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PAPER MAKING METHOD AND APPARATUS

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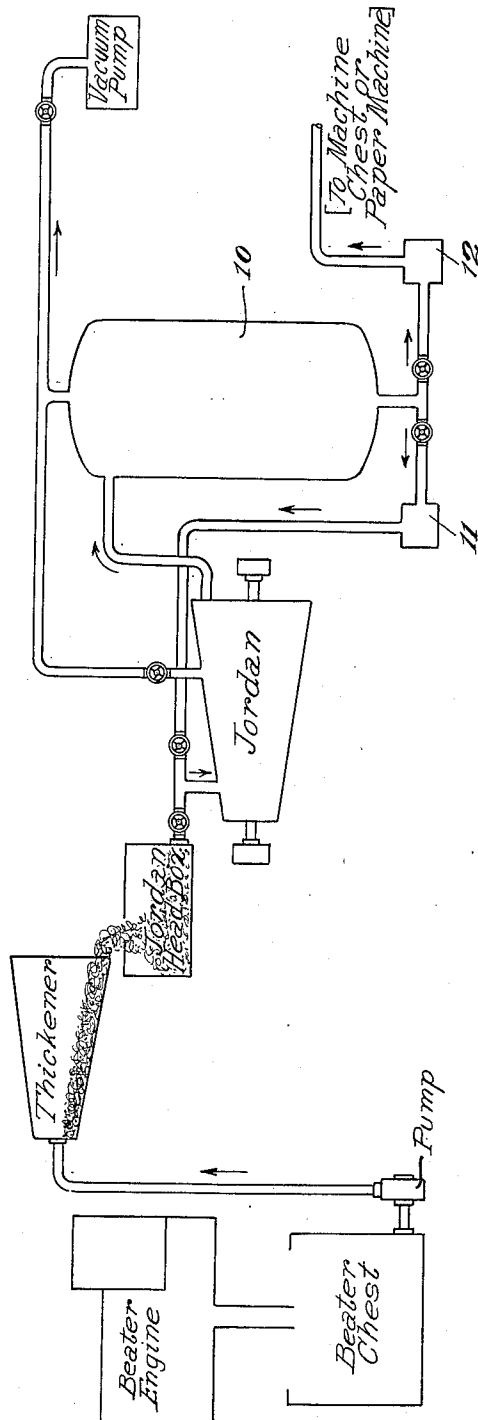


Fig. 1.

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PAPER-MAKING METHOD AND APPARATUS.

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This invention relates particularly to paper making methods and apparatus, and includes a method of eliminating the froth that generally forms during the process of manufacturing paper as carried on during the present day.

The objects of the invention are set out in detail in the description which follows, but include generally a means and method for manufacturing an improved quality of product, at a faster rate of production, with less equipment, and at reduced cost.

All these objects are attained in the manner herebelow described, and as shown diagrammatically in the accompanying drawing, in which—

Figure 1 is a diagrammatic side-elevation view of the essential apparatus, with their connections, for carrying on this new process. The present-day manufacture of paper consists essentially of the following methods of operation:

The first step in the conversion of the pulp into paper, is to bring the pulp into a fluid state with water in a beating engine, where at a concentration of from 3% to 7% total solids, it is mixed with special materials such as sizing, loading, and coloring, which give the special properties required in the paper.

The beating engine is not only a machine for mixing these materials but the knives of the beater roll and bedplate perform other functions which are mainly the cutting and hydration of the fibers.

Something else occurs in the beating engine while the stock is being mixed and hydrated and this is the beating of air into the stock by the bars of the beater roll. The amount and character of this depends largely upon the surface tension conditions of the water carrying the fibers, for in some cases the air is beaten into a fine froth which is very hard to break up, and in other cases the air is held in coarse bubbles or in solution in the aqueous medium. In any event there are more or less gases emulsified or dissolved in the wet stock by the time it leaves the beating engine.

While the stock lies in the beater chest, nothing much happens to it, but when it is pumped into the headbox over the Jordan, it is put under pressure for a short space of time and during this period many fine particles of dispersed gases are forced into solution from which they emerge as soon as the pressure is relieved. When the gases come out of solution they form very fine bubbles

on the surface of the fibers which give a light spongy appearance to the pulp stock.

When the stock passes through the Jordan for the purpose of further cutting and hydrating action, the air particles undergo a much more violent churning action than they do in the beater and the particles are made finer and are more difficult to separate from the others. As more air is generally drawn into the Jordan along with the stock and beaten into it by the rotating knives, the pulp stock emerges from the Jordan with the maximum amount of emulsified and dissolved gases that can be held in the stock under the given surface tension conditions. If the stock now passes to a machine chest very little change will take place but as soon as it is pumped to the paper machine screens or to the riffles or headboxes, where it is diluted with a large amount of water, the suspended and dissolved gases will begin to separate with the formation of froth. This froth formation continues in the paper machine headbox and on the slice and even on the wire for the dissolved gases cannot come out of solution as rapidly as free air can be separated.

The fact is that in all stages of the paper making process we are dealing not only with solids and liquids but with gases, and the only means of separating the gases from the solids and liquids that has yet been employed is by dilution with water until the entire mass is so liquid that a part of the gases separate by gravity. In the dilution of the paper stock to this liquid state, mill waters are generally used which are already saturated with gases to the limit of their solubility. Under these conditions it is quite impossible for the felted paper fibers to be free from occluded gases at any stage of its formation, even on the wire or under the press rolls, and consequently it is impossible to obtain the closest contact and felting properties of the fibers.

It is a well-known fact that the large amount of froth that is generally formed on paper machine screens and headboxes, carries into the waste a large quantity of good fiber, filling material, sizing and color, but this is considered to be an unavoidable loss. Froth is one of the serious problems in paper making and many efforts have been made to minimize it by the use of froth killers, consisting of oils and compounds made therefrom. The effect of these is to partly break up the froth before it is carried onto the paper

machine wire to form blemishes in the paper. This is not the only factor, however, for all those fibers that have any particles of air adhering to them will float to the top of the sheet and will not adhere as closely to the neighboring fiber as if it were not separated by particles of gas.

The gases dissolved in the liquid medium are not only the oxygen of the air which is beaten into the pulp but also the carbon-dioxide which is formed or liberated by chemical reaction. As all paper is finished with an acid reaction from the use of alumn, any bi-carbonates in the natural water or in the filling material used will be neutralized with the formation of CO_2 gas, which is much more soluble in water than oxygen. There is often enough CO_2 dissolved in a beater to produce a distinctly acid reaction from this cause alone and this has an injurious effect upon sizing and coloring as well as being an ever present cause of froth.

After having described the conditions that exist in paper making practice, as it is carried out to-day, and the detriment to quality and production that comes from trying to make paper with a mixture of solids, liquids and gases, I will describe my discovery, which is the introduction of a new step in the process of manufacture, this step being the separation of the gases from the solids and liquids by means of reduced pressure, before the latter are sent out to the paper machine to be felted into a sheet of paper.

I start to remove the gases from the solids and liquids that have been discharged from the beater, for there is where the gases are first formed and dissolved. I remove a portion of the gases as the stock passes first through the Jordan by having the shell of the Jordan under a partial vacuum so that the air bubbles will all break and not form again because the gas will be removed through the air vent of the Jordan, and which is connected to the vacuum tank 10. The stock fills all of the space within the Jordan, and passes through it rapidly, being forced by the centrifugal force of the revolving Jordan plug and the suction from the vacuum tank. While the stock remains in the vacuum tank, any gases still dissolved are expelled from solution, the froth bubbles are expanded and broken and the air held within the cell walls of the fibers is expanded so that the fibers are swelled and the fiber surface is increased. After this there is less resistance to the wetting of the inner tube surface of the fibers.

As by this process it is possible to treat the stock at high density and as the stock passes through the Jordan at high velocity, the stock can be treated by the Jordan at least twice before it goes to the paper machine. In passing it through the Jordan the second time, it is drawn from the tank where

it is under a vacuum, and by means of the pump 11, it is discharged through a closed system of pipe into the Jordan where it receives a treatment that is quite different from what it received the first time. It will be noted that in passing from the tank 10 to the Jordan, the stock is again under some pressure produced by the pump 11 and this again disappears under the reduced pressure in the Jordan. The fibers are now in a more collapsible condition and can be flattened and drawn into fibrillæ by the knives of the Jordan. In the second and subsequent treatments, real hydration takes place, and it is quite easy to duplicate any results that could formerly only be obtained in the very best types of beaters.

In operating this process very little power is used by the Jordan because all of the best paper-making results can be obtained without the hard grinding of the Jordan surfaces that is now the common practice.

This treatment or system may be operated in several ways. The stock may be treated in batches or it may be treated continuously, depending upon the requirements and mill conditions.

An example of continuous operation is as follows:

While the pump 11 is withdrawing stock from the tank 10 and discharging it into the Jordan and this stock is then being forced or drawn back into the tank 10, a supply of fresh stock is drawn into the Jordan from the head box and at the same time a stream of stock is withdrawn from the tank 10 by the pump 12 and delivered to a machine chest or a paper machine.

Another method of operation would be to use two or more Jordans—one for feeding the fresh stock to the vacuum tank 10 and the other for treating the stock from which the gases have been partially removed.

Another would be to have a vacuum tank behind each Jordan and pass the stock successively from Jordan to tank until sufficient treatment is received.

A partial application of this process would be to have the tanks under little or no vacuum and rely on partial vacuum produced for an instant at the suction end of the pump, for the slight reduction of pressure followed by the pressure at the discharge end of the pump produces movement of the air particles which loosens their hold on the fibers, and the fibers can be more rapidly wetted in this way. This application will produce hydration although at a slower rate than if the higher vacuum of a greater difference in pressure were produced, and does not give the freedom from froth that the latter method will.

The other extreme in the application of this invention is to ignore the matter of beating or hydration and to treat entirely

the froth problem. In this case, one treatment by the Jordan is sufficient but a longer exposure in the vacuum tank 10 at as high a vacuum as possible is required so that all particles of air will be removed from the surface and interior of the fibers so that they will felt together into a paper of even texture.

There is a definite relationship between the process of extracting the air by prolonged vacuum and extracting it by exposing it to various pressures. When the stock under partial vacuum is passing through the Jordan and it is struck by the knives of the revolving Jordan plug, the fibers are exposed to a wide range of pressures from the minimum to the maximum. Also while the stock is passing through the pump it is exposed to heavy pressure for an instant, which is again released so that the principle of wetting the fibers by displacing the air particles can be carried out by this variation in pressures and naturally it is the greatest when there is the greatest range of pressure. When the process is operated in a closed circuit so that the Jordan is constantly filled with stock at the high density that can only be carried when using this process, then the work done by the Jordan with a given power consumption is increased by several hundred per cent. It is not generally known that long beating in water containing dissolved oxygen will produce an oxidation of the cellulose that is detrimental to the strength and quality of the paper. If the same work is done in the Jordan after the gases are removed, such chemical change is impossible, regardless of the time of treatment.

It is also possible to carry out the usual sizing reactions during the vacuum Jordan treatment, and if these reactions take place without the presence of either oxygen or CO_2 , they are much more uniform and reliable than when affected by these gases.

This process can be modified in many ways and still obtain a portion of the results, as the gas might be extracted before the Jordan or after the Jordan treatment, although the method I prefer is the one previously described.

It will be noted that this is the only process that actually removes the gases from the cell walls of the fibers and also the gases that remain dissolved in the liquid at atmospheric pressure.

In the foregoing specifications, I have referred to the treatment of stock that has been in a beater, and although it is common practice to mix the paper stock with its other ingredients in a beating engine, yet it is not necessary to this invention that the stock pass through a beater.

Thus, it is possible to make good paper by my process without the use of any beaters in the mill. It is only necessary to mix the in-

redients together in a tank and then do all of the mixing and beating by circulating the stock continuously through Jordan-like machines until the stock is prepared for the paper machine. In such case there will be less air to remove from the stock and more time and power are saved.

When it is desirable to remove all causes of froth from the paper machine, it is not only necessary to remove the air from the liquids surrounding the paper stock but also from the back waters returning from the paper machine which are used again in the stock and on the screens and other places where froth can be produced. These waters generally contain a considerable amount of air which is sometimes under pressure so that it is an ever-present source of froth. This can be easily removed by storing the white waters in an enclosed tank, and by means of reduced pressure removing the gases from the top of the tank while the water and suspended paper stock is removed from the bottom and pumped to the machine. It can be operated continuously in the same way as an open tank and the vacuum in the tank adjusted to the size and height of the tank so that very little extra power is required when drawing the waters from this tank. This part of the process in which the gases are withdrawn from the liquids used to make paper, is entirely similar to the rest of the invention.

It is to be understood that the present disclosure is for the purpose of illustration only, and that the invention is not limited thereto. To those skilled in the art, many modifications of the invention will be readily apparent, and it will also be obvious to such skilled persons that parts of the device may be used without other parts thereof, and steps in the method, without other steps, many such combinations readily suggesting themselves. Therefore, it should be and is to be distinctly understood that for a definition of the limitations of the invention, reference must be had to the appended claims.

Having now described the invention, what is claimed as new, and for which Letters Patent of the United States is desired, is:

1. A step in the manufacture of paper which consists in removing the gases from the solids and liquids comprising the paper stock, before it is converted into paper.

2. A step in paper manufacture which consists in placing the stock from the beater under reduced pressure before making it into paper.

3. A step in paper manufacture which consists in Jordaning the stock in a partial vacuum.

4. A method of Jordaning paper stock which consists in drawing the stock through the Jordan by suction and into a closed tank under a partial vacuum.

5. A method of treating paper stock which

includes removing the gases by means of reduced pressure within a closed tank.

6. A method of Jordaning paper stock which includes treating the stock from which a portion of the gases have been removed.

7. A method of treating paper stock which includes the step of passing it through a machine of the Jordan type after the gases are removed.

8. A method of treating paper stock which includes passing it through machines of the Jordan type while the gases in the stock are being removed by means of reduced pressure.

9. A method of treating paper stock which consists of exposing it alternately to vacuum and pressure, while passing it through machines of the Jordan type.

10. A method of treating paper stock which comprises circulating it continuously through a Jordan engine by means which produces reduced pressure within the stock.

11. Means for removing the gases in a Jordan during the operation of paper-making, including an air-vent, a vacuum tank, and a connection therebetween.

12. Means for expediting the movement of paper stock through a Jordan, comprising the revolving Jordan plug in combination with means for generating a suction from the Jordan.

13. The combination in a paper-making

apparatus, of a Jordan, a vacuum tank, a connection therebetween, and a pump adapted to force the material from the tank to the Jordan.

14. In combination in a paper-making apparatus, a vacuum tank, a Jordan, a pump for removing the paper stock from the tank to the Jordan, other connecting means between the Jordan and the tank adapted to permit the movement of the stock from the Jordan to the tank, and a second pump between the tank and a paper machine, and adapted to remove the stock from the tank to the paper machine.

15. The process of treating paper stock fiber including the step of subjecting the fiber successively to varying degrees of vacuum for the purpose of separating the gases from the fiber.

16. A method of preparing paper stock which comprises mixing the ingredients together and then passing them through a Jordan into a tank under a partial vacuum and through succeeding Jordans and tanks under partial vacuums until the processing of the stock is complete.

Signed at New York, in the county of New York and State of New York, this 20th day of February, A. D. 1928.

JUDSON A. DE CEW.