June 16, 1942. G. W. E. NICHOLSON 2,286,924

MANUFACTURE OF SHEET MATERIAL

Filed Jan. 12, 1938

Fig. 1.

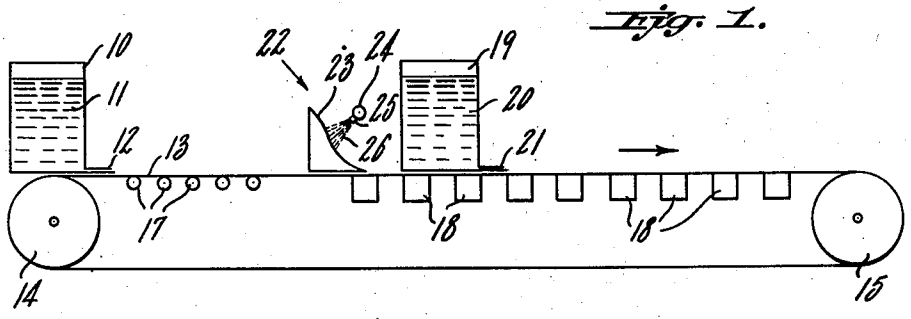


Fig. 2.

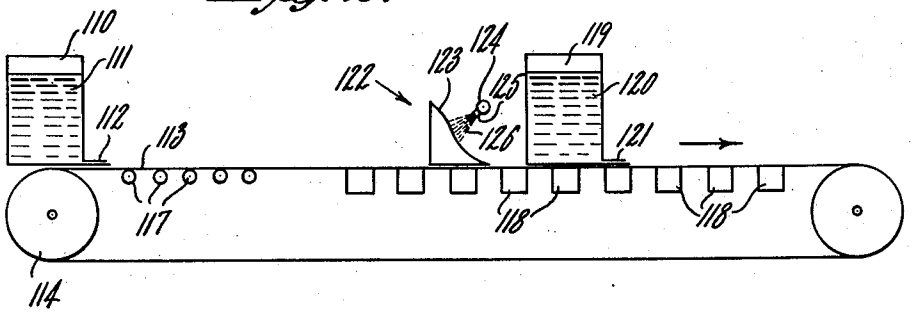
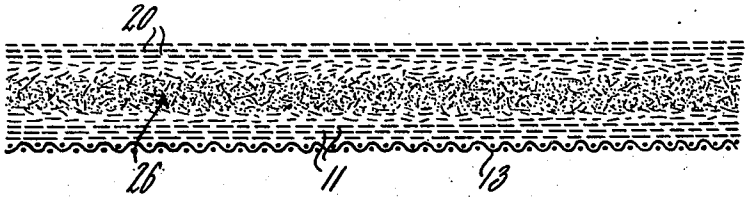


Fig. 3.



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MANUFACTURE OF SHEET MATERIAL

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Application January 12, 1938, Serial No. 184,525

1 Claim. (Cl. 92—40)

My present invention relates to the manufacture of sheet material and, more particularly, to the manufacture of paper of the built-up layer type upon a Fourdrinier machine.

In the manufacture of certain types of multiply sheet material, it has been proposed to flow a layer of stock upon the wire of a Fourdrinier machine from a head-box located adjacent the breast roll. This layer of stock is partially dehydrated as the wire passes over a series of devices, such as table rolls and suction boxes. Another head-box has been mounted in a position along the wire to flow a second layer of stock upon the partially dehydrated layer already upon the wire. If the dehydration of the first layer of stock has progressed only to such an extent that the fibers adjacent the wire have been set or matted and the stock on the upper side of the layer is in watery condition at the time the second layer of stock is flowed thereon, the succeeding suction boxes will draw water from the second layer of stock down through the first layer which acts as a filter pad. The filtering of the water through the first layer will draw certain of the fibers in the second layer partially into the first layer and certain of the uppermost fibers of the first layer will be displaced and projected into the second layer to produce an interfelting or interlocking of the fibers of the two layers. The two layers will therefore become integrally united and there will be no line of demarcation or separation between the layers along which peeling may occur.

In the practice of the process just outlined, the degree of dehydration of the first layer must be very carefully controlled in order that a satisfactory interlocking of fibers will occur when a second layer is laid thereon. The dehydration of the first layer must not be carried to such an extent that all of the fibers thereof will be permanently set and thus unavailable for interlocking with the fibers of the second layer. It may be desirable to provide a stock for the second layer whose fibers are very finely divided or which contains valuable fines or sizing, filling or coloring material which must not be drawn too deeply into the first layer and which of course must not be drawn through the layer and lost through the wire. In such event, it is desirable that the stock in the first layer shall be well matted and dehydrated in order that it may effectively serve as a filter pad. Under these circumstances, interfelting of the fibers in the respective layers may not be sufficient to satisfactorily form a union between the two layers. In addition to the example already given, it will be appreciated that there may be many instances in which interfelting of the fibers might be inadequate to provide an inseparable bond between the layers of a built-up paper, paperboard or other sheet material.

It is an object of my invention to improve the bond between successive layers of sheet material laid upon the sheet forming portion of a paper making machine.

It is a further object of my invention to provide for the addition of any desirable stock modifying material, such as a chemical, filler, adhesive or other substance in the zone of union between successively applied layers of fibrous material.

It is a specific object of my invention to provide for the formation upon a Fourdrinier machine of a homogeneously interfelted sheet of fibrous material whose opposite surfaces may vary greatly in their characteristics.

It is a further object of my invention to provide apparatus upon which sheet material, having the characteristics herein set forth as desirable, may be formed.

It is a further object of my invention to provide sheet material having the characteristics herein set forth as desirable.

According to my invention a layer of stock is laid upon the wire of a Fourdrinier machine from the lip of a head box in a well known manner. This layer of stock may be partially dehydrated and a suitable stock modifying material in aqueous or other solution suspension or mixture may be flowed thereon by means of a distributing device which uniformly distributes such material across the web. This material may form a protective or modifying coating for the layer or for the individual fibers within the layer, or may serve to size the upper portion of the partially dehydrated layer, or may serve as an adhesive for bonding of the fibers in the partially dehydrated layer with fibers of a layer subsequently applied. Immediately after the aforesaid material is flowed upon the partially dehydrated layer, a second layer of stock is laid thereon by the lip of a second head box suitably supported above the wire. This second layer of stock may be of any desired type and may have any desirable characteristics. The water in which this second layer of stock is suspended is progressively drawn through the first layer and the fibers of the two layers may become interfelted and interlocked as above discussed. The modifying material applied by the distrib-

uting device will remain within the zone of union between the two layers and may serve in various ways to improve the bond between the fibers of the respective layers.

I have found that in the practice of my invention, the first layer may be dehydrated to such an extent that all of the fibers thereof are permanently set in condition to act as an extremely effective filter pad. Sizing or adhesive material may be flowed thereon and a second layer of stock of any desirable characteristics may be laid thereon as above described. The multiply web thus formed has been found to be homogeneously interfelted and unmarked by any line of separation between the layers thereof. It appears that the presence of the sizing or adhesive material in the zone of union between the respective layers so improves the bond therebetween as to compensate for relatively inefficient interfelting of fibers which has heretofore rendered such unions unsatisfactory.

It will thus be seen that my invention may be particularly adapted for the production of a homogeneously interfelted sheet comprising layers of fibrous materials which may vary widely in characteristics. Thus, the first layer may comprise a free, slightly hydrated long fiber stock which will present a surface of a porous absorbent nature. For example, this layer may be a relatively undercooked, slightly beaten kraft stock. This layer of stock may contain no size or may be sized to any desirable degree. A suitable binding agent, such as animal glue, sizing material, sodium silicate or latex compound, may be flowed upon the partially dehydrated first layer. A second layer comprising a stock which may be slow and/or highly hydrated and/or short-fibered and/or sized to any desirable degree and/or loaded with any desirable filler or coloring material and/or containing fines may now be laid upon the partially formed sheet whose upper surface bears the binding material. For example, the second layer may be a relatively overcooked, well beaten kraft stock. When the stock of the first layer is of extremely free flowing nature, it may be subjected to the action of any desirable number of table rolls and suction boxes in order that it will be well formed and will serve as an efficient filter mat for the layer of stock to be subsequently laid thereon. The provision of binding material intermediate the layers of stock enables me to form a satisfactory bond between the layers irrespective of the degree of dehydration of the first layer and thus enables me to prevent the loss of the short fibers or valuable sizing, filling or coloring materials which may be contained in the second layer of stock.

Other objects and advantages of my invention will become more apparent from a consideration of the following description of preferred, but not necessarily the only, forms of my invention taken in connection with the drawing accompanying and forming a part of this specification.

In the drawing:

Fig. 1 is a somewhat diagrammatic illustration of a machine upon which my invention may be practiced;

Fig. 2 is a similar view of a modified machine; and

Fig. 3 is a greatly enlarged cross-sectional view of one form of paperboard which may be produced according to my invention.

Similar characters of reference indicate similar parts throughout the several views. Referring now to the drawing, Fig. 1 illustrates a machine of a well known Fourdrinier type to which my invention has been applied. The machine includes a main head or flow box 10 from which stock 11 flows through a lip 12 upon a wire 13 of the Fourdrinier part of a paper-making machine. The wire 13 is supported by the usual breast roll 14 and driven by the usual couch roll 15 in the direction of the arrow in Fig. 1.

The stock 11 is flowed upon the wire in a layer of any desired depth controlled in a well known manner as by adjustment of the lip 12 and variation in the speed of the wire. The stock upon the wire is progressed by the wire over a series, comprising any desired number, of table rolls 17 the action of which is to progressively remove water from the stock 11. The partially dehydrated stock is then carired over a series, comprising any desired number, of suction devices 18 which serve to further successively dehydrate the stock and form the same into a web of interfelted fibrous material. The web may then be conducted from the wire to the usual pressing, drying and calendering stages of paper machines of well known types.

According to my invention, a second head or flow box 19 is supported in any convenient manner above the Fourdrinier wire 13. Preferably, the supporting means for head box 19 is so constructed as to permit the box 19 to be located at any desirable position along the wire in the path of travel thereof. The head box 19 is provided with the usual lip 21 from which stock 20 may be flowed in a layer of controlled depth upon the wire 13.

As shown in Fig. 1, the second head box 19 is positioned above the first several suction devices 18 encountered by the web upon the travelling wire 13. In this position, the stock 20 will be flowed upon the stock 11 when the stock 11 has been dehydrated only by the action of table rolls 17 and the first few suction devices 18.

Located immediately ahead of the second head box 19 I have provided a distributing device indicated generally by the reference numeral 22. The distributing device 22 may take any suitable or convenient form. Thus, this device may comprise a box or chest provided with a lip, weir or slice suitable for the distribution of diluted materials. The lip, weir or slice may be supplied from any suitable source other than a box or chest, if so desired. For the purpose of illustration, I have disclosed a distributing device which comprises a baffle plate 23 which extends across the wire and which may be corrugated, ribbed or grooved to secure an even flow of material thereon. The baffle plate 23 is supported in any convenient manner above the wire and is preferably movable, either with or independently of the head box 19, along the wire. The lower extremity of baffle plate 23 acts as a lip from which material may be flowed upon the wire 13. A pipe 24 is suitably supported and extends across the wire. The pipe 24 is connected with a suitable supply of modifying material and is provided with a series of nozzles 25 which are so designed and located as to distribute material supplied under pressure to the pipe 24 upon the baffle 23 in the form of a finely divided spray. The material being sprayed by nozzles 25 is indicated by the reference numeral 26. The material 26 forms an evenly distributed film upon the baffle plate 23 and flows down the plate to be evenly distributed across the wire 13.

In Fig. 2, I have shown a modification of the

machine illustrated in Fig. 1. In this figure, the parts indicated by reference numerals 110 to 126 inclusive correspond respectively to the parts indicated by the numerals 10 to 26 inclusive in Fig. 1. In Fig. 2, however, the second head box 119 is illustrated in a position farther down the wire. The distributing device 122 has been correspondingly moved. In the position illustrated in Fig. 2, the stock 120 is laid upon the stock 111 after the stock 111 has been subjected to the action of the table rolls 117 and a relatively large number of suction devices 118. Thus, in the device illustrated in Fig. 2, the stock 111 will be dehydrated to a much greater degree than the stock 11 upon the machine shown in Fig. 1. A suitable binding agent 126 is distributed upon the stock 111 by the distributing device 122 in the same manner as discussed above in connection with Fig. 1.

Illustrative examples of the formation of certain specific types of sheet material upon the devices shown in Figs. 1 and 2 will now be given.

Considering first the machine illustrated in Fig. 1 and the sheet material illustrated in Fig. 3, a stock 11 of any desirable characteristics or type is flowed through the lip 12 of head box 10 upon the wire 13. For example, the stock 11 may be a kraft pulp cooked and beaten to any desirable extent. The stock 11 is conducted by the wire 13 over the table rolls 17 and a suitable number of suction devices 18 to cause dehydration of the stock to such an extent that the fibers upon and adjacent to the wire 13 may become set while the stock forming the upper surface of the layer remains in watery condition. The second head box 19 is so located that the lip thereof will discharge stock 20 upon the stock 11 when it has reached the exact degree of dehydration desired. The distributing device 22 is positioned immediately ahead of the head box 19 and a supply of binding material, such as animal glue, casein, latex compounds or sizing material, is supplied to the spray nozzles 25. This material 26 is sprayed upon the baffle plate 23 and distributed thereby in an even flow of desired volume upon the upper portion of the stock 11. Obviously, the binding material 26 will be in aqueous solution sufficiently thin to permit spraying and to insure its even distribution upon the stock 11 by the baffle plate 23. The addition of this thin aqueous solution to the surface of the stock 11 will result in an increase in the amount of water in and upon the upper surface thereof. The stock 11 bearing the material 26 is then conducted to the lip 21 of the second head box 19. At this point, the stock 20 is flowed upon the watery, binder loaded surface of the stock 11 and commingles therewith to form a firm, interfelted, fibrous bond between the two layers of stock. For the purposes of the present example, the stock 20 may be identical in all respects with the stock 11. In this case, the binding material 26 merely serves to improve the bond between the interfelted fibers within the zone of union between the stock layers 11 and 20. The composite web thus formed is subjected to further dehydration by any necessary number of suction devices 18 and is then conducted to the finishing stages of the paper machine.

The sheet material formed according to the example just discussed is shown in Fig. 3. From an inspection of this figure, it will be seen that the fibers of layer 11 are well arranged and formed adjacent the wire and that they become increasingly disarranged as they approach the upper portion of this layer. It will also be observed that the lowermost fibers of the layer 20 are disarranged and thoroughly interfelted with the upper fibers of the layer 11. The fibers within the upper portion of the layer 20 may become increasingly well arranged as a result of the action of the conventional dandy rolls (not shown) and any other devices which may be used for the smoothing of the upper surface of paper according to principles too well known to require further discussion herein. It will be observed that the binding material 26 is confined within the zone of interfelting between the fibers of the layers 11 and 20. The binding material 26 thus serves to firmly cement the fibers of the respective layers in interlocked position.

A very great number of modifications of the above example will occur to those skilled in the art. It is obvious that the stocks 11 and 20 may vary relative to one another to any desirable extent. Thus, either of the layers may be cooked and/or beaten to a greater extent than the other or the relative degrees of hydration of these stocks may be chosen as desired. The stocks 11 and 20 may vary in their relative freeness or fiber lengths and may contain relatively different percentages of fines, sizing, filling, coloring or other materials. Any desired characteristics or combination of characteristics may be imparted to either of the layers 11 or 20 and in any case the stock modifying or binding material 26 will serve to improve the bonding or interfelting between the respective layers.

It will be understood that the exact position of the second head box 19 along the wire 13 will be chosen with regard to the type of stock furnished from the head box 11 and the exact degree of dehydration and fiber formation desired within the layer 11 upon its arrival at the lip 21 of the second head box. It will be further understood that the exact location of the second head box 19 must be determined by experiment and that the position illustrated in Fig. 1 is merely an example to which it is not my intention to be limited.

In Fig. 2, I have illustrated a specific modification of my invention which is particularly adapted for the formation of a composite web whose surfaces vary widely in characteristics. The formation of a web to which this form of my invention is particularly adapted will now be described. A stock 110 which may be an undercooked kraft stock or a free flowing stock containing a large percentage of long slightly hydrated fibers may be flowed upon the wire 113. The stock is progressed by the wire over the table rolls 117 and a sufficient number of suction boxes 118 to establish a substantially permanent set within all of the fibers of the layer 111 before the second layer 120 is applied thereto. For the purposes of this example, the stock 120 may be overcooked kraft pulp or may contain a much greater percentage of short fibers or may have been subjected to longer beating or may be hydrated to a much greater degree or may be much slower than the stock 111. A uitable stock modifying or binding material, such as animal glue, casein, sodium silicate or latex compound, is applied by the distributing device 122 to the upper surface of the layer 111 immediately prior to the flowing of the stock 120 thereon. The binding material 126 will remain within the zone of union between the layers 111 and 120 and will

serve to effectively improve the bond therebetween.

It will be understood that many modifications of the example just given will occur to those skilled in the art. The fact that the first layer of stock 111 is completely formed or matted at the time the second layer is flowed thereon enables it to serve as an effective filter mat for any type of stock 120 which it may be desired to apply thereon. In this embodiment of my invention, I am enabled to secure a thoroughly satisfactory bond between superimposed layers of stock which differ so greatly that it has heretofore been impossible to satisfactorily unite them by known processes.

While in the above examples I have dwelt upon the function of the stock modifying material applied by the distributing device to improve the bond between separately laid plies, it will be appreciated that such material may have various functions. For example, a suitable quantity of sizing or filling material may be flowed upon the partially dehydrated first layer to effect the sizing or filling of this layer upon the wire. A second layer of unsized or unfilled or differently sized or filled stock may then be applied by the second head box. As another example, the stock modifying material may be so chosen as to affect the inner fibers of a composite web to stiffen or to raise the Mullen test of such a web without affecting the exterior fibers and surfaces thereof.

It will thus be seen that I have provided an apparatus, method and product fulfilling the objects of my invention. While the above detailed description has been made in order to comply with statutory requirements, it will be understood that this description is to be taken in an illustrative rather than in a limiting sense and that the scope of my invention is to be limited only by the appended claim.

I claim:

The process of forming a homogeneously interfelted web of cellulosic fibrous material, comprising flowing a layer of cellulosic fibrous stock upon the wire of a Fourdrinier type of paper making machine, dehydrating said layer to an extent sufficient to impart a substantially permanent set to all the fibers of said layer while leaving the upper surface of said layer in a watery condition, flowing a quantity of thin aqueous adhesive solution upon the watery surface of said layer and thereby increasing the amount of water on the upper surface thereof, immediately flowing an additional layer of cellulosic fibrous stock upon the water and adhesive loaded surface of said layer, dehydrating said superimposed layers simultaneously by suction and simultaneously thereby commingling and interlocking the fibers and adhesive in the adjacent surfaces of said layers only, and finishing said web.

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