Dec. 21, 1954 R. F. HOLLIS 2,697,661

DIGESTION OF PULP

Filed July 31, 1946

FIG. 1.

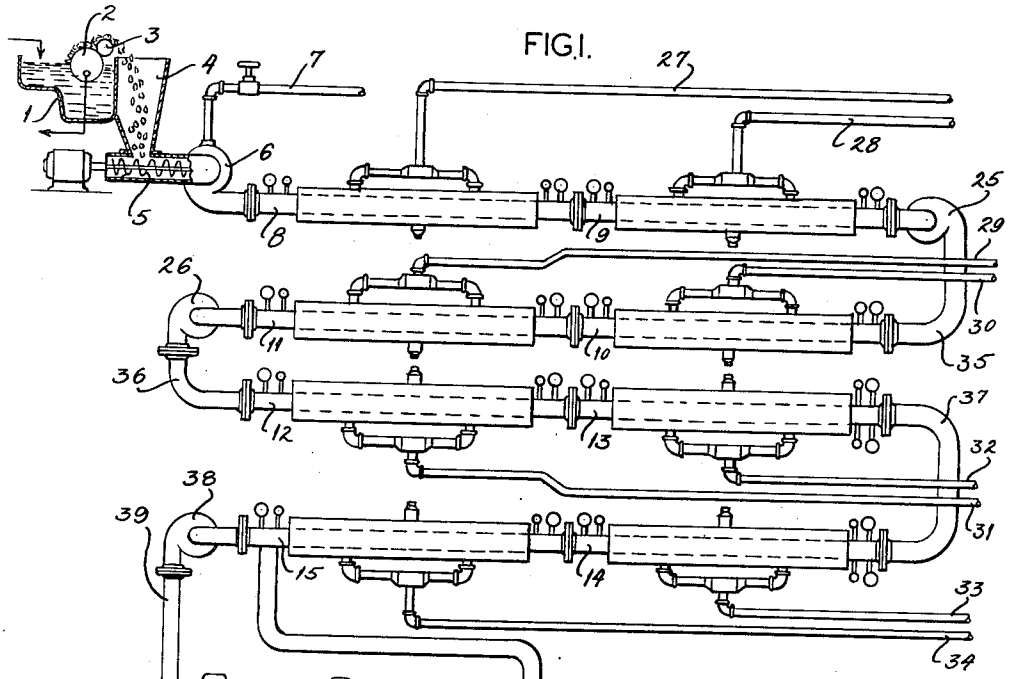
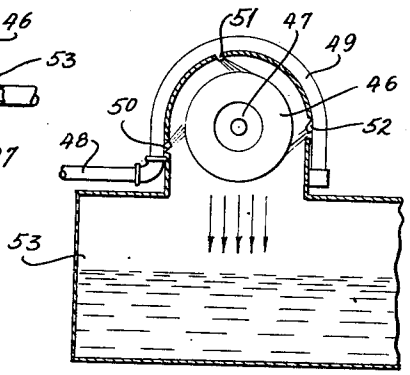


FIG. 2.



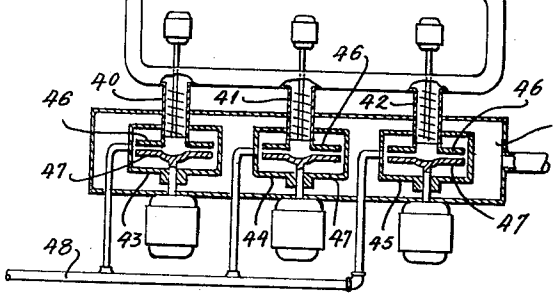
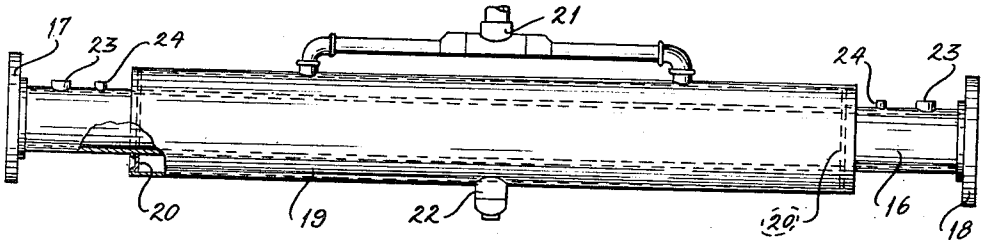


FIG. 3.



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DIGESTION OF PULP

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2 Claims. (Cl. 92—1.4)

This invention relates generally to the treatment of pulp for the manufacture of paper and has particular reference to the treatment of pulp for the manufacture of cardboard, boxboard, and the like.

In the manufacture of cardboard and boxboard, the paper stock for some or all of the lamina is frequently made from waste paper, used boxboard, and other paper scrap. These materials are more often than not contaminated with gum, asphalt, glue, rubber, or other non-cellulosic materials. The presence of these contaminants in the raw material is readily discerned in the finished board (made according to the usual process) where the contaminants appear as specks and globs, which not only detract from the appearance of the finished board, but deleteriously affect its physical properties.

The stock, whether waste or virgin, from which the paper lamina of boxboard and cardboard has been made heretofore, has necessitated careful control to maintain the solids content thereof not substantially above four percent by weight, the balance being water, sometimes with dissolved chemicals. Higher consistencies were deemed impossible to pump through the pipe lines. Such control involves pulping the raw material to produce stock having a very low consistency, dewatering in a decker to raise the solids content to about 4%, and thereupon the stock is delivered to a refining engine of any of a variety of types with or without an intervening batch digesting treatment. The low consistency of the stock requires deckers, digesters, and refiners of sufficient capacity to handle the great volume of liquid. For example, to deliver a given weight of cellulosic solids at consistency of 4%, requires equipment having twice the capacity that would be necessary if the stock were at a consistency of 8%.

The temperature at which the stock at a consistency of about 4% has heretofore been pumped through the tube lines has heretofore been on the order of 80°–120° F. I have discovered, however, that, if the temperature of the stock be elevated, greater consistencies than 4% may be readily pumped through tube lines. In seeking an explanation of this phenomenon, I have discovered that the Stormer viscosity of high consistency stock is reduced by elevation of temperature though measurement of viscosity by other standard methods does not provide any positive indication of such a change. For example, the viscosity of 4% stock at 80° F. is greater than that of 6% stock at 200° F. according to a Stormer method of measuring viscosities.

The object of the present invention, generally stated, is to provide a continuous process of digesting paper stock.

A further object of the invention is to provide a process and apparatus for the treatment of paper stock which minimizes the water content required to be handled.

Other objects of the invention will become apparent from the following description when read in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a continuous pulp digester constructed in accordance with the present invention;

Figure 2 is a sectional view taken along the line 2—2 of Figure 1, showing in detail a modification of a conventional refining engine as contemplated by the present invention; and

Figure 3 is a detail view of a single tube section, of which a plurality is shown in Figure 1.

In accordance with the present invention, any suitable

cellulosic raw material, such as waste paper, scrap boxboard, straw (wheat, oat, clover, soybean), swamp grass, cornstalks, etc., may be formed into a pulp containing from six to eleven percent by weight of cellulosic solids, balance water, with or without the usual chemical additives. Such high consistency stock is subjected to concurrent heat and pressure. The range of temperatures contemplated is from 200° F. to 450° F., it being understood that the higher temperatures are attained gradually as the stock advances from stage to stage of the process, all without permitting the pressure on the stock to reduce to a point where general boiling of the water will take place.

The concurrent heat and pressure treatment of the high consistency stock is preferably accomplished continuously as distinguished from by batches. The invention contemplates an elongated confined path, such as a circuitous line of tubes individually jacketed to receive steam under controlled pressure so as to heat the stock within the tubes without, however, condensing steam in the stock. Individually jacketed tubes enable nice control of the temperature at each stage so that, by utilizing steam at progressively higher pressures from the first to the last of the jacketed tubes, the temperature may progressively increase from stage to stage.

Where the series of tubes constituting the elongated confined path is on the order of thirty-five to fifty feet and the maximum temperature to which the stock is subjected does not greatly exceed 200° F., two pumps, arranged one at the entry and the other at the delivery end of the tube system, provide adequate force to move the stock. In cases where longer tube systems amounting to a hundred feet or more are necessary to elevate the stock to the higher range of temperatures, it is desirable to interpose additional pumps between the tube runs, the number and spacing of which will depend upon the character of stock, the size of the tubes, the rate of flow, the type and number of turns, and other factors peculiar to each installation, the criterion being to provide enough pumps not only to move the stock through the system, but also to maintain sufficient pressure on the stock at all times that it is kept in a liquid state. Localized boiling at the interface between the stock and the wall of the confining tube is, however, not necessarily to be avoided and in fact it is postulated that the ease of pumping the high consistency stock may be attributable to the violent reaction of increments of the stock contacting the highly heated tube wall (which, with steam at 140 pounds per square inch pressure, might have a temperature as high as 350° F.) whether or not incremental boiling takes place at the interface.

It is advantageous that the elongated confined path be serpentine rather than rectilinear in form. The former not only admits of banking the tubes, but it also appears that the turning of the dense stock at the bends in the tube system contributes to the effectiveness of the treatment.

After the stock has undergone the heat and pressure treatment during its travel through the elongated confined path, the treated stock is delivered to a refining engine of any suitable type, such as a Jordan, Claflin, or other well known type of engine. While the invention is not limited thereto, it is advantageous to maintain the stock under superatmospheric pressure until it emerges from the refining engine. Refining engines of the Sprout-Waldron type are especially adapted to use where it is preferred to maintain the pressure on the stock and deliver it to the refining engine under pressure.

From the refining engine the stock is fed to the paper machines in the usual manner.

Referring now to the drawings for an illustrative embodiment of the invention, the paper stock, after having been pulped and riffled in the usual manner, is fed at a consistency of 1% or 2% to a dewatering apparatus 1, such as the usual decker employed in paper mills. Such a decker includes a drum 2 and cooperating roll 3. The drum 2 lifts the stock from a bath in which the drum is partially submerged and the partially dewatered stock is lifted from the drum 2 by roll 3. In accordance with the present invention, the low density stock fed into the decker 1 is dewatered to an extent such that the stock

emerging from roll 3 has a consistency of at least 6% and preferably on the order of 9% to 10%, which is to say that the stock contains the indicated percentage of cellulosic solids by weight.

From the decker 1, the high consistency stock is delivered to a hopper 4, from which it is advanced by a screw conveyor 5 to a pump 6. The pump 6 is provided with a water inlet 7, which may be utilized when and if necessary to slightly dilute the stock when fouling conditions are encountered. The pump 6 is diagrammatically shown as of the central intake centrifugally operating type, but it will be understood that other types of pumps may be utilized.

The pump 6 discharges the dense stock into an elongated confined path consisting, in the embodiment shown, of a plurality of jacketed tubes 8, 9, 10, 11, 12, 13, 14, and 15, connected in series. Said jacketed tubes are of identical construction and are shown more in detail in Figure 3, to which reference may now be had. Each of the jacketed tubes consists of a central tubular member 16, to the respective ends of which connecting flanges 17 and 18 are secured, as by welding or in any other manner, but preferably so as to avoid the presence of interiorly projecting obstructions. About the mid-section of tubular member 16, a cylinder jacket 19 is provided. The jacket 19 extends for almost the full length of tubular member 16 and, where it is not necessary to provide gauges and control apparatus extending directly from tubular member 16 to the exterior, the jacket 19 may extend the full length of tubular member 16. The interspace between tubular member 16 and jacket 19 is closed at each end of the latter by an annular plate 20, which may be welded in position so as to seal the interspace. The jacket 19 is provided with a conduit 21 for delivering steam to the interior of the jacket. In the embodiment shown, the conduit 21 is branched so as to deliver steam at widely separated zones within the jacket. Where the steam being admitted to the jacket is under high pressure, it is recommended that suitable baffles be provided adjacent the orifices through which steam is admitted to the jacket. A suitable trap 22, from which condensate may be bled from the jacket, is provided. Tubular member 16 is preferably provided with connections 23 and 24 at one or both ends thereof for the reception of instruments for controlling or indicating the temperature and pressure of the stock within tubular member 16.

The tubular members 8 to 15, inclusive, are connected together in series, with one or more pumps intervening in spaced relation, by means of their connecting flanges 17 and 18, above described, so as to provide a tube-line as free of internal obstructions as possible.

In the embodiment shown, a pump 25 is interposed between jacketed tubes 9 and 10; and a pump 26 is interposed between jacketed tubes 11 and 12, but it will be understood that, depending upon the factors hereinbefore indicated, the number of pumps employed in any particular installation may be varied above or below the showing of the drawings.

In the embodiment shown, each of the jacketed tubes is provided with a separate steam supply line. Lines 27, 28, 29, 30, 31, 32, 33, and 34 supply jacketed tubes 8, 9, 10, 11, 12, 13, 14, and 15, respectively. The invention contemplates that each of the steam supply lines conveys to its corresponding jacketed tube steam at different pressure, preferably increasing from jacketed tube 8 to jacketed tube 15, so as to accomplish a progressively increasing temperature as the stock advances from stage to stage. If desired, a plurality of the tubes may be supplied with steam at the same pressure, a plurality of other tubes with steam at a higher pressure, etc.

In the embodiment shown, the jacketed tubes are arranged in pairs and the direction of flow of the stock is reversed between each succeeding pair, such reversal being accomplished by the pump 25 and its adjunct elbow 35, the pump 26 and its adjunct elbow 36, and the U-turn 37. Frequent reversal of the direction of flow of the stock is advantageous.

At the delivery end of jacketed tube 15, a pump 38 is provided for drawing the stock from the series of jacketed tubes and discharging it into a reentrant tube 39, the opposite end of which is connected with jacketed tube 15, so that a recirculating, continuously flowing system is provided about pump 38.

From tube 39 a plurality of mechanically controlled bleeders 40, 41, and 42, of which any number may be

provided, are arranged for delivering the treated stock to refining engines 43, 44, and 45 respectively. In the embodiment shown, the bleeders 40, 41, and 42 each comprises an enclosed screw, which is turned by external mechanical means, such as an electric motor individually controlled, whereby to separately regulate the rate of flow of stock from tube 39 to the refining engines 43, 44, and 45, respectively.

In the embodiment shown in the drawings, the refining engines 43, 44, and 45 are of the Sprout-Waldron type, which consists essentially of a centrally apertured stationary plate 46, through the central aperture of which the stock is admitted to the engine. Arranged in coaxial relation with the plate 46 is a concave rotatably driven plate 47, the operation being that, as the plate 47 is rotated, the stock is thrown centrifugally outward through the constriction defined by the outer peripheries of the plates 46 and 47. In view of the fact that the present invention contemplates the handling of unusually dense stock and that the temperature thereof may be somewhat elevated by the friction encountered at the constriction between plates 46 and 47, it is contemplated that the housing which encloses the plates 46 and 47 be provided with jets for spraying water upon the stock as it emerges from between plates 46 and 47, thereby to concurrently cool and dilute the stock. Such an arrangement may take the form of a water supply line 48 having a bustle 49 with a plurality of nozzles 50, 51, and 52 arranged on the interior of the casing surrounding plates 46 and 47.

From the refining engines, the stock is discharged into a chest 53, from which the paper machines are fed.

It will be noted in particular that, from the time the dense stock is injected into pump 6, to the time of its discharge from refining engines 43, 44, and 45, pressure above atmospheric is maintained upon the stock. Such pressure is provided by the pumps 6, 25, 26, and 38 and is regulated in degree so as to accomplish a continuous movement of the dense stock through the series of tubes without at any time permitting the pressure on the stock to descend to a point such that boiling of the stock will occur.

In Figure 1 of the drawings, the elongated confined path consisting of the series of jacketed tubes, the intervening pumps, and turns typifies an arrangement suitable for elevating the temperature of the stock on the order of 300° to 400° F. Fewer jacketed tubes, pumps, and turns may, however, be utilized with advantage particularly when the high temperature of treatment just indicated is not desired. For example, a battery of two such jacketed tubes, each approximately twenty feet in length, connected by a U-turn comparable to 37, and energized by a pump at the entrance end and a pump at the delivery end of the series of two tubes, is adequate to elevate the temperature of the stock from about 120° F. at hopper 4 to about 212° F. at the delivery end. Such a system has been operated with stock at consistencies ranging from 6% to 10% where the tubular members 16 had an inside diameter of six inches at the flow rate of 220 gallons of stock per minute.

In a typical test of the apparatus just referred to, the stock was delivered by the decker at a consistency of 9.7% and a temperature of 120° F. with a Williams freeness of 61 seconds. After being passed through the digester composed of the two tubes above referred to, heated with steam under 140 pounds per square inch pressure, and, while maintaining the stock under between 30 and 15 pounds per square inch gauge pressure (sufficient to move the stock through the line), the stock as delivered from the series of tubes had a temperature of 212° F. with a Williams freeness of 116 seconds. The base of the stock in this case was waste corrugated boxes.

With the two-tube digester operating under the conditions just described, the stock treated thereby was delivered to an 8-cylinder board machine which had been running 0.16 inch caliper by 67 pounds per thousand square feet test liner board, the eighth cylinder being furnished with high grade kraft beaten and refined in the normal manner and the other seven cylinders being furnished with waste corrugated box stock beaten and refined in the usual manner. The two-tube digester operating as aforesaid supplied about 75% to 80% of the stock required to supply the seven cylinders last mentioned. When the stock treated in accordance with the present invention appeared at the head box (said

stock having been previously contaminated with lampblack for identification), the paper machine continued in operation as previously, but within a short time thereafter it was observed that the stock treated in accordance with the present invention was exhibiting a better freeness than that previously experienced and consequently appropriate adjustment in the pump suctions and other mechanical changes, necessitated by an increased freeness, were made. It was further noted that the board produced from stock treated in accordance with the present invention dropped to 62 pounds per thousand square feet, as compared to the previous 67 pounds. This required adjustments to bring the board weight back to about 64 pounds, but enabled an increase in the speed of the paper machine from a previous 360 feet per minute to approximately 380 feet per minute. Drying of the formed sheet is accomplished more readily with stock treated in accordance with the present invention than with stock from the same source (waste corrugated boxes) treated in accordance with the previous practice, enabling a reduction in the steam pressure on the paper machine driers from 29 to 26 pounds per square inch.

While the board resulting from the stock originally used had a Mullen test value of 85 average, treatment of the stock in accordance with the present invention resulted in an increase in the Mullen test value to 90–92 average. It was also noted that the board resulting from stock treated in accordance with the present invention was more leathery, that its bending qualities were improved, its resistance to cracking far superior to that resulting from the original stock, and its tearing resistance increased. Whereas, in the board produced from the original stock, the asphalt, gum, rubber, and comparable contaminants always present in waste paper appeared as substantial globs in the finished board, board produced from stock treated in accordance with the present invention was free of such globs, the contaminants apparently being dispersed and exhibiting themselves only as minute specks. It is noted especially that, the greater the consistency of the stock treated in accordance with the present invention, the better the aforesaid results, other things being equal.

While in the foregoing disclosure and in the operations referred to therein, the digestion of the stock was accomplished without chemical additives, it is readily apparent that the provision of pumps intervening the several stages of the elongated confined path provides a ready means of injection into the stock of such chemicals as may be deemed desirable under certain circumstances.

While the foregoing disclosures have particular reference to the treatment of stock made from waste paper, it may be pointed out that the process and apparatus are equally applicable to the digestion of stock produced from virgin raw materials. The latter may be shredded while dry or substantially dry, wet down with enough water to produce a stock containing on the order of 10% or more of solids, and then pumped through the elongated confined path under concurrent heat and pressure, with the addition of the chemicals usually employed for digesting such virgin stock injected at the several stages of the digestion process.

From the foregoing description, those skilled in the art should readily understand the construction, operation, and advantages of the present invention and realize that

it accomplishes its objects aforesaid. While a complete disclosure of one embodiment with suggested modifications has been given merely for the purpose of illustrating the invention, it is not to be understood that the invention is limited to the details of such disclosure. On the contrary, it is realized that those skilled in the art will envision many modifications and variations not herein suggested. The latter are contemplated by the invention and within the scope of the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In the art of making paperboard from waste paper containing asphaltic contaminants, the process of dispersing the asphaltic contaminants as minute specks comprising, preparing an aqueous stock from waste paper containing asphaltic contaminants, thickening the stock to a consistency of at least 6%, heating the thickened stock to a temperature in the range of 200°–450° F. while maintaining a pressure thereon sufficient to maintain the water in the stock liquid, mechanically working the stock while under such temperature and pressure, and chilling the stock immediately as it emerges from such mechanical working.

2. In the art of making paperboard from waste paper containing asphaltic contaminants, the process of dispersing the asphaltic contaminants as minute specks comprising, preparing an aqueous stock from waste paper containing asphaltic contaminants, thickening the stock to a consistency of at least 6%, heating the thickened stock to a temperature in the range of 200°–450° F. while maintaining a pressure thereon sufficient to maintain the water in the stock liquid, mechanically working the stock while under such temperature pressure, and substantially concomitantly releasing the stock from pressure and chilling the same.

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