

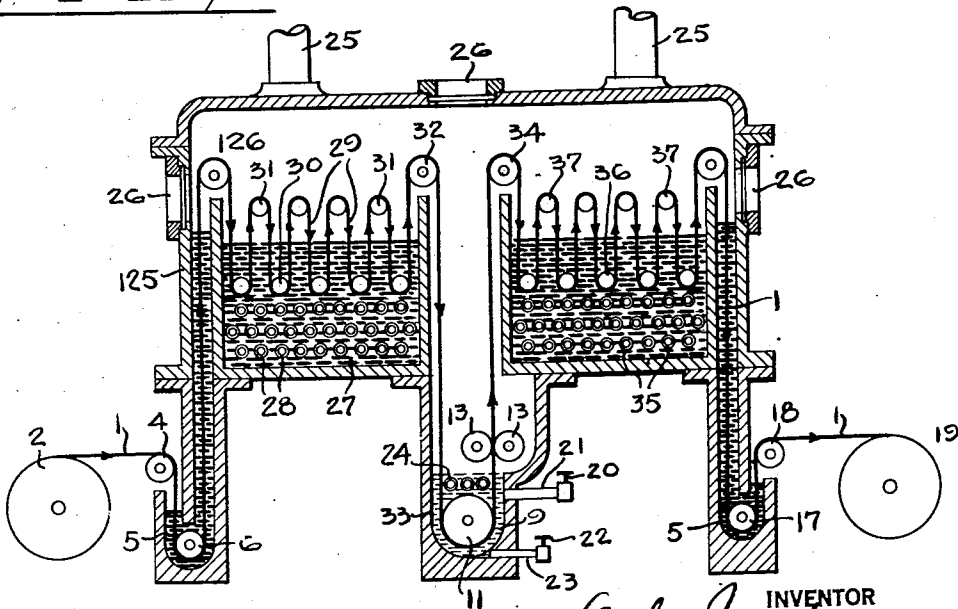
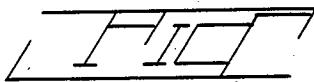
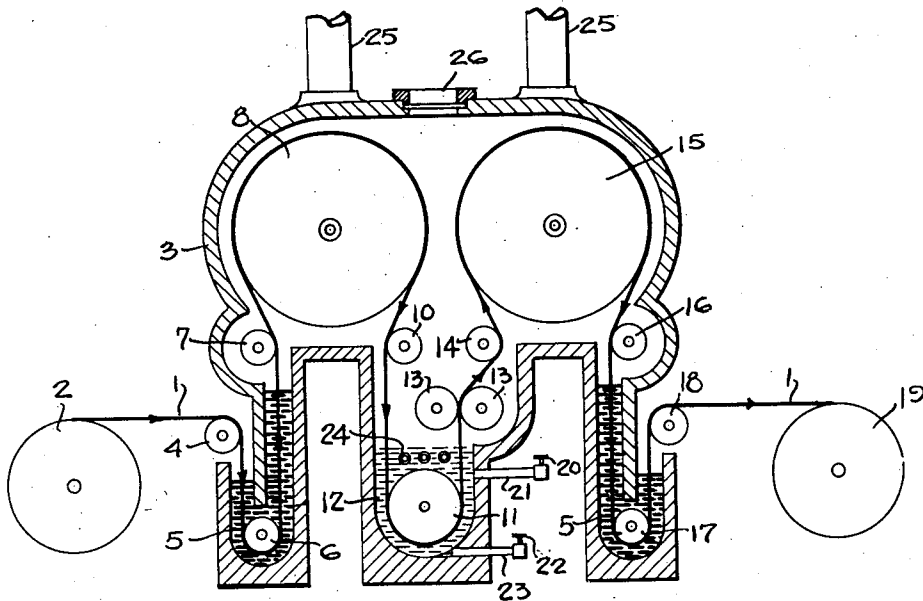
Aug. 10, 1926.

1,595,475

O. MINTON

TREATMENT OF MATERIAL IN A VACUUM AND APPARATUS

Original Filed March 4, 1920 3 Sheets-Sheet 1



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TREATMENT OF MATERIAL IN A VACUUM AND APPARATUS

Original Filed March 4, 1920 3 Sheets-Sheet 2

FIG 3

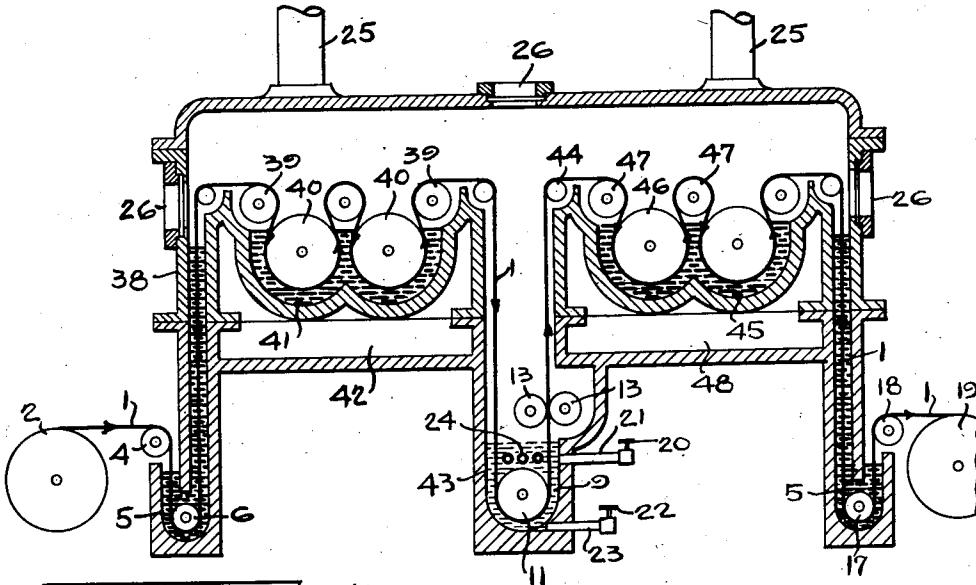
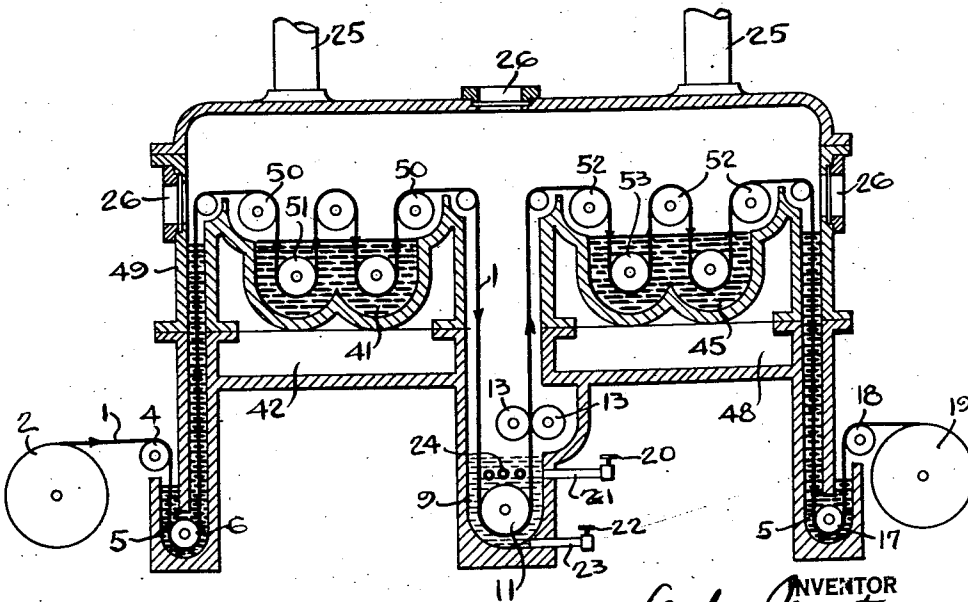


FIG 4

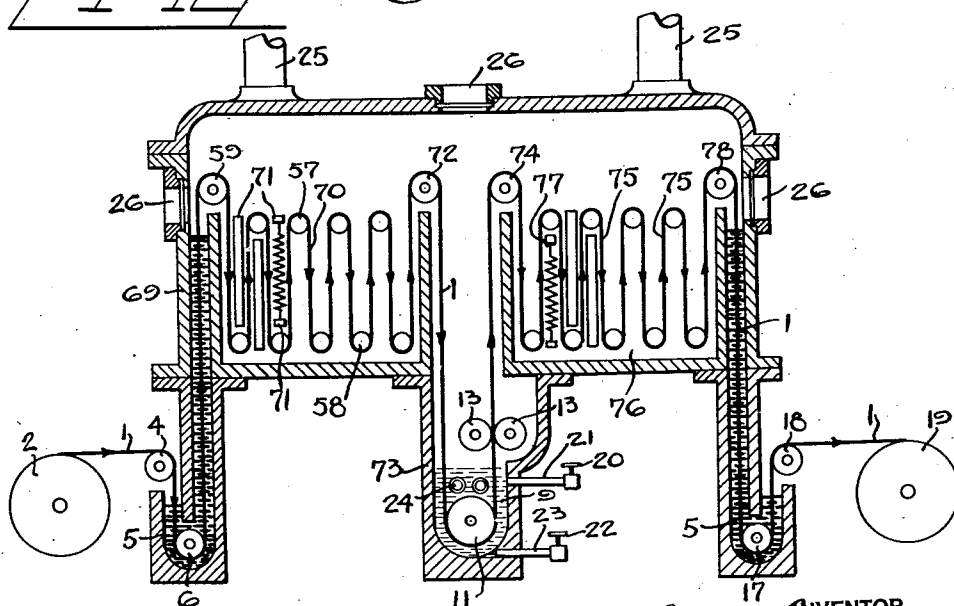
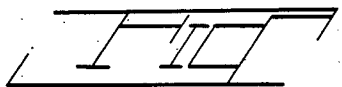
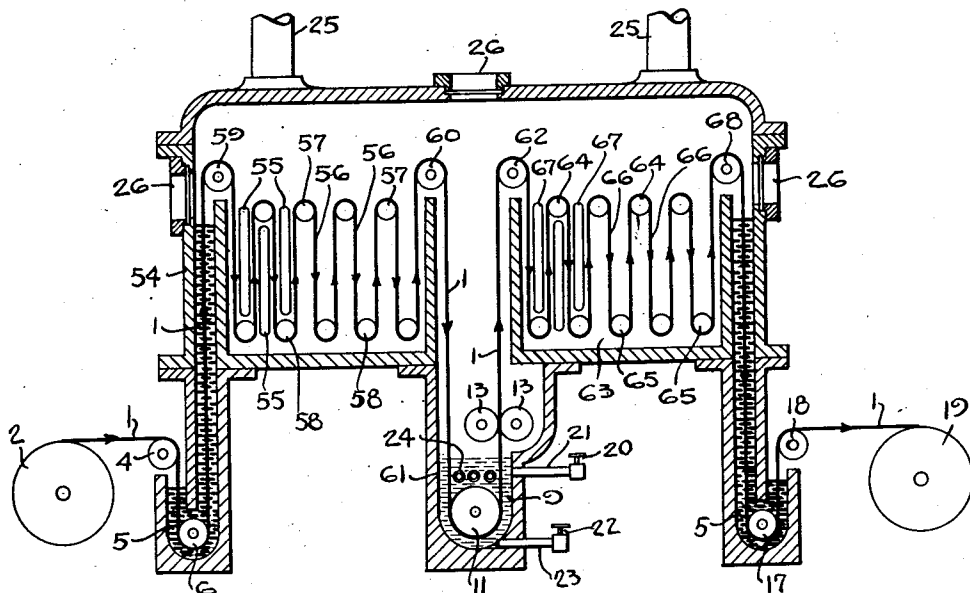


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TREATMENT OF MATERIAL IN A VACUUM AND APPARATUS

Original Filed March 4, 1920 3 Sheets-Sheet 3



17
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UNITED STATES PATENT OFFICE.

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TREATMENT OF MATERIAL IN A VACUUM AND APPARATUS.

Application filed March 4, 1920, Serial No. 363,351. Renewed February 17, 1926.

The present invention relates to an apparatus and method for the drying of paper and other sheet material, in a vacuum chamber, and then immediately, while still in the vacuum chamber, coating, or coloring, or sizing or impregnating the paper or other sheet material, and then immediately drying the coated, colored, sized or impregnated paper or other sheet material while still in the vacuum chamber.

My improved method consists in passing the sheet material which is to be dried into a vacuum chamber through a liquid sealing medium which has no affinity for the material, subjecting it to heat to drive off its contained moisture, immediately coating or coloring, or sizing or impregnating the sheet material while in the vacuum chamber, then subjecting the coated or colored, or sized or impregnated sheet material to heat to drive off its contained moisture or other liquid, and then passing the sheet material out of the chamber through a seal.

This method may be practiced by the use of various forms of apparatus, some of which are herein disclosed. In any form, however, it is essential that the apparatus be provided with a closed chamber in which a partial vacuum may be maintained. In order that the material to be dried, treated, and again dried may be continuously passed through the vacuum chamber, the latter is provided with openings closed to the admission of air by a liquid sealing medium which has no affinity for the material. The liquid seal effectively closes the entrance and exit passages against the admission of air to the chamber, but permits the passage of the material into and out of the chamber. The heating elements within the vacuum chamber, for drying the material, the shape, form, dimensions and location of the liquid seal containers, and the means for passing the sheet material through the chamber, may all vary. I have shown herein a number of varieties which I contemplate using.

My invention further relates to withdrawing from the sheet material substantially all, or a large portion, of its occluded air and filling the interstices normally filled by the occluded air with a coating of impregnating compound, and then drying said coated or impregnated sheet material in the vacuum chamber before subjecting the said sheet material to atmospheric conditions.

My invention further relates to obtaining

a better and more uniform product than any now known on the market. My invention further relates to the method of coating or impregnating sheet material which insures that there will be no blemishes, uneven surfaces, blisters or minute raised portions due to the air which may be held or occluded within the sheet material which, in the present practice of coating as for example with a water-proof compound, leads to rejections or discards due to these imperfections with the consequent waste of material and labor.

My invention further relates to the treatment of paper, either from the wet end of a paper machine or from a roll or reel of wet or damp paper, feeding the web of wet or damp paper into a vacuum chamber without breaking the vacuum, drying said web in the vacuum chamber, and removing substantially all of its occluded air, and immediately coating or impregnating or coloring said dry web with a coating or impregnating or coloring compound, and then again drying the web, the second time with its coating or impregnating or coloring compound, within the vacuum chamber and all these steps being continuous and prior to subjecting the coated or impregnated compound to the action of the atmosphere.

My invention further relates to manufacturing paper wherein the fibers are not weakened and the size in the paper is not injured or damaged due to drying at high temperatures.

My invention further relates to manufacturing colored paper and drying it without substantially impairing the coloring matter and mordants used in the paper. Among other advantages this insures that the paper will have bright colors, which will be substantially uniform in different runs of paper, permitting matching of colored paper without any appreciable difference in tone or color.

My invention further relates to rapidly and expeditiously coating or impregnating sheet material in a continuous web or sheet.

My invention further relates to sizing paper in a vacuum chamber and drying the sized paper in said vacuum chamber at such low temperatures as not to injure the fibers of the paper or the size. My invention further relates to withdrawing the occluded air from the paper and immediately drying and then filling the interstices nor-

mally filled with the occluded air with the size, and then drying the thoroughly sized paper in the vacuum chamber before it is subjected to atmospheric conditions. My invention further relates to carrying out this method continuously with a continuous web of paper which passes into and out of the vacuum chamber without breaking the vacuum. My invention further relates to certain steps, and combinations of steps, also to certain elements and combinations of elements, whereby the method or processes herein described may be carried out, as well as to certain details of construction, all of which will be more fully hereinafter described in the specification and pointed out in the claims.

The accompanying drawings, which are partly diagrammatic illustrate several, but not the only, forms of my apparatus, by the use of which my improved method may be practiced.

In the accompanying drawings the same reference numerals refer to similar parts in the several figures.

Fig. 1 is a vertical diagrammatic section through one form of apparatus which may be used to carry out my improved process;

Fig. 2 is a diagrammatic vertical section of a modified form in which the web of sheet material is passed through a heated bath to dry the same;

Fig. 3 is a vertical diagrammatic section of a modified form of apparatus in which a combination of heated drums and a heated bath are used to dry and finish the sheet material;

Fig. 4 is a vertical diagrammatic section of another modification in which different sized drums are used with a heated liquid bath to vary the finish given to the sheet material;

Fig. 5 is a vertical diagrammatic section of still another modification in which the web of sheet material is passed in folds or loops through the vacuum chamber adjacent to but not in contact with fixed heating surfaces; and

Fig. 6 is a vertical diagrammatic section of still another modification in which the web of sheet material is fed through the vacuum chamber, and in its passage through said chamber subjected to radiant heat, preferably a glowing member of an electric heater.

In describing my invention I will describe it as applied to sheet material in the form of paper though it is to be distinctly understood that textile fabrics may also be treated by my process and that my broader claims cover all forms of materials.

In the ordinary drying of a web of paper such high heat is used as to injuriously affect the fibers of the paper; and in case the paper is colored it will materially affect the

coloring matter and mordants used. Drying paper in the high temperatures used in ordinary practice often affects the size so that the resulting paper varies in quality, is not uniform and is not a perfect product.

In coating or impregnating fabrics it is found in practice that the coated fabric will frequently have blemishes due to large or small blisters and blow holes, these often being about the size of a pin-head or a pin-point. This is caused by the air which is held or occluded being collected, more or less, in small pockets under the coating or impregnating material, or in some cases causing minute blow holes. In water-proof fabrics this results in large quantities of the material being rejected with the consequent loss to the manufacturer.

By my invention I insure that substantially all the occluded air is withdrawn from the sheet material which will permit the coating or impregnating material, whatever it may be, to thoroughly fill these minute interstices or pockets normally occupied by occluded air, forming thereby a better and more uniform product and one devoid of blisters, blow holes or such blemishes. By my invention I immediately dry such coated or impregnated sheet material while still in the vacuum chamber so that when the sheet material emerges from the vacuum chamber the coating or impregnating material is dry and set without any danger of atmospheric pressure or atmospheric conditions spoiling or marring the finished product.

As previously stated I will describe my invention with relation to coating or impregnating paper, though it is to be understood that textile fabrics may be treated in the same manner.

The web of paper 1 is fed direct from the wet end of a paper making machine, or in some cases it may be fed from a roll or reel 2 of wet or damp paper. The web is fed into the vacuum chamber 3 by passing over the guide roller 4, into the liquid seal 5, under the submerging roller 6, and thence in contact with the guide roller 7. This liquid seal 5 may be of any suitable material which has no affinity for the sheet material treated and has no deleterious effect upon it. Preferably I use mercury as the sealing medium 5, but it is to be distinctly understood that any amalgam, alloy, or any other suitable liquid sealing medium may be employed which has the characteristics above specified.

The web 1 is immediately upon its entry into the vacuum chamber 3 dried preparatory to coating or coloring or impregnating it. I have shown in Fig. 1 a revolving drying drum or cylinder 8, which is heated in any suitable manner, and over which the web 1 passes and is dried preparatory to

entering the coating or impregnating bath 9. It may be fed into the bath in any suitable manner as by engaging with the guide roller 10 and under the submerging roller 11 in the chamber 12, containing the coating or coloring or impregnating bath 9. This bath may be of any suitable material to coat or impregnate or color sheet material whether it be paper or textile fabric. Simply by way of example, this coating or impregnating bath 9 may be size, tar, wax, or in fact any coating or waterproofing, or impregnating or coloring compound. The web is then fed through the squeeze rollers 13, 13, which remove all the surplus coating or coloring or impregnating compound, thence in contact with the guide roller 14 and over the second revolving heating drum 15, which completely dries the web with its coating or impregnating compound, thence in contact with the guide roller 16 and out through the second liquid seal 5 under the submerging roller 17 and over the guide roller 18, where the web 1 is preferably wound into the finished roll or reel 19. This second liquid seal 5 will preferably be of the same material as the first seal 5, though of course it may be varied provided it has no affinity for or deleterious affect upon the finished dry coated or impregnated web 1.

While I have shown one drying drum 8 to dry the web prior to coating or impregnating it within the vacuum chamber, it is of course understood that a greater number of drying drums may be used if found necessary or convenient. This also applies to the number of drying drums 15 to dry the web after it has been coated or impregnated.

The coating or impregnating compound 9 may be fed into the chamber 12 in any suitable manner such as by operating the cock 20 in the supply pipe 21. The material of the bath 9 may be withdrawn and the chamber 12 cleaned, preparatory to using a different coating or impregnating compound, in any suitable manner, such as for example, by operating the cock 22 in the pipe 23. This coating or impregnating bath may be heated if desired by passing steam or hot water through the pipes 24, 24. The vacuum chamber 3 is provided with exhaust pipes 25, 25 and is connected to any suitable form of vacuum machine or condenser to maintain the particular degree of vacuum within the chamber desired, and at the same time withdraw the steam, moisture, air, and other vapors given off by the web of paper as it dries. If the coating or impregnating material includes volatile liquid, which it may be desired to recover and use over again, this may be done in any well known manner. The vacuum chamber is provided

with windows, such for example as 26 and with suitable man-holes, not shown.

When the web passes into the vacuum chamber 3 and is dried over the drum 8 the high vacuum, which is preferably maintained, withdraws not only all of its moisture but also substantially all of its occluded air, so that while in this condition with its interstices, normally filled with occluded air free of such air, it passes immediately into the coating or impregnating bath 9 so that a better application of the coating or impregnating compound will be had because portions of the bath will fill these minute intersices in the web.

The drying drums or cylinders may be heated by exhaust steam or hot water, or otherwise. Their temperature may be varied within quite wide limits, but they must not be heated to such a temperature as to injuriously effect the material treated, or the size, or coloring matter or mordants, if such be used.

If the coating or impregnating material 9 is a compound including highly volatile liquids, these volatile liquids will of course boil or be given off at a lower temperature than that given above.

In my invention I thoroughly dry the coated or impregnated web at a relatively low temperature in the vacuum chamber so as not to injure its constituent fibers or elements, and also to permit the coating or impregnating compound to thoroughly set before the web is passed out of the vacuum chamber and subjected to atmospheric conditions. In my invention a smooth and fine product is obtained without blemishes, blisters or defects due to small portions of air being held under any of the coating; or seeking to escape therefrom, causing pinholes to appear on the surface. In passing the web over the revolving drying drums or cylinders it is given a flat and smooth surface.

In some cases it is desirable to give a different finish to the web than that which is given by the drying drums or cylinders of Fig. 1. When the web 1 is of paper it is also desirable, in some cases, to let the fibers of the web shrink under little or substantially no tension, so that the resulting sheet or web is substantially as strong lengthwise of the sheet as it is crosswise.

I have shown a modification in Fig. 2, in which the web 1 is fed from the wet end of a paper machine, or from a reel 2 in the same manner as in Fig. 1, into the vacuum chamber 25, through a similar liquid seal 5. In this form of my invention the web passes over the guide roller 26 and into a heated bath 27 of some medium which will dry the web but which has no affinity for, or deleterious action upon it. Prefer-

ably this heated bath is mercury, which may be heated in any suitable manner as by the steam pipes 28, 28. It is to be distinctly understood, however, that this heated bath may be any amalgam, alloy, or any other suitable medium which has the characteristics above specified.

Preferably the web is fed in folds or loops 29, 29 under submerging rollers 30, 30, and over the guide rollers 31, 31 the web having only sufficient tension upon it to insure its proper passage through the apparatus. After passing through the heated bath 27, and dried, the web is fed over the guide roller 32 and then, while still in the vacuum chamber, is fed into the chamber 33, through the coating or impregnating liquid 9. It then passes through the squeeze rollers 13, 13 which remove all surplus coating or impregnating compound, thence over the guide roller 34 and into the second heated bath 35 under the submerging rollers 36, 36 and over the guide rollers 37, 37. This bath 35 is one having the same characteristics as the first liquid bath 27. The web, now coated or impregnated, in passing through the second heated bath 35 is thoroughly dried and the coating or impregnating compound is set so when it passes out of the vacuum chamber through the second liquid seal 5, under the submerging rollers 17 and over the guide roller 18 it is a finished and dry product ready to be immediately rolled into a roll or reel 19.

In some cases it may be desirable to give the web 1 a finish and smoothness different from what it is given in the apparatus, shown in Figs. 1 and 2. I may for example pass the web 1, Fig. 3, into the vacuum chamber 38 through a similar liquid seal 5 and over comparatively small guide rollers 39, 39 and in contact with relatively large submerging rollers 40, 40 which may be heated and rotated, or not, as found convenient or desirable. These rollers 40, 40 are mounted in the liquid bath 41 preferably of mercury, though of any suitable medium having the characteristics previously described in connection with the baths 27 and 35, Fig. 2. The liquid in this bath may be heated in any suitable manner as by steam, hot water or products of combustion passing through the chamber 42.

After the web 1 has been thoroughly dried by its passage through this bath 41 and in contact with the drums 40, 40 the guide rollers 39, 39 it is immediately, while still in the vacuum chamber, passed into the compartment 43, containing the coating or impregnating liquid 9, thence through the squeeze rollers 13, 13 over the guide roller 44 and through the second liquid bath 45, while in contact with the drums or rollers 46, 46; the web passing over the guide rollers 47, 47. The liquid bath 45 is pref-

erably mercury, but it may be of any suitable material having the characteristics previously described. This second bath may be heated in any suitable manner, as by steam, hot water, or products of combustion passing through the chamber 48. The coated or impregnated web is dried in the second bath 45, where the coating or impregnating material is thoroughly set in the web at relatively low temperatures which temperatures do not injure the constituent elements or fibers of the web. It is then passed out of the vacuum machine through the second liquid seal 5 under the submerging roller 17 and over the guide roller 18 where it may be immediately wound into a finished roll of coated or impregnated paper or fabric 19.

The finish of the web, particularly if it is of paper, may be still further varied by changing the size of the rollers 39, 40 and 46 and 47. These changes may be made within wide limits. Simply for purposes of illustration I have shown in Fig. 4 another variation of my invention in which the vacuum chamber 49 is provided with the same liquid baths 41 and 45. The guide rollers 50, 50 of the first liquid bath and the guide rollers 52, 52 of the second liquid bath are substantially the same size as the similar guide rollers of Fig. 3, but the drums 51, 51 of the first liquid bath and the drums 53, 53 of the second liquid bath are smaller than the corresponding drums 40, 40 and 46, 46 respectively, of Fig. 3. In this modification the web 1 will not have a finish quite so flat and smooth as given by the apparatus shown in Fig. 3 or that shown in Fig. 1, but will give a flatter and smoother finish than the apparatus of Fig. 2. While these different forms are shown, it is of course to be understood that they are simply illustrative and that my invention is not to be confined to them.

The forms shown in Figs. 2 to 4 are the subject of my divisional application, Serial No. 545,218.

It is desirable in finishing some webs of sheet material, particularly paper, to pass them adjacent to, but not in contact with the heating elements. I have shown in Fig. 5 a vacuum chamber 54 provided with fixed heated elements 55, 55. These elements are preferably heated with steam or hot water. The web 1 of paper coming from the wet end of a paper machine, or from the roll 2, is passed through a portion of the vacuum chamber 54 in folds or loops 56, 56 with little or no tension upon it, only such as is sufficient to insure its proper passage over the guide rollers 57, 57 and 58, 58 and through the apparatus. Between one or more of these folds or loops 56, 56, preferably between each of the folds, I mount one of the fixed heating elements 55, 55 so that the web

will be thoroughly and uniformly dried on its passage from the guide roller 59 to the guide roller 60, and will also have substantially all of its occluded air removed by the high vacuum preferably maintained. It then passes into the chamber 61 in which is the coating or impregnating compound 9. In passing from this bath the squeeze rollers 13, 13 will remove the surplus liquid prior to the web passing over the guide roller 62 and through the compartment 63 of the vacuum chamber in contact with the guide rollers 64, 64 and 65, 65. Between one or more, preferably between each one of the folds or loops 66, 66 of the coated or impregnated web 1, I mount a fixed heating element 67, 67 which is heated by steam or hot water, and is in all respects, similar to the elements 55, 55 except that they are mounted in that portion of the vacuum chamber that is used to dry the coated or impregnated web. After passing through the compartment 63 to the guide roller 68, the web will have been dried at a comparatively low temperature and one which does not injure the fibers of the paper, it being well known that every time the fibers of paper are subjected to a high temperature they are more or less injured resulting in an inferior product. The web is then fed out of the vacuum chamber through the second liquid seal 5, under the submerging roller 17, over the guide roller 18 and is preferably, although not necessarily, rolled or reeled into the finished roll 19.

In some cases I may use a vacuum chamber 69, Fig. 6, in which the web 1 is fed through in folds or loops 70, 70 and in its passage is subjected to the action of radiant heat, preferably the glowing member of an electric heater 71. By the time the web reaches the guide roller 72 the web will be thoroughly dried and substantially all of its occluded air will be removed by the vacuum in the chamber. It is then passed into the compartment 73 containing the liquid or impregnating bath 9, then over the guide roller 74 where it is again passed in folds or loops 75, 75 through the portion 76 of the vacuum chamber. The coated or impregnated web is also preferably subjected to glowing members of other electric heaters 77, 77 mounted in the compartment 76, so that when the coated or impregnated web reaches the guide roller 78 it will be thoroughly dried and the coating or impregnating material will be thoroughly dry and set before the web passes out of the second liquid seal 5, under the submerging roller 17 and over the guide roller 18 to be wound into the finished roll or reel 19.

The forms illustrated by Figs. 5 and 6 are the subject of my divisional application Ser. No. 545,213.

The thermal efficiency of my vacuum

method is very much greater than that of the atmospheric cylinder drying heretofore in universal use for drying paper. Theoretically, it requires about 5287 pounds of steam to dry one ton of paper at atmospheric pressure, but to compensate for convection and conduction losses, and those due to leaks in the piping system, and other inefficiencies, it has been shown in practice that about 10,600 pounds are required.

Some of the modern open air paper dryers are equipped with a blower system by which air, either heated or not, is blown through the dryer section which is open to the atmosphere. This will lower the temperature at which the water is evaporated from the paper in such open air dryers much below 212° F., and may, in some cases, reduce the temperature of evaporation as low as 180° F. or lower.

In my method, using a vacuum of about 28", the convection, conduction and piping losses are exceedingly small and the total steam required to dry a ton of paper by my method is approximately 5200 pounds.

It is an established fact that paper dried at low temperatures is much stronger than when it is dried at the high temperatures used in paper machine atmospheric drying. Paper dried in a vacuum of 28", or at a temperature of about 100° F., as in my method, is very much stronger than paper dried at atmospheric pressure, when the steam in the driers is at 228° F. When paper is dried by my method, therefore, a cheaper furnish can be used and still produce a coated or impregnated or sized paper equal in strength to atmospheric dried paper, in which a higher grade furnish is used. In making newsprint paper, I am able to dispense with a considerable portion of the more expensive sulphite pulp, as this can be replaced with the cheaper ground wood pulp. By my method I also reduce the number of breaks in the web as it passes over the cylinder.

Furthermore, in my method there is a great saving of heat (or steam) because the process is carried on in a vacuum chamber which acts on the principle of a thermos bottle, and the steam and vapors driven out of the wet paper are caught in the closed vacuum chamber, and conducted away to the condenser. The operating room is free from steam, humidity and heat, and fans, and exhausters are dispensed with. In the use of my method the apparatus is at all times operating under definite humidity, the control of the drying can be closely standardized, and the moisture content in the paper carefully regulated.

By my process and apparatus the wet or damp web of sheet material, whether it be paper or textile material, is dried in a vacuum chamber and is rapidly coated or col-

ored or impregnated and immediately dried within the same vacuum chamber, so that when it emerges the coating or impregnating material is dried and set permitting it to be immediately wound into a roll or reel for transportation. The low temperature used and the great difference in temperature which I employ from that necessary under atmospheric conditions insure that the sheet material will not be injured in any particular and that the process may be speeded up, thereby reducing the cost of manufacture. The sheet material is never subjected to high temperatures, which high temperatures invariably injure its fibers or threads. I am enabled also to use a comparatively small machine, which takes up comparatively small floor space thereby reducing overhead expenses.

Having pointed out the many advantages of my method and apparatus over those heretofore used, it will be apparent that the use of my invention results in great economy in the initial cost of apparatus and in large savings in cost of operation, maintenance and repairs.

Having thus described this invention in connection with illustrative embodiments thereof, to the details of which I do not desire to be limited, what is claimed as new and what is desired to secure by Letters Patent is set forth in the appended claims.

What I claim is:—

1. The method of treating sheet material consisting in feeding it into and out of a vacuum chamber without breaking the vacuum, drying the sheet material in the vacuum chamber under slight tension sufficient to cause its constituent elements to slightly rearrange themselves in the direction of travel of the sheet material thereby giving a smooth and flat surface to the material treated, then coating, sizing or impregnating the sheet material while still in the vacuum chamber, and then immediately drying the coated, or impregnated or sized material while still in the vacuum chamber and prior to passing it into the atmosphere.

2. The method of continuously treating

sheet material consisting in feeding it into and out of a vacuum chamber without breaking the vacuum, continuously drying the sheet material in the vacuum chamber under slight tension sufficient to cause its constituent elements to slightly rearrange themselves in the direction of travel of the sheet material thereby giving a smooth and flat surface to the material treated, then coating, continuously sizing or impregnating the sheet material while still in the vacuum chamber, and then immediately and continuously drying the coated, or impregnated or sized material while still in the vacuum chamber and prior to passing it into the atmosphere.

3. The method of treating a wet web of paper consisting in feeding it continuously into and out of a vacuum chamber without breaking the vacuum, drying the web in the vacuum chamber and at the same time putting the fibers under more or less tension so that they will be pulled out slightly in the direction of travel of the web, coating, sizing or impregnating the web of paper in the vacuum chamber, and then while still in the vacuum chamber drying the coated, sized or impregnated web of paper and giving it a smooth flat surface before permitting it to pass into the atmosphere.

4. An apparatus for treating a web of paper, including a vacuum chamber, means to permit the web of paper to pass into and out of the vacuum chamber continuously without breaking the vacuum, drying means located in the vacuum chamber to dry the web and at the same time to cause its constituent fibers to slightly rearrange themselves from the position assumed by them on the wire of the paper machine thereby giving a smooth flat surface to the web of paper, means within the vacuum chamber to coat or size or impregnate the web, and other drying means mounted in the vacuum chamber to dry the coated or sized or impregnated web of paper prior to its continuous passage into the atmosphere.

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