

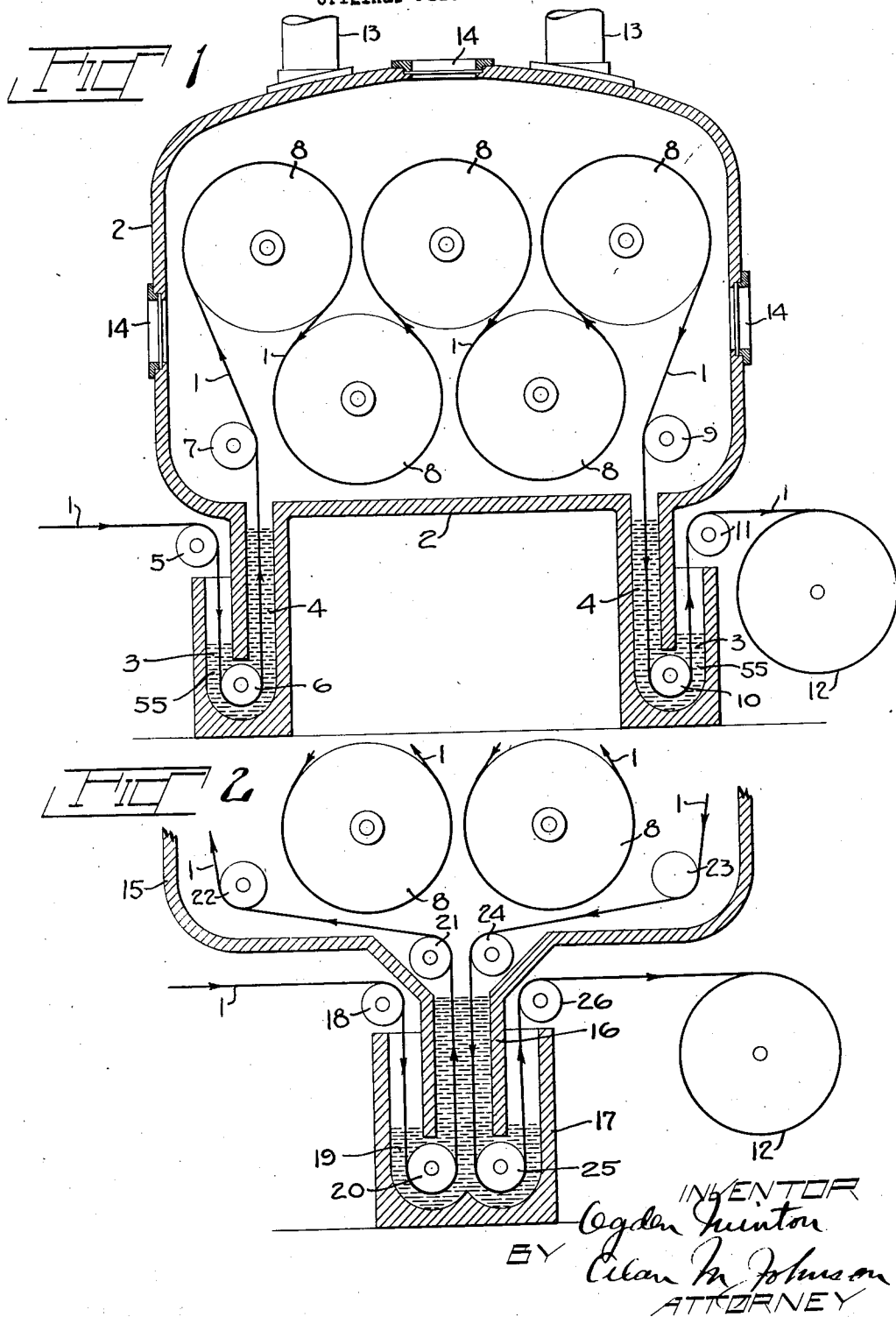
Aug. 10, 1926.

O. MINTON

1,595,473

METHOD AND APPARATUS FOR DRYING SHEET MATERIAL

Original Filed Jan. 8, 1920 2 Sheets-Sheet 1



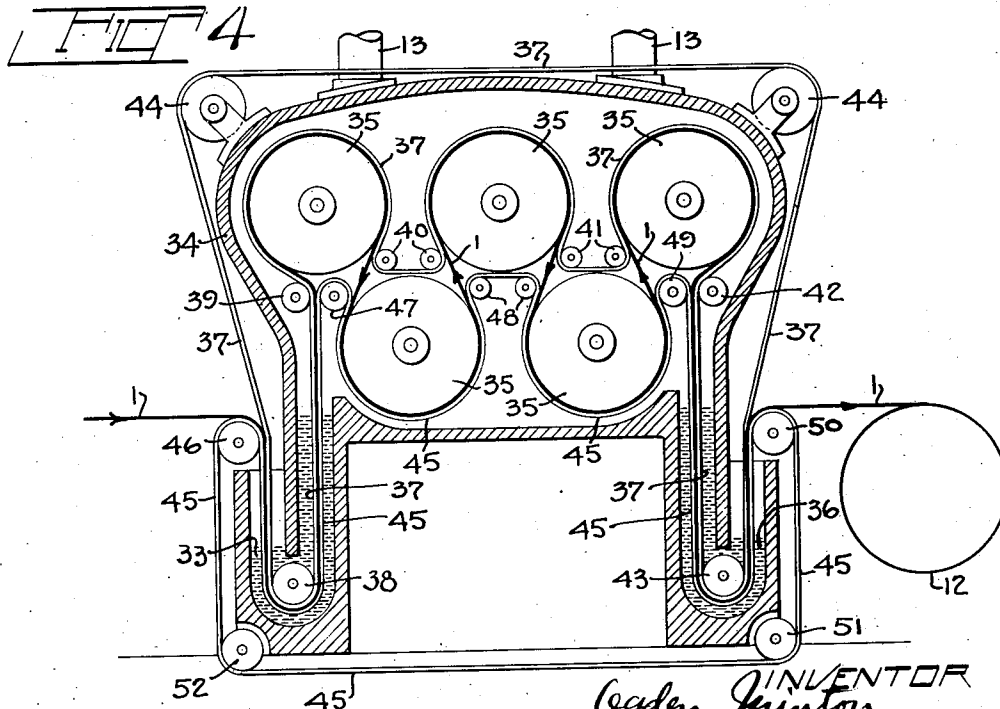
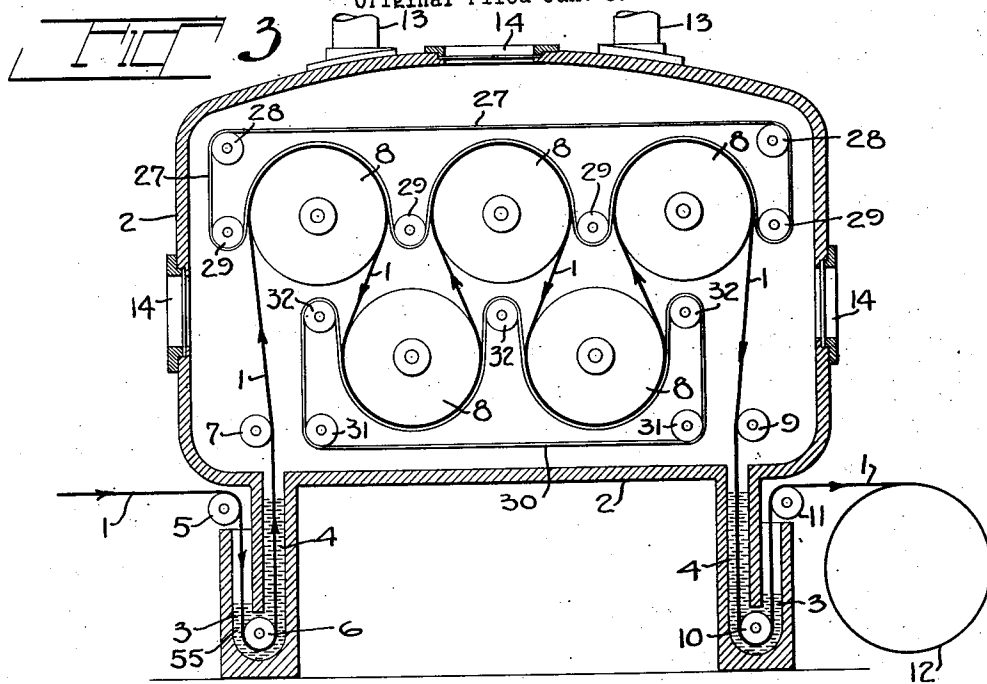
Aug. 10, 1926.

O. MINTON

1,595,473

METHOD AND APPARATUS FOR DRYING SHEET MATERIAL

Original Filed Jan. 8, 1920 2 Sheets-Sheet 2



Ogden Minton
BY Alan M. Johnson
ATTORNEY

Patented Aug. 10, 1926.

1,595,473

UNITED STATES PATENT OFFICE.

OGDEN MINTON, OF GREENWICH, CONNECTICUT.

METHOD AND APPARATUS FOR DRYING SHEET MATERIAL.

Application filed January 8, 1920, Serial No. 250,233. Renewed February 17, 1926.

My invention relates to drying material as for example sheet material in a vacuum chamber while in contact with a heated element. My invention further relates to passing said material of said sheet material, into and out of the vacuum chamber without breaking the vacuum. My invention further relates to continuously drying sheet material by continuously passing it into and out of the vacuum chamber, without breaking the vacuum, and heating it while in the vacuum chamber in contact with heated drums or cylinders.

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 taking a web of wet paper, either from the wet end of a paper making machine, or from a seizing vat or from a coloring apparatus or coating machine or a printing machine and continuously passing the web of paper into and out of a vacuum chamber, without breaking the vacuum in the chamber, and heating, smoothing, flattening and drying said web of paper in said vacuum chamber.

My invention further relates to employing one or more heated cylinders or drums in said vacuum chamber, over which the web of paper passes, and which exerts a slight tension upon said paper to slightly rearrange the fibers of said paper to insure a flat and smooth finished sheet of paper, but drying it at such a low temperature as not to injure the fibers of the paper, or the size, or mordants and coloring matter if any be used.

My invention further relates to feeding and pressing said web of paper or sheet material into contact with said drying drum or drums in said vacuum chamber. My invention further relates to passing said sheet material or paper through a liquid sealing

medium into and out of said vacuum chamber, said sealing medium being formed of any liquid material which will have no deleterious effect upon, or affinity for, either the wet or dry sheet material or paper.

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.

I have shown in the drawings, somewhat diagrammatically, different forms of apparatus which may be used to carry out my improved method, but it is to be distinctly understood that my invention is not to be confined to the particular form of apparatus, shown by way of illustration.

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 fragmentary diagrammatic vertical section of a modified form in which one seal is used instead of two;

Fig. 3 is a vertical diagrammatic section of a form of apparatus in which I may employ one or more means to press or feed the web, or sheet of material, into contact with the heated drying drums or drum.

Fig. 4 is a vertical diagrammatic section of a modification in which the endless felts or belts pass into and out of the vacuum chamber without breaking the vacuum.

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 it is equally applicable to and covers drying sheet material in the form of textile fabrics, as for example, drying such fabrics after they have been washed, or bleached or dyed, or otherwise treated with a liquid of some description.

In the ordinary drying of a web of wet 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. In drying paper in the high temperatures used in ordinary practice often af-

fects the size, so that the resulting paper varies in quality, is not uniform, and is not a perfect product.

By my invention I take the web of paper 1, either as it comes from the wet end of a paper machine, or from a sizing vat, or from a coloring apparatus or coating machine or a printing machine and pass it into a vacuum chamber 2 so that the vacuum in said chamber will not be broken either as the web of paper enters or is withdrawn after being treated.

I have shown, for purposes of illustration, the vacuum chamber 2 provided with liquid seals 3 and 4. The sealing medium used may be any suitable material which has no affinity for the sheet material and has no deleterious action upon it. I have found in practice that mercury is a very satisfactory sealing medium and this is the sealing medium that I preferably employ, 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.

I pass the web 1 over the guide roll 5, around the guide roll 6 in the sealing bath 3 and thence up in contact with the guide roll 7, in the vacuum chamber 2, and around one or more revolving, heated, drying drums 8, 8, five being shown by way of illustration, though this number may be increased or decreased as found expedient.

The web is then fed out of the vacuum chamber, passing the guide roll 9 and out through the seal 4 under the guide roll 10 and over the guide roll 11, where it may be immediately rolled or reeled into a roll or reel 12 of dry finished paper.

In drying the web 1 of paper in contact with the drying drums 8, 8, there is some slight degree of tension upon the web which will cause the fibers of the paper to slightly rearrange themselves, forming a sheet of dry paper, which is very flat and smooth.

The vacuum chamber 2 is provided with pipes 13, 13 which are connected to any suitable form of vacuum machine or condenser to maintain the particular degree of vacuum within the chamber desired, withdrawing the steam, moisture and air given off by the web of paper as it dries. I also preferably provide the vacuum chamber with one or more windows 14, 14 so that the operation within the vacuum chamber may be observed.

In some cases, instead of having two seals for the vacuum chamber, I may use only one seal, as shown for example in Fig. 2. In this form of my invention the vacuum chamber 15 is provided with a funnel shaped member 16, which fits into a cup shaped member 17. The web 1 is fed around the guide roller 18, within the liquid sealing medium 19, under the guide roller 20, thence

into the vacuum chamber 15, in contact with the guide rolls 21, 22, and thence in contact with the drying drums 8, 8 the guide rolls 23, 24 and emerges as a dry sheet, through the same funnel shaped member 16 into the same liquid sealing member 19, under the guide roll 25 and thence out into the atmosphere over the guide rolls 26, where it may be wound into a roll or reel if so desired.

In some cases I employ means for feeding and pressing the web 1 into contact with the heating elements mounted within the vacuum chamber. I may for example feed the web 1, through the liquid sealing medium into the vacuum chamber 2, passing it around the drying drums 8, 8 the same as in Fig. 1, but in addition thereto having one or more endless felts or aprons 27, passing over the rollers 28, 28 and under the rollers 29, 29. This felt or apron serves to press and feed the web 1 in close contact with three of the steam cylinders 8, 8. In addition to the endless felt 27 I may employ an additional endless felt 30 which passes under the rollers 31, 31 and over the rollers 32, 32. This endless felt 30 serves to press the web into contact with the two bottom heating drums 8, 8.

In some cases I may employ endless felts or aprons which pass into and out of the vacuum chamber without breaking the vacuum. Preferably, in this form or modification of my invention I feed the endless felt or apron, through the same sealing bath that the web of paper is fed into and out of.

I have shown such a modification of my invention in Fig. 4, in which the web 1 of sheet material, whatever that sheet material may be, is fed into a sealing bath 33 of the vacuum chamber 34, then around the heating drums 35, 35 and thence out through the sealing bath 36. Passing into the sealing bath 33 with the web 1 is an endless felt 37, which passes under the guide roll 38, at the bottom of the seal 33, and thence into the vacuum chamber in contact with the guide roll 39, the first heating drum 35, and then around the guide rolls 40, 40, the second drying drum 35, the guide rolls 41, 41, the third heating drum 35, guide roll 42, guide roll 43 in the second sealing bath 36, and out of said bath over the top of the vacuum chamber passing over the guide rollers 44, 44.

I may also, though not necessarily, employ a second endless felt 45, passing over the guide roll 46 with the sheet material 1, thence under the guide roller 38 in the first liquid seal, around the guide roll 47, one of the lower heating drums 35, guide rollers 48, 48, the other heating drum 35, guide roller 49, under the guide roller 43 and over the guide roller 50 and under the vacuum chamber 34 in contact with the guide rollers 51, 52. In this form of my invention

the web 1 enters and emerges from the sealing baths between the two endless felts 37 and 45.

It is of course to be understood that the drying cylinders or drums 8, 8 are driven by any suitable power, and that doors are used to permit cleaning of the vacuum chamber and for rethreading of the machine should this become necessary.

My method possesses many advantages not present in processes heretofore used for many years in the drying of paper.

The evaporation process, which is characteristic of the so-called loft drying of paper, has many fully recognized disadvantages, and yet it is used today and has been in use for many years. In this method the wet paper is taken from the paper machine, cut into sheets, hung on poles, carried to the drying room where it is subjected to hot air at about 130° F. for about 48 hours, and when dry, each sheet is separately calendered. Although possessing the advantage of drying at a comparatively low temperature, whereby the moisture is slowly evaporated, loft drying is obviously very inefficient and costly, because it requires many separate manipulations, is extremely slow, uses extensive floor space and wastes heat.

The process which is employed in the ordinary paper machine in common use, is likewise subject to many disadvantages. In such machine, the wet paper as it comes from the paper machine, is passed over many revolving cylinders, heated internally by steam to sufficiently high degree of heat, to raise the temperature of the water in the paper to 212° F., the atmospheric boiling point of water. It is customary to supply the drying cylinders with steam at approximately 5.3 pounds gauge pressure, at which the steam has a temperature of 228° F., giving a difference of temperature (228° - 212°) of only 16° F. With this slight difference of temperature the transfer of heat is extremely slow, and hence it is necessary to employ many drying cylinders, in board machines often one hundred, and in news print machines, forty or more.

Also due to convection and conduction losses, as well as those incident to leaks in the piping system and other inefficiencies, the heat actually required for atmospheric drying of a ton of wet paper, is very much in excess of the theoretical requirement. The thermal efficiency of atmospheric drying by steam heated cylinders is therefore very low. Furthermore, the steam produced from boiling the water out of the paper, is driven off into the operating room, and although fans and exhausters are employed, at large expense for power and maintenance, the room atmosphere is so constantly saturated with moisture as to rust and ultimately destroy all iron and

steel materials, and produces an exceedingly disagreeable and unhealthy atmosphere in which to work. It is well known that the minimum temperature 212°, the atmospheric boiling point of water, is positively injurious to, and results in oxidizing, the fibres of the paper, the strength of which is vastly improved when the paper is dried at lower temperatures, as in loft drying. This atmospheric drying process requires large initial cost for cylinders, felts, and other necessary equipment, and extensive floor space, and results in the consumption of large amounts of power, and great cost for operation, maintenance and repairs.

In my improved vacuum drying method I contemplate maintaining within the chamber a vacuum of about 28" of mercury, in which water boils at 100° F., and supplying the drying cylinders with steam at 5.3 pounds gauge pressure, producing a temperature of 228° F. The temperature difference between the temperature of the steam in the cylinders and that of the paper is therefore, 128° F. in my vacuum method, or 8 times greater ($16^\circ \times 8 = 128^\circ$ F.) than the temperature difference in atmospheric drying. In my improved method the paper dries approximately 8 times faster than in atmospheric drying, and I require only about one-eighth the number of drying cylinders to dry paper at the same rate of speed. I am able to dry paper with 5 cylinders in the same time required of 40 cylinders drying at atmospheric pressure, resulting in great economies in cost of the machine, floor space and of necessary piping, felts, auxiliary equipment, and particularly in power and maintenance charges.

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 4287 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.

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 or stock can be used and still produce a paper equal in strength to atmospheric dried paper, in which a higher grade furnish or stock 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 cylinders.

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.

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

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 drying a web of paper consisting in passing it into a vacuum chamber through a liquid seal which has no affinity for said web, passing the web while in the chamber over one or more revolving heated drying drums to dry, flatten, and give a smooth finish to the web, pressing said web of paper into contact with said heated drying drums, and then passing said dry, flat and smooth web of paper out of the chamber through a liquid seal which has no affinity for said web.

2. The method of drying paper consisting in passing a web of the paper in contact with one or more endless felts into a vacuum chamber through a liquid sealing

medium which has no affinity for, or deleterious effect upon the paper, drying said web in said vacuum and withdrawing the dry web of paper and the felts from the vacuum chamber through a liquid sealing medium having the same characteristics.

3. The method of drying material consisting in passing it into a vacuum chamber through a sealing medium which has no affinity for said material, drying, and smoothing the entire surface of the material while in the vacuum chamber, and then passing the dry and smooth material out of the vacuum chamber through a sealing medium which has no affinity for the material dried.

4. The method of drying sheet material consisting in passing it into a vacuum chamber through a sealing medium which has no affinity for said sheet material, drying, and smoothing the entire surface of the sheet material while in the vacuum chamber, and then passing the dry and smooth sheet material out of the vacuum chamber through a sealing medium which has no affinity for the sheet material.

5. The method of continuously drying a web of paper consisting in passing it into a vacuum chamber through a sealing medium which has no affinity for or deleterious effect upon said web, drying said web in the vacuum chamber and at the same time putting it under slight tension so that its constituent elements will slightly rearrange themselves to form a smooth flat surface over the entire surface of the paper, and passing said web with its smooth flat finished surface out of said vacuum chamber through a sealing medium which has no affinity for or deleterious effect upon said web.

6. The method of continuously drying a web of paper consisting in passing it into a vacuum chamber through a sealing medium which has no affinity for or deleterious effect upon said web, drying said web in the vacuum chamber and at the same time putting it under slight tension in the direction of its travel so that its constituent elements will tend to be drawn out slightly in the direction of the travel of the web to form a smooth flat surface over the entire surface of the paper, and passing said web with its smooth flat finished surface out of said vacuum chamber through a sealing medium which has no affinity for or deleterious effect upon said web.

7. In a vacuum drying apparatus the combination of a vacuum chamber, having entrance and exit passages, liquid sealing means sealing said entrance and exit passages, the liquid of said seals having no affinity for or deleterious effect upon the material to be dried, and means mounted within the vacuum chamber to dry material passing therethrough and at the same time

cause a slight mechanical rearrangement of the constituent elements of the material dried.

8. In a vacuum drying apparatus the combination of a vacuum chamber, having entrance and exit passages, liquid sealing means sealing said entrance and exit passages, the liquid of said seals having no affinity for or deleterious effect upon the material to be dried, and means mounted within the vacuum chamber to dry sheet material passing therethrough and at the same time cause a slight mechanical rearrangement of the constituent elements of the sheet material dried.

9. In a vacuum paper drying apparatus the combination of a vacuum chamber, having entrance and exit passages, liquid sealing means sealing said entrance and exit passages, the liquid of said seals having no affinity for or deleterious effect upon the paper to be dried, and means mounted within the vacuum chamber to dry a wet web of paper passing therethrough and at the same time cause a slight mechanical rearrangement of the constituent fibres of the web of paper.

10. In a vacuum drying apparatus, a vacuum chamber, having entrance and exit passages, liquid sealing means sealing said entrance and exit passages, the liquid of said seal or seals having no affinity for or deleterious effect upon the material to be dried, drying means mounted in the vacuum chamber, said means comprising rotatable means to advance the material to be dried, and means traveling with the material to be dried adapted to press said material into contact with the drying means.

11. In a vacuum drying apparatus, a vacuum chamber, having entrance and exit passages, liquid sealing means sealing said entrance and exit passages, the liquid of said

seal or seals having no affinity for or deleterious effect upon the material to be dried, drying drums or cylinders mounted in the vacuum chamber, said drums or cylinders rotating so as to advance the material to be dried, and means traveling with the material to be dried adapted to press said material into contact with the said drying drums or cylinders.

12. The method of drying material consisting in passing it into and out of a vacuum chamber through liquid seals, protecting it from coming in contact with the liquid of the seals, and drying said material in the vacuum chamber.

13. The method of drying material consisting in passing it into and out of a vacuum chamber through liquid seals, protecting it by two traveling felts or belts from coming in contact with the liquid of the seals, and drying said material in the vacuum chamber.

14. The method of drying a web of wet paper consisting in passing it into and out of a vacuum chamber through liquid seals and protecting the web of paper from coming into contact with the liquid of the seals by a plurality of traveling felts or belts, and drying the web of paper in the vacuum chamber.

15. In a vacuum drying apparatus, a vacuum chamber, having entrance and exit passages, liquid seals for the passages, and means to protect the material to be dried from coming in contact with the liquid of the seals as it passes through said seals.

16. In a vacuum drying apparatus, a vacuum chamber, having entrance and exit passages, liquid seals for the passages, and traveling felts or belts to protect the material to be dried from coming in contact with the liquid of the seals as it passes through said seals.

OGDEN MINTON.