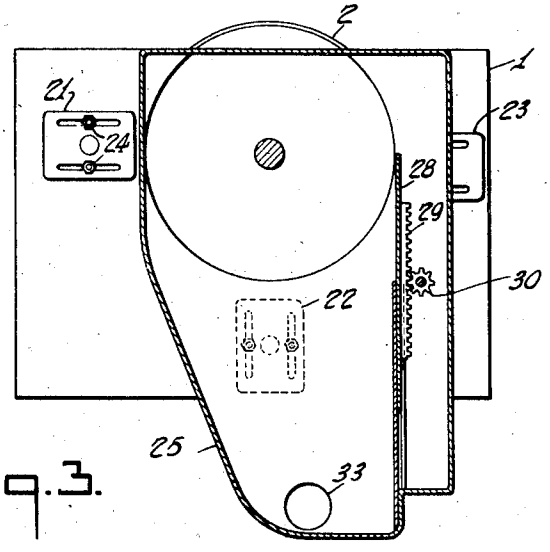


Fig. 3.

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METHOD OF MAKING PAPER ON CYLINDER MOLD TYPE PAPER MACHINES

Philip H. Goldsmith, New Rochelle, N. Y.

Application September 27, 1938, Serial No. 231,854

1 Claim. (Cl. 92—38)

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This invention relates to the art of paper making and more particularly to cylinder paper machines of the type commonly used for manufacturing the heavier grades of paper, such as paper board and the like. My Patents Nos. 2,393,244, 2,354,007, and 2,363,786 resulted from divisional applications based upon the present application.

A cylinder paper machine consists of one or more vats, each equipped with a foraminous rotatable cylinder mold which rotates in a roughly semi-cylindrical compartment located within the vat, the wall of the compartment being known as the vat circle. A paper stock is caused to flow between the surface of the cylinder mold and the vat circle through what is known as the vat circle space, and the water from the stock passes through the foraminous surface of the rotating cylinder mold, the fibers being retained on the surface to form a continuous web which is removed near the top of the cylinder mold onto an endless felt belt. Water from the interior of the cylinder, known as whitewater, is removed at both ends of the cylinder. On multi-cylinder machines the same felt usually picks up the web from several cylinder molds to form a composite sheet. Since it is frequently desirable to make the different plies of the sheet of different materials and different thicknesses, each vat is ordinarily equipped with its own stock supply system and is really a separate machine.

There are many types of vats known in the art, each suitable for a particular grade of paper board under individual conditions of speed, nature of raw material, and requirements of products. The two types of vats most widely used heretofore may be referred to for the purpose of this description as the counterflow type of vat and the overflow type of vat. In the counterflow vat stock is fed to the upturning side of the cylinder mold and flows in a direction contrary to the direction of rotation of the cylinder mold. Such a vat normally operates without recirculation of stock. In the overflow type of vat the stock is supplied to the downturning side of the cylinder mold and flows in the same direction as the surface of the mold. In vats of this type a portion of the stock is usually removed at a point beyond the cylinder and recirculated. The present invention is described as applied to an overflow type of vat, although as the description proceeds it will be readily apparent that by a few minor changes the invention may equally well be applied to a counterflow type vat.

The present invention provides a method and means for obtaining more uniform formation of the fibers on the surface of the cylinder mold and for generally improving the physical characteristics of the web. The characteristics of the web are affected by many factors, among which might be mentioned stock velocity ratio, that is, the ratio of the mean velocity of the stock flowing through

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the vat circle space to the peripheral speed of the cylinder mold; homogeneity of the stock supplied to the vat circle space; uniformity of stock velocity across the width of the machine; and the extent to which the flow of stock approaches theoretically perfect streamline flow. The stock velocity ratio has an important bearing on the relation between the tensile strength of the sheet in the machine direction and the cross-tensile strength. As the stock velocity ratio increases in an overflow vat the cross-tensile strength of the sheet improves at the expense of the tensile strength in the machine direction. In order to obtain the desired degree of uniformity, it is desirable to maintain the stock velocity ratio constant, and since formation takes place all the way around the vat circle the quantity of stock flowing is constantly being reduced and optimum stock velocity ratios can be attained only by suitably reducing the cross-sectional area of the vat circle space. Furthermore, since the rate of flow of water through the cylinder mold and the quantity of circulating flow are substantially independent of each other, the optimum rate of decrease in the cross-sectional area of the vat circle space will vary with the quantity of circulating flow. Hence, for best results the vat circle should be made adjustable.

Previous attempts to make the vat circle adjustable have not been completely satisfactory because of the fact that it is difficult to prevent leakage of stock at the vat ends. As a result, there has been costly leakage of valuable stock, or, if the circle fitted tightly to the vat ends, it was difficult to use the adjustment because of binding. To overcome this difficulty water pressure chambers have been tried, but these have resulted in even more serious operating difficulties. If a water seal is used the water pressure must be maintained at a higher value than that existing within the vat circle space, and hence there will be some leakage of water into the vat circle space. This water dilutes the stock near the vat ends, thus making the edges of the sheet lighter than the central portion with the result that the sheet is not only of uneven weight but has a tendency to tear very easily on the machine.

In the present invention complete adjustability is attained and substantially all leakage is prevented by the use of a double circle vat. The stock upon entering the vat passes between an outer rigid vat circle and an inner adjustable vat circle before reaching the inner vat circle space. Since the consistency of the stock is substantially the same in both the inner vat circle space and the outer vat circle space, leakage at the ends of the inner vat circle will result in no change in the composition of the stock. Furthermore, since the pressure difference between inner and outer vat circle spaces is negligible, there will be very little leakage. Ample clearances may be al-

lowed between the inner vat circle and the vat ends to permit the adjustments to function easily.

The homogeneity of the stock supplied to the vat has not heretofore received the consideration to which it is entitled. The common practice has been to mix the incoming fresh stock, the recirculated stock and the whitewater in an open top rectangular headbox. Each of the three components is normally introduced into the headbox through a separate pipe line, and it has been assumed that the natural turbulence resulting from such a procedure would produce adequate mixing. However, this is not accomplished under present-day operating conditions. Pockets of different consistency stocks are formed in the corners of the headbox, and this segregation causes streaks of uneven consistencies of stock to pass through the underfeed pipe and cause irregularities in the sheet. These irregularities produce blemishes in the formation, irregular caliper and finish across the sheet, and numerous operating troubles.

The present invention provides an improved type of mixing device comprising a Venturi-shaped fitting through which one component of the stock flows while a second component of the stock is introduced at the neck of the venturi where the velocity is highest. It has been found that the most thorough and intimate mixture is obtained by joining two streams of flow in such a manner that their cross-sectional areas are small and their velocities high at the point of mixing, and hence the diameters of both pipes are reduced at the point of joining. The mixing is accomplished before the stock reaches the headbox, and hence does not interfere with the proper functions of the headbox which are the maintenance of a constant flow level and the elimination of air or other gaseous materials from the stock.

Owing to the present tendency in the art to use wider machines and also higher rates of flow, the problem of obtaining proper approach flow has become increasingly important. One of the most important features of the present invention is the improved approach flow obtained. It has heretofore been the practice to attempt to obtain smooth and uniform flow by passing the stock over or under baffles just before it reaches the vat circle space. While baffles of this type reduce turbulence to some extent, they are introduced too late in the process to accomplish best results. They bring with them other evils, such as segregation of stock into uneven consistencies, flocculation of fibers into bunches, and a generally disturbed formation, and make proper "washing up" of the vat more difficult. They must be regarded in the nature of one evil which is used to counteract another.

The machine of the present invention is designed to minimize turbulence at a number of critical points in the process. The mixing of the various components of stock is completed before the stock reaches the headbox, and an upflow headbox is provided. This enables the stock to flow smoothly over the dam of the headbox, and thus the elimination of air is more complete than in the conventional type headbox wherein the extreme turbulence of mixing serves to increase the air content of the stock. The stock is spread to the full machine width by means of a flow spreader having a constant or slightly decreasing cross-sectional area and makes a full pass in the machine direction before entering the inner vat circle space. In this way eddy currents are substantially eliminated and uniform stock velocity across the width of the vat is obtained.

Apparatus capable of carrying out the method of the present invention is shown in the accompanying drawings in which:

Figure 1 is a diagrammatic view of the cylinder machine in perspective;

Figure 2 is a cross-section of the vat and flow spreader taken on the line 2—2 of Figure 1; and

Figure 3 is a view of the vat end showing the whitewater compartment in section taken on the line 3—3 of Figure 1.

Referring to the drawings, and more particularly to Figure 1, there is shown a vat of generally rectangular shape indicated at 1 and containing a foraminous cylinder mold 2 rotatably supported by the bearings 3, only one of which is shown. The mechanism for rotating the cylinder mold forms no part of the present invention and hence is not shown. Stock is supplied to the vat 1 through a flow spreader 4, which as noted above is of such shape and cross-sectional area as to spread the flow of stock to the full machine width with substantially no change or with a slight increase in stock velocity. Upon entering the vat 1, the stock passes through a conduit 5 (see Figure 2) to the outer vat circle space 6 which is formed by an outer vat circle 7 of generally cylindrical contour, and an inner vat circle 8 of similar contour, the vat circle 7 being rigidly secured to the vat ends and the vat circle 8 adjustably secured to the vat ends in a manner more fully described hereinafter. The vat circles 7 and 8 are constructed of sheet metal, preferably of copper, in order that the desired degree of flexibility may be obtained. A washout connection 9a is provided near the bottom of the vat circle 7 and a similar washout connection 9b is provided near the bottom of the vat circle 8 to facilitate cleaning of the vat circle spaces when it is necessary to change the type of stock supplied to the machine in order to produce a different type of paper board. From the vat circle space 6, the stock flows over the smoothly curved upper end 10 of vat circle 8 into the inner vat circle 11. The curved surface 10 is analogous to the making boards of the vats known to the prior art and may be so described.

As the stock passes through the inner vat circle space 11, the cylinder mold 2 rotates in a counterclockwise direction, as shown, and a portion of the water from the stock passes through the foraminous surface of the cylinder mold forming a web of fibers on the surface of the mold, which is removed near the top of the mold after it has emerged from the stock. The water passing through the surface of the mold, known in the art as whitewater, is removed in a manner which will be described later. The excess stock from the vat circle space 11 passes over an adjustable dam 12 and leaves the vat through the pipe lines 13 and 14 (best shown in Figure 1) to be recirculated in a manner hereinafter described.

The inner vat circle 8 is fabricated in such a manner as to be supported by three adjusting bars 18, 19, and 20, preferably of tubular cross-section. These adjusting bars are covered on both sides by the sheet metal forming the inner vat circle so that both of the vat circle spaces are completely streamlined and no obstruction is presented to the flow of stock. The adjusting bars are in turn supported by a series of movable plates 21, 22, and 23 located at the vat ends (best shown in Figure 3). Adjustment of the

clearance between the vat circle 8 and the periphery of the cylinder mold is accomplished by loosening the bolts 24 which hold the movable plates in position and moving the plates in the desired direction. Normally the adjustable bar 18 will be positioned further from the periphery of the cylinder mold 2 than will the bar 20, and the bar 19 will be positioned at an intermediate distance from the cylinder mold in order to form a vat circle space having a decreasing cross-sectional area which will compensate for decreases in the quantity of stock due to water flowing through the surface of the mold.

The water which flows through the surface of the cylinder mold is removed at the end of the mold and flows into two whitewater compartments 25 and 26 at the vat ends, the compartments being separated from the vat ends by the spacer rings 27*a* and 27*b*. Suitable seals should be provided at the ends of the cylinder mold 2 to prevent stock in the vat circle space 11 from flowing into the interior of the cylinder mold. Such seals are well-known in the art and hence are not shown in detail. As shown in Figure 3, the whitewater compartments contain an adjustable dam having a rack 29 rigidly attached thereto. Raising and lowering of the dam is accomplished by rotation of the pinion 30, which in turn is actuated by rotation of a knob 31 located on the outside of the whitewater compartment. The portion of the whitewater which overflows the dam 28 is the excess whitewater and flows out of the whitewater compartment through a line 32 which leads to a suitable point of disposal. The remainder of the whitewater, constituting the major portion thereof, is pumped by means of the whitewater pump from the whitewater compartment through the line 33, whence it is again divided, one portion flowing through the line 34 and pump 35 to the screen or screens (not shown), where it is used as a diluent, and a second portion flowing to a Venturi-shaped mixing device 36. In the mixing device 36 the whitewater is thoroughly mixed with the recirculated stock coming from the lines 13 and 14. The recirculated stock is introduced at the most restricted portion of the mixer and hence at the point where the whitewater velocity is a maximum, thus insuring adequate mixing of the two components. From the mixer 36 stock passes through pump 37 to a second mixing device 38 of similar design where fresh incoming stock from the screens (not shown) is introduced through the line 39.

Stock from the mixing device 38 passes to a conical upflow headbox 40 comprising an outer inverted cone 41 and an inner inverted cone 42 concentric therewith and forming an annular space 43. The outer cone 41 is provided at its top with a short cylindrical section 44. If desired, the inner cone 42 may also be provided with a cylindrical section which may be made adjustable in height. It is desirable that the dimensions of the cones 41 and 42 be such that at the top of the inner cone the annular area between the two cones approximately equal the cross-sectional area of the inner cone. Stock flows upwardly through the inner cone 42 at a constantly decreasing velocity, passes over the dam 45 formed by the upper edge of the cone 42 and flows downwardly through the annular space 43 at a constantly increasing rate. Because of the upward direction of flow of the incoming stock and the relatively low stock velocity at the dam 45, headbox 40 is well-adapted to remove air and other gaseous materials from the stock and improve the smoothness of flow. Furthermore, variations in the rate of flow of stock will cause only relatively small turbulence or changes in the liquid level in the headbox because of the large overflow area of the dam 45 and the large area of the free liquid surface. It is to be noted that this type of headbox has no dead corners where stock segregation can occur and is much easier to "wash up" than the usual type of headbox.

From the annular space 43 stock flows through an underfeed supply pipe 46 which is preferably of a relatively large size and thence to the flow spreader 4 and the vat 1.

The machine of the present invention makes possible the production of a paper board having a substantially greater uniformity than was heretofore possible. The double circle vat enables the machine operator to control the stock velocity ratio in such a manner as to obtain the formation characteristics desired, uniform fiber deposition around the vat circle, and further provides a full pass in the machine direction to iron out minor irregularities in the flow of stock before the stock reaches the forming surface of the cylinder mold. The relative machine and cross tear and tensile tests, for example, can be varied at will between wide limits and the optimum stock velocity can be obtained at every point around the vat circle. Positive, rapid, and complete mixing of the various components of the stock is insured by the Venturi-shaped mixing devices, and this mixing takes place at a point remote from the forming surface. The upflow headbox insures proper elimination of air from the stock and the flow spreader spreads the flow to the full width of the machine with no sudden changes in stock velocity to produce unnecessary turbulence at this critical point in the process. Thus when the stock finally reaches the forming surface, eddy currents have been substantially eliminated and the flow of stock approaches theoretical streamline flow much more closely than has heretofore been possible.

Since many embodiments might be made of the above invention, and since many changes might be made in the embodiment above disclosed, it is to be understood that all matter hereinbefore set forth is to be interpreted as illustrative only and not in a limiting sense.

I claim:

In the art of manufacturing paper, paper board and the like by means of the cylinder mold type machine, that improvement which includes the steps of: mixing components of paper stock and whitewater by injecting one of the components into the other at a point where one component is at a maximum velocity; pumping the mixed stock upwardly with progressively decreasing velocity and increasing cross-sectional area to a quiescent, free stock surface; flowing the stock across the free surface and then downwardly by gravity from the free surface with progressively increasing velocity and decreasing cross-sectional area; spreading the stock with streamline flow to form a smoothly-flowing ribbon of stock of a width approximating the width of the paper forming cylinder; supplying the ribbon of stock to the cylinder; maintaining at a constant value around the cylinder a given ratio of mean velocity of stock to peripheral speed of the cylinder; removing the paper product from the cylinder; and removing whitewater and excess paper stock from the cylinder and recirculating them.

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