Aug. 10, 1926. 1,595,240

O. MINTON

VACUUM SEAL, METHOD AND APPARATUS

Filed June 20, 1923 4 Sheets-Sheet 1

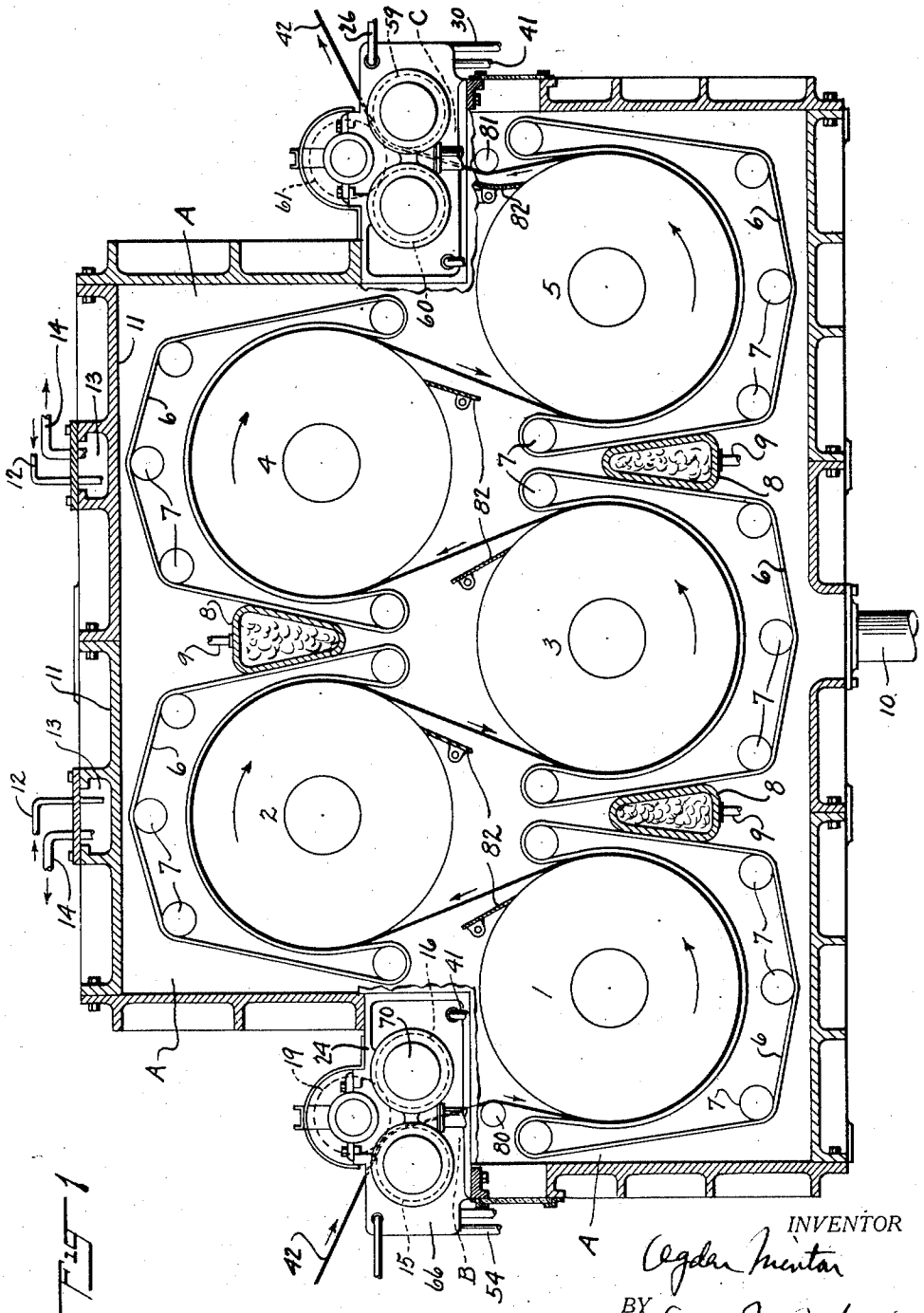


Fig. 1

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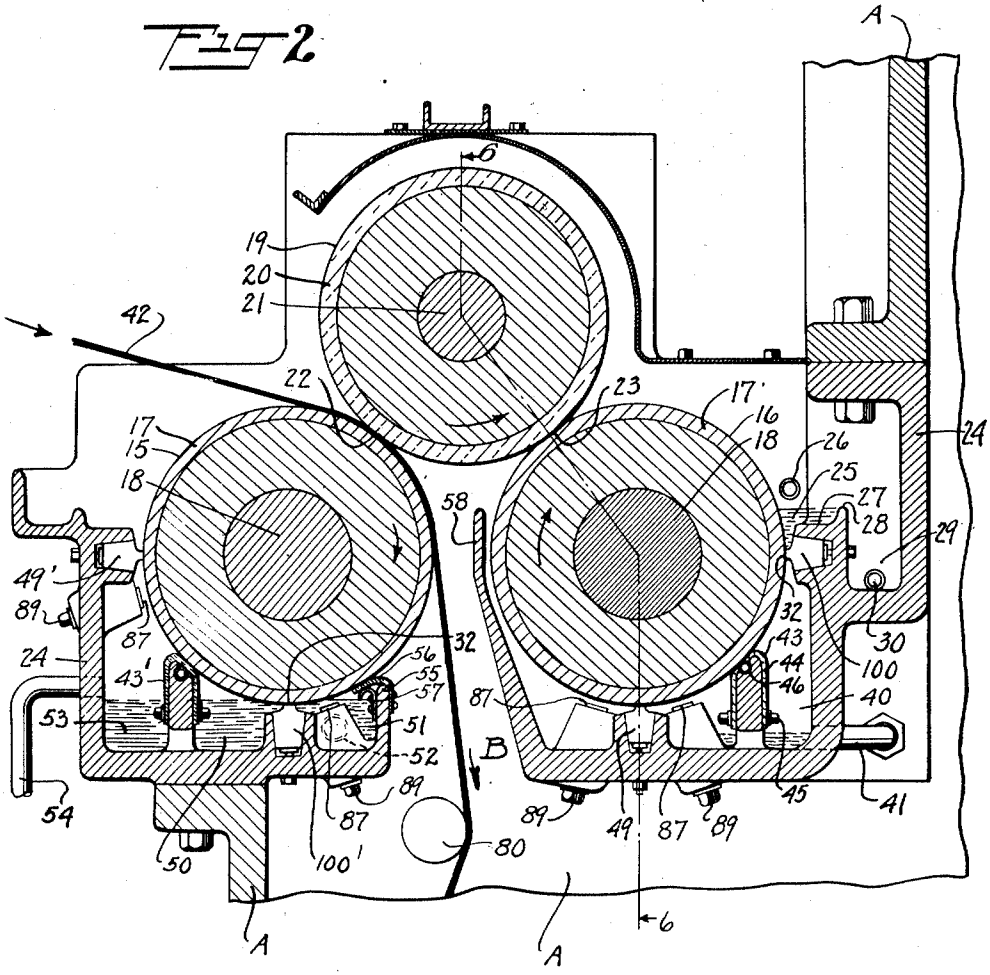
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Fig 2



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VACUUM SEAL, METHOD AND APPARATUS

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Fig. 3

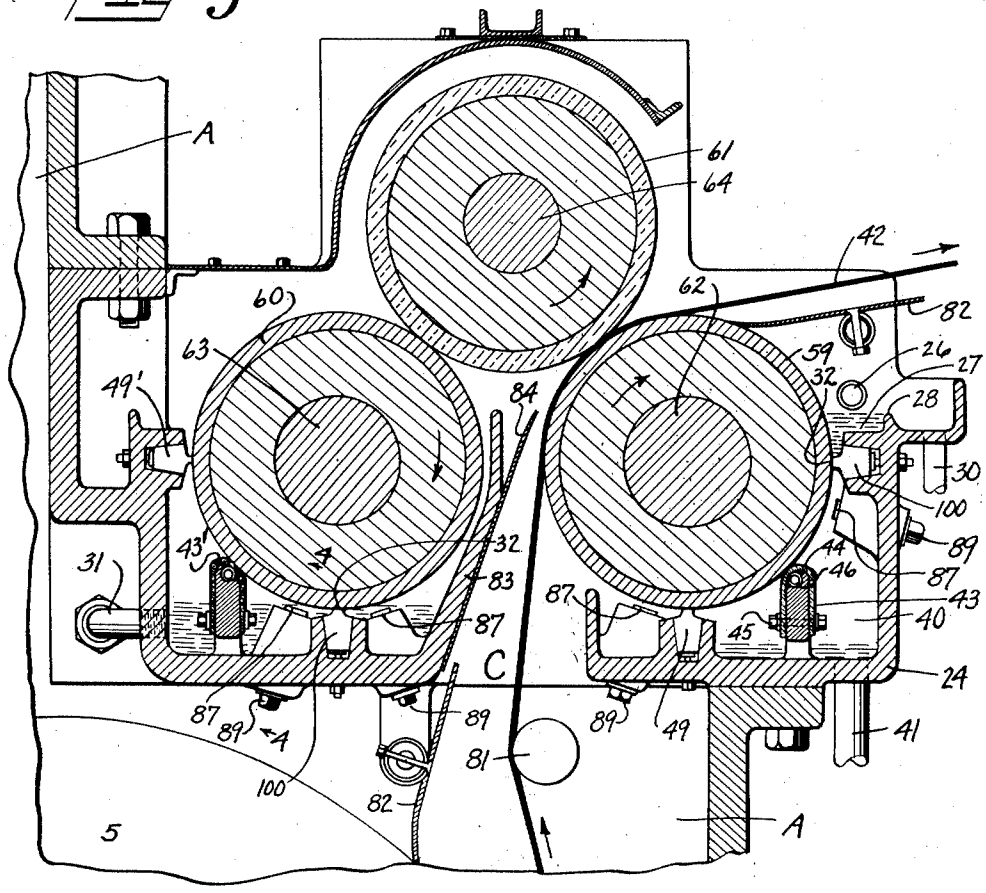


Fig. 4.

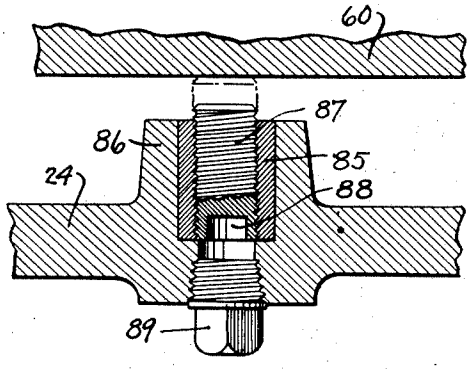
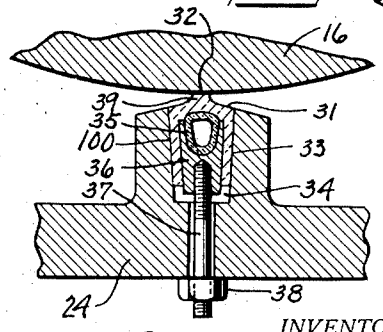


Fig. 5



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VACUUM SEAL, METHOD AND APPARATUS

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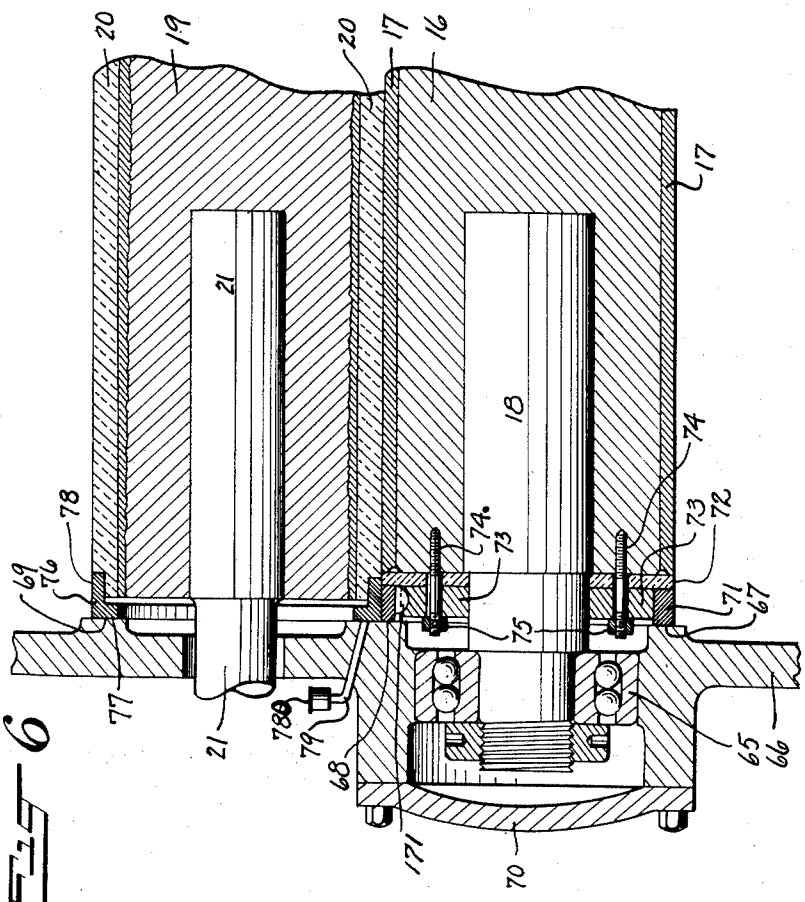


Fig. 6

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UNITED STATES PATENT OFFICE.

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VACUUM SEAL, METHOD AND APPARATUS.

Application filed June 20, 1923. Serial No. 646,693.

My invention relates to the method of treating materials in a vacuum, and more particularly to the method of protecting the opening or openings into the vacuum chamber, through which opening or openings the material to be treated is introduced and withdrawn from the chamber.

More particularly it relates to sealing the entrance and exit passages of the vacuum chamber by a plurality of rotating contacting members forming between them a dry rotating air-tight closure, and sealing other portions of the surfaces of the rotating members by means of liquid seals.

My invention further relates to passing the web of paper, or other material to be treated into the vacuum chamber, through the rotating dry air-tight closure without the aid of belts.

My invention further relates to sealing said rotating members with liquid seals, the liquid not coming in contact with the unguarded or unprotected web of paper, or other similar material, to be dried or otherwise treated in the vacuum chamber.

My invention further relates to the method of permitting a film of the liquid of the liquid seal, to pass through a restricted adjustable passage in contact with a portion of a rotating member and then removing the liquid, forming said film, from the rotating member before that portion of the rotating member again comes in contact with the web of paper, or similar material, to be treated in the vacuum chamber.

My invention further relates to a closure for a vacuum chamber consisting of a plurality of rotating members sealing the inlet and exit passages to said chamber, at least one of each set of rolling contact members being provided with a yielding periphery to come in direct contact with, and press the material to be treated, firmly against one of the other rolls to form a dry rolling air-tight closure, and then sealing other portions of the rolls by means of a liquid seal.

My invention further relates to one form of apparatus, to carry out my improved method. in which the periphery of one or more of the rotating rolls is rendered air-tight by means of a liquid seal, and the ends of said roll or rolls are rendered air-tight by packing means; or, preferably, by another liquid seal to form a film of liquid, preferably a lubricant, between the ends of said roll or rolls and a fixed non-rotating part of the vacuum apparatus.

The liquid which I preferably employ to seal the periphery of the roll or rolls is water, or similar liquid. When a liquid is used to seal the end of the roll or rolls, water or a similar liquid may be used, but preferably I employ some lubricating oil to form a lubricating film between the rotating and stationary parts so as to reduce friction, as my device is meant to be used at high speeds where a lubricant would be necessary. It is understood, however, that my invention may be used at either high or low speeds.

My invention further relates to the method of drying any sheet material in a vacuum chamber, whether such material be woven fabric or not. It relates more particularly to drying a continuous web of paper either coming from the wet end of a paper machine, or from a sizing vat, or from a coloring apparatus, coating machine or printing machine or directly from a roll of wet paper.

My invention further relates to certain steps and combination 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.

Various forms of apparatus may be employed to carry out my improved method. I have shown in the accompanying drawings one form of apparatus which may be so used; but it is to be distinctly understood that this form is shown simply by way of example and that my invention is not to be confined to it.

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

Fig. 1 is a vertical section through a vac-

uum drying apparatus, which is shown somewhat diagrammatically, the entrance and exit passages of the vacuum chamber being protected by my improved vacuum seals which are shown in side elevation;

Fig. 2 is a vertical section on an enlarged scale of my vacuum seal protecting the entrance of the vacuum chamber;

Fig. 3 is a vertical section of my vacuum seal protecting the exit passage of the vacuum chamber;

Fig. 4 is a detail vertical section substantially on the line 4—4 of Fig. 3;

Fig. 5 is a detail section;

Fig. 6 is a vertical section on the staggered section line 6—6 of Fig. 2, showing the manner of mounting the rotating rolls.

The vacuum chamber A, Fig. 1, may be of any suitable construction and provided with drying drums or cylinders 1, 2, 3, 4 and 5. The drying drums or cylinders are steam heated (not shown) in the well known manner in the art and each drying drum or cylinder is provided with a separate felt 6 running over guide rolls 7, 7. These separate felts 6, 6 may be dried in any suitable manner, such as by passing adjacent to, or in contact with, steam radiators 8, 8, to which steam is supplied by the pipe 9, one of these steam radiators being preferably mounted between two of the separate felts 6, 6 and serving to dry both felts. The entrance B to the vacuum chamber A is protected by one of my seals; the exit passage C is protected by a similar seal, a little differently arranged, but the same in all essential particulars.

The vacuum is maintained in the vacuum chamber A in any suitable manner, such as by connecting pipe 10 with any suitable form of vacuum apparatus or condenser. In some cases, to prevent condensation of water upon the top 11 of the vacuum chamber, I may heat the top 11 in any suitable manner, as by passing steam or hot water through the pipes 12, 12 into the transverse chambers 13, 13 and out through the pipes 14, 14. This will prevent any moisture condensing on the top of the vacuum chamber and dropping onto the drying drums or cylinders 2 and 4, or upon the upper felts 6, 6 running in contact with these drying drums or cylinders.

In the preferred form of apparatus, carrying out my method I preferably employ three rolls to guard and seal each passage into and out of the vacuum A, making, in this form of apparatus, six rolls in all. In each group, or set of three rolls, two of them, 15 and 16, Fig. 2, and 59 and 60, Fig. 3, are rolls provided preferably with a brass periphery 17, 17. The body of these rolls is preferably iron and on their ends are mounted steel bearing shafts 18, 18 and 62 and 63. The rolls 19 and 61 are preferably formed of iron and are provided with a yielding periphery 20, preferably rubber, and rest upon the other rolls 15 and 16 and 59 and 60, as shown respectively in Figs. 2 and 3. This rubber periphery 20 may be secured to the roll 19 in any suitable manner, such as by being vulcanized on the rolls. These rolls 19 and 61 are also provided with steel bearing shafts 21, 64 secured to them in any suitable manner.

At the point 22, where the rubber roll 19 rests upon the brass roll 15, there will be a dry air-tight rolling closure, and a similar dry air-tight rolling closure at point 23 where the rubber roll 19 rests upon the brass roll 16.

To make the periphery of the brass rolls 15 and 16 air-tight, with relation to the frame 24 of the seal, which frame is secured to, and is practically a part of, the vacuum apparatus A, I employ a liquid seal 25, Fig. 2. This liquid is preferably water, or any other similar material, and is fed through the supply pipe 26 into the chamber 27, surplus water falling over the weir 28 into the well 29, where it is drawn off by means of the waste pipe 30. Free passage of the liquid 25, as for example, water, into the vacuum chamber is prevented by an adjustable wiper or packing 100. This wiper or packing is formed of a contact member 31 (see Fig. 5 for construction) bearing against the brass roll 16 and forming a restricted passage 32. This member 31 is adjustable so that the area of the restricted passage 32 is also adjustable depending upon the degree of pressure with which the member 31 is pressed against the periphery of the brass roll 16.

This member 31 is preferably formed of rubber and has a surface 33 to fit into the flaring opening 34 in the frame 24. Mounted within the rubber member 31 is a pneumatic inflatable tube 35, and a metal adjustable member 36 within which fits the end of the bolt 37 provided with a nut 38. In positioning the parts the rubber member 31, the pneumatic tube 35 and the metal member 36 are placed in the flaring opening 34 and the rubber member is locked to the frame 24 by rotating the nut 38. This will cause the conical metal member 36 to move down the inclined surface of the rubber member 31 and lock it firmly in the socket 34. Air under pressure is forced into the pneumatic tube 35 thereby pressing the portion 39 of the rubber member 31 into contact with the brass roll 16. This pneumatic pressure upon the end 39 of the rubber member 31 serves to regulate the area of the restricted passage 32, and consequently the amount of liquid 25 which will pass into the well 40 which is connected with the vacuum maintained in the vacuum chamber A. The liquid which passes through the restricted passage 32 falls into this well 40 and is

drawn off in any suitable manner as by the pipe 41, which is connected to an evacuated receiver and pump.

I may use other types of packing in place of the member 31 to form a restricted passage.

The member 31 may be so firmly pressed against the roll 16 as to permit hardly any liquid to pass through the restricted passage 32. Preferably, however, the pressure within the tube 35 is so regulated that only a small quantity of water will pass through the restricted passage 32 in the form of a film adhering to the periphery of the roll 16. This film of water serves as a seal against the admission of air to the vacuum chamber, and also as a lubricant, in that it prevents excessive wear of the surface 39 of the rubber member 31 against the roll. I may in some cases use only the member 31, both as a seal and wiper. That is, the film of water is so small as not to be objectionable.

Before this film of water on the brass roll 16 could be transferred to the rubber roll 19, and by it transferred to the web of paper or other similar material 42 to be treated, I substantially remove the film of liquid from the roll 16. This may be done in various ways.

I have shown in Fig. 2 a pneumatic wiper 43 consisting preferably of a strip of flexible material 44 held at its longitudinal edges by means of the fastening devices 45 and passing over a flexible pneumatic tube 46. Pneumatic pressure within this tube 46 will press the material 44, with any desired pressure, against the periphery of the roll 16 necessary to remove the excess liquid which may adhere to the periphery of said roll.

In some cases I may use a second pneumatic wiper 49, which is similar in all respects to the wiper 100, shown in Fig. 5, except the parts are so adjusted as to remove any surplus moisture which may pass the first wiper 43. The wiper 100 is preferably adjusted, as previously stated, to form a very small restricted passage 32 to permit a thin film of liquid to pass between it and the roll. The wiper 49 is adjusted to remove any film of liquid, which may not be removed by the wiper 43.

In connection with the cooperating brass roll 15 I use duplicate restricted passages and wipers but they have to be arranged in a little different manner; their function, however, is the same.

The brass roll 15 revolves in contact with the liquid seal 50 of water, or similar liquid, which is fed into the receptacle 51 through the water inlet 52 and passes through the restricted passage 32 formed by the wiper 100 and between the end 39 of the rubber 31 of said wiper, and the brass roll 15. The action of this device is the same in all respects as the one previously described in connection with the roll 16. The liquid of the seal will pass through the restricted passage 32 and will be caught in the portion 53 of the receptacle 51. Any excess liquid will flow into the overflow waste pipe 54. Since the roll 15 revolves clockwise and in contact with the liquid of the seal some of the liquid will adhere to its surface. This is removed by a wiper 43′, which is the same in all respects as the wiper 43 previously described. That portion of the liquid seal lying to the right of the restricted passage 32, Fig. 2, will be under the vacuum maintained in the vacuum chamber A, while that portion of the liquid seal to the left of the restricted passage 32 will be under atmospheric pressure, the restricted passage 32 being the dividing line between the vacuum and the atmospheric pressures.

Should any moisture remain upon the brass roll 15 after it passes the wiper 43, it may be removed by the wiper 49′, which is the same in all respects as the wiper 49 operating in connection with the roll 16. It may be, however, adjusted closer to the brass roll to substantially remove any moisture from the roll, rather than to form a restructed passage and permit a thin film of liquid to pass between it and the roll.

To guard against splash or spray of water being carried into the machine proper. I preferably mount a strip of felt, or other similar material 56 on the edge 55 of the receptacle 51, the felt 56 being partly supported by a shelf or bracket 57. In some cases I may also employ a guard 58, as shown in Fig. 2.

The exit passage C in the vacuum chamber A is protected by a similar set of rolls and liquid seals.

In this set the rolls (Fig. 3) 59 and 60 are the brass rolls and 61 is the rubber roll. The restricted passage 32 and the wipers 43 and 49 are the same, as previously described except that they are necessarily located a little differently from their prototypes located at the inlet B of the vacuum chamber A.

I can seal the ends of the different sets of rolls by packing means alone. Preferably, however, I seal the ends by another liquid seal, which is simply a thin film of liquid, preferably, a lubricant as my device may be run at high speeds.

I have shown the roll 16, Fig. 6, supported by means of a roller bearing 65 (only one being shown in Fig. 6) carried by the face plate 66. This face plate 66 is secured to the frame 24 of the seal and is provided with smooth contact bearing surfaces 67, 68 and 69. The rolls 15 and 16 are supported as shown in Fig. 6. A cap 70 protects the roller bearing 65.

On the end of the rollers 16 is mounted

a metal ring 71 which bears directly upon the smooth lubricated surfaces 67 and 68 of the face plate 66. Between the metal sealing ring 71 and the end of the roll 16, I mount a resilient member, as for example, a ring of rubber 72, to yieldingly press the metal sealing ring 71 against the stationary surfaces 67 and 68 on the face plate 66. This metal ring 71 is supported directly upon an annular ring 73 which, in turn, is secured to the end of the brass roller 16 by means of the bolts 74, 74.

The metal ring is keyed to the annular supporting ring 73 by the key 171.

The nuts 75, 75 are used to clamp the rubber ring 72 in place and hold it true. This construction is, of course, duplicated on the other end of the roller 16 and on both ends of the roller 15.

The roller 19, which has preferably an iron core and a rubber covering 20, is provided on its end with a sealing ring 76 L-shaped in cross section. The side 77 of this ring bears upon the smooth lubricated surfaces 68, 69 of the face plate 66. The other portion 78 of ring 76 rests upon the metal sealing rings 71, 71 carried by the brass rolls 15 and 16. (Only one sealing ring 71 being shown in Fig. 6). The resilience of the rubber periphery 20 of the roll 19 is sufficient to press the metal sealing ring 76 firmly against the contact surfaces 68 and 69 of the face plate 66. These metal rings 76 and 71 bear against the face plate 66 so as to form an air-tight fit and prevent any air working around the ends of the rolls. Both ends of the rubber roll 19 are equipped with these metal friction rings 76, the other simply being a duplicate of the one shown.

The liquid used for lubricating these surfaces forms a thin film of liquid which may be termed a second liquid seal preventing air working around the ends of the rollers into the vacuum chamber A.

Any suitable liquid may be employed to form this second seal. While it would be possible to lubricate these surfaces with a thin film of water, I preferably lubricate them with some suitable lubricating oil or grease fed from the oil cup 780, Fig. 6, through the pipe 79 to these contacting surfaces; the oil forms a thin sealing film, which not only lubricates the friction rings 71 and 76, and the friction surfaces 67, 68 and 69 on the face plate 66, but also prevents any air working by the ends of the rollers, as previously noted. Water, if used as a lubricant, may be fed from the cup 78, or fed in any other manner to these contacting surfaces.

The brass rollers 59 and 60, Fig. 3, and the rubber roll 61 are provided with the same sealing means shown in Fig. 6, just described.

In the operation of my invention a wet web of paper 42, or any other material to be treated within the vacuum chamber, is fed into the entrance B of the vacuum chamber A by being brought into direct contact with the brass roll 15 and the rubber roll 19, Figs. 1 and 2. The rubber roll 19 presses the web 42 firmly against the brass roll 15 and thereby forms an air-tight rolling seal. The web 42 then passes down into the entrance B of the vacuum chamber A, Fig. 1, in contact with the guide roll 80, around the drying drum or cylinder 1, pressed thereon by the separate felt 6, thence around the drying drums or cylinders 2, 3, 4 and 5 in contact with the separate felts 6, 6, over guide roll 81, and out through the exit passage C through the rolling dry air-tight closure between the rotating brass roll 59 and the rubber roll 61, Figs. 1 and 3.

I may employ any suitable form of doctors 82, 82. At the exit C I may use a guard 83 and a deflector plate 84 to keep the web from coming in contact with the roller 60.

In the particular form of devices that I have illustrated the rubber roll 19 rests upon and is wholly or partially supported by the brass rolls 15 and 16. These rolls as shown in Fig. 6 are supported by the face plate 66. At times it is desirable to remove the face plate 66 for inspection or cleaning of the mechanism which would leave the ends of the rolls unsupported. I, therefore, employ a plurality of screw jacks 87, which are shown in detail in Fig. 4. These screw jacks are mounted in screw-threaded sleeves 85 mounted in bosses 86 in the frame 24. The ends of these screw jacks are provided with recesses 88 for the reception of any suitable tool or key to screw and unscrew the screw jack within the sleeve 85. As shown in full lines in Fig. 4 the screw jacks are shown screwed away from the roll, as for example 60, which it is adapted to support. Preferably, I employ two of these screw jacks 87 arranged at an angle to each other to support one of the heavy brass rolls. Before the face plate is removed, the screw jacks are screwed into the dotted position shown in Fig. 4 and hold the rolls free of the face plate 66 which can then be removed. After the face plate 66 has been repositioned, the screw jacks 87 are screwed away from the rolls and brought back into the position shown in full lines in Fig. 4, Figs. 2 and 3. The pipe plugs 89 are then screwed into place to close the openings as shown in Fig. 4.

My invention is particularly adapted to be used in connection with drying sheet materials 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 by a liquid of some description.

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 machines, 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., or thereabouts. 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.

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.

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° F.×8=128° F.) than the temperature difference in atmospheric drying as usally practiced. 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 atmosperic 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.

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 one illustrative embodiment 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 sealing an opening in a vacuum chamber against the admission of air which consists in causing members to move in intimate contact with each other and in sliding engagement with the walls of said chamber and maintaining a liquid in contact with the surfaces of some of said members and the walls of the vacuum chamber with which said surfaces contact and creating and maintaining a vacuum in the vacuum chamber.

2. The method of sealing an opening in a vacuum chamber against the admission of air which consists in causing members to move in intimate contact with each other and in sliding engagement with the walls of said chamber and maintaining water in contact with the surfaces of some of said members and the walls of the vacuum chamber with which said surfaces contact and creating and maintaining a vacuum in the the vacuum chamber.

3. The method of sealing an opening in a vacuum chamber against the admission of air which consists in causing rotatable members to revolve in intimate contact with each other and in sliding engagement with the walls of said chamber and maintaining a liquid in contact with the surfaces of some of said members and the walls of the vacuum chamber with which said surfaces contact and creating and maintaining a vacuum in the vacuum chamber.

4. The method of sealing an opening in a vacuum chamber against the admission of air which consists in causing rotatable members to revolve in intimate contact with each other and in sliding engagement with the walls of said chamber and maintaining water in contact with the surfaces of some of said members and the walls of the vacuum chamber with which said surfaces contact and creating and maintaining a vacuum in the vacuum chamber.

5. The method of sealing an opening in a vacuum chamber against the admission of air which consists in causing rotatable members to revolve in intimate contact with each other and in sliding engagement with the walls of said chamber, maintaining a liquid in contact with the surfaces of some of said members and the walls of the vacuum chamber with which said surfaces contact, and maintaining a liquid in contact with the end surfaces of the members and the walls of the chamber with which said end surfaces contact and creating and maintaining a vacuum in the vacuum chamber.

6. The method of sealing an opening in a vacuum chamber against the admission of air which consists in causing rotatable members to revolve in intimate contact with each other and in sliding engagement with the walls of said chamber, maintaining a liquid in contact with the surfaces of some of said members and the walls of the vacuum chamber with which said surfaces contact, and maintaining water in contact with the end surfaces of the members and the walls of the chamber with which said end surfaces contact and creating and maintaining a vacuum in the vacuum chamber.

7. The method of sealing an opening in a vacuum chamber against the admission of air which consists in causing rotatable members to revolve in intimate contact with each other and in sliding engagement with the walls of said chamber, maintaining a liquid in contact with the surfaces of some of said members and the walls of the vacuum chamber with which said surfaces contact, and maintaining a yielding sealing contact between the end surfaces of said members and the walls of the chamber.

8. The method of sealing an opening in a vacuum chamber against the admission of air which consists in causing rotatable members to revolve in intimate contact with each other and in sliding engagement with the

walls of said chamber, maintaining said intimate contact by gravity, and maintaining a liquid in contact with the surfaces of some of said members and the walls of the vacuum chamber with which said surfaces contact.

9. The method of feeding a web into and out of a vacuum chamber having entrance and exit passages which consists in passing the web into the chamber, moving the web through the chamber and out of the exit passage, excluding air from the chamber at certain places by exerting pressure and at other places by maintaining a liquid.

10. The method of feeding a web into and out of a vacuum chamber having entrance and exit passages which consists in passing the web into the chamber, moving the web through the chamber and out of the exit passage, excluding air from the chamber at certain places by exerting pressure and at other places by maintaining water.

11. The method of feeding the web into and out of a vacuum chamber having entrance and exit passages which consists in passing the web into the chamber, moving the web through the chamber and out through the exit passage, excluding air from the chamber at certain places by exerting pressure on the web and a moving member and at other places by maintaining a liquid in contact with other moving members and the walls of the chamber.

12. The method of feeding the web into and out of a vacuum chamber which consists in passing the web into the chamber, moving the web through the chamber and out through the exit passage, excluding air from the chamber at certain places by exerting pressure on the web and a moving member and at other places by maintaining water in contact with other moving members and the walls of the chamber.

13. The method of feeding the web into and out of a vacuum chamber having entrance and exit passages which consists in causing rotatable members to revolve in sliding contact with the walls of said chamber and in intimate contact with each other in the openings of said chamber, passing the web between the surfaces of two of said members, and maintaining the vacuum in said chamber by maintaining a liquid in contact with the surfaces of some of said members and the walls of the chamber with which said surfaces contact.

14. The method of feeding a web into and out of a vacuum chamber having entrance and exit openings which consists in causing rotatable members to revolve in sliding engagement with the walls of said chamber and in intimate contact with each other in the openings of said chamber, passing the web between the surfaces of two of said members, and maintaining the vacuum in said chamber by maintaining water in contact with the surfaces of some of said members and the walls of the chamber with which said surfaces contact.

15. The method of feeding a web into and out of a vacuum chamber having entrance and exit openings which consists in causing rotatable members to revolve in sliding engagement with the walls of said chamber and in intimate contact with each other in the openings of said chamber, passing the web between the surfaces of two of said members, and maintaining the vacuum in said chamber by maintaining a liquid in contact with the surfaces of some of said members and the walls of the chamber with which said surfaces contact, and removing substantially all of the liquid from the surfaces of said members to prevent transference of the liquid to the web.

16. The method of continuously drying any material which consists in passing the material into a vacuum chamber having entrance and exit passages, drying the material while in said chamber, moving the material through the chamber and out through the exit passage, and excluding air from the chamber at certain places by exerting pressure and at other places by maintaining a liquid.

17. The method of continuously drying any material which consists in passing the material into a vacuum chamber having entrance and exit passages, drying the material while in said chamber, moving the material through the chamber and out through the exit passage, and excluding air from the chamber at certain places by exerting pressure and at other places by maintaining water.

18. The method of continuously drying any web material which consists in continuously passing the material into a vacuum chamber having entrance and exit passages, drying the material while in said chamber, moving the material through the chamber and out through the exit passage, excluding air from the chamber at certain places by exerting pressure on the web and a moving member, and at other places by maintaining a liquid in contact with other moving members and the walls of the chamber.

19. The method of continuously drying any web material which consists in continuously passing the material into a vacuum chamber having entrance and exit passages, drying the material while in said chamber, moving the material through the chamber and out through the exit passage, excluding air from the chamber at certain places by exerting pressure on the web and a moving member, and at other places by maintaining water in contact with other moving members and the walls of the chamber.

20. The method of continuously drying

any material in a vacuum chamber having entrance and exit openings which consists in causing rotatable members to revolve in sliding engagement with the walls of said chamber and in intimate contact with each other in the openings of said chamber, passing the material between the surfaces of two of said members, maintaining the vacuum in said chamber by maintaining a liquid in contact with the surfaces of some of said members and the walls of the chamber with which said surfaces contact, and drying the material while in said chamber.

21. The method of continuously drying any material in a vacuum chamber having entrance and exit openings which consists in causing rotatable members to revolve in sliding engagement with the walls of said chamber and in intimate contact with each other in the openings of said chamber, passing the material between the surfaces of two of said members, maintaining the vacuum in said chamber by maintaining water in contact with the surfaces of some of said members and the walls of the chamber with which said surfaces contact, and drying the material while in said chamber.

22. The method of continuously drying any web material in a vacuum chamber having entrance and exit openings which consists in causing rotatable members to revolve in sliding engagement with the walls of said chamber and in intimate contact with each other in the openings of said chamber, passing the material between the surfaces of two of said members, maintaining the vacuum in said chamber by maintaining a liquid in contact with the surfaces of some of said members and the walls of the chamber with which said surfaces contact, drying the material while in said chamber, and removing substantially all of the liquid from the surfaces of said members to prevent the transference of the liquid to the web.

23. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, relatively moving members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, and a liquid in contact with parts of the relatively moving means for further sealing said passages and means to create and maintain a vacuum in the vacuum chamber.

24. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages and in air-tight contact relatively to each other to seal said passages, and water sealing means in contact with parts of the relatively rotating members for further sealing said passages and means to create and maintain a vacuum in the vacuum chamber.

25. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding contact with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, and a liquid in contact with parts of the relatively rotating members for further sealing said passages, one of said rotatable members having a yielding peripheral surface.

26. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding contact with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, and means cooperating with one or more of said rotatable members adjacent the peripheral surface of said members adapted to form restricted passages for the passage of a thin film of liquid.

27. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding contact with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, means cooperating with one or more of said rotatable members adjacent the peripheral surface of said members adapted to form restricted passages for the passage of a thin film of liquid, and means to remove liquid from the surfaces of the rotatable members before the said surfaces come in contact with the material to be dried.

28. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding contact with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, means cooperating with one or more of said rotatable members adjacent the peripheral surface of said members adapted to form restricted passages for the passage of a thin film of liquid, and adjustable means to remove liquid from the surfaces of the rotatable members before the said surfaces come in contact with the material to be dried.

29. In a vacuum drying apparatus, the combination of a vacuum chamber having

entrance and exit passages, rotatable members mounted in the passages in sliding contact with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, and means cooperating with one or more of said rotatable members adjacent the peripheral surface of said members adapted to form restricted passages for the passage of a thin film of liquid, and means to remove liquid from the surfaces of the rotatable members before the said surfaces come in contact with the material to be dried, said liquid removal means consisting of a yielding material.

30. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, and means cooperating with one or more of said rotatable members adapted to form restricted passages for the passage of a thin film of liquid, and means to remove liquid from the surfaces of the rotatable members before the said surfaces come in contact with the material to be dried, said liquid removal means consisting of rubber.

31. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-ight contact relatively to each other to partially seal said passages, a liquid in contact with the longitudinal surfaces of said rotatable members, and means for sealing the end surfaces of said rotatable members against the admission of air.

32. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with the longitudinal surfaces of said rotatable members, and a liquid for sealing the end surfaces of said rotatable members against the admission of air.

33. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, water in contact with the longitudinal surfaces of said rotatable members, and water for sealing the end surfaces of said rotatable members against the admission of air.

34. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, and means for producing yielding engagement between the end surfaces of said rotatable members and the walls of the entrance and exit passages.

35. The combination in a vacuum closure apparatus, a vacuum chamber, one or more sealing rolls in sliding engagement with the walls of said chamber and provided with closure rings adapted to bear directly on a portion of the vacuum chamber to form an air-tight rolling connection, and yielding means to press said closure rings into contact with the vacuum chamber.

36. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, three rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other, the axes of two of said members being in the same plane and the axis of the other of said members being in a different plane and a liquid in contact with the surfaces of said members whose axes are in the same plane.

37. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, three rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other, two of said members mounted to rotate in the same plane, the other of said members mounted above and resting by gravity upon the surfaces of the other two members and a liquid in contact with the surfaces of said members whose axes are in the same plane.

38. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, three rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other, two of said members being mounted to rotate in the same plane and the other of said members being provided with a yielding surface and mounted above and resting by gravity upon the surfaces of the other said members and a liquid in contact with the surfaces of said members whose axes are in the same plane.

39. In a vacuum apparatus, a vacuum chamber, two sealing rolls having a hard pe-

riphery, a third sealing roll having a yielding surface resting upon the other two rolls, metal closure rings mounted on each of the rolls provided with a hard periphery and adapted to bear directly upon and have frictional contact with the vacuum chamber to form an air-tight joint, and means to yieldingly press said closure rings against the vacuum chamber, the roll provided with a yielding periphery having at its ends metal closure rings to also bear upon the vacuum chamber and upon the closure rings carried by the other two rolls.

40. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, and fluid operating means cooperating with one or more of said rotatable members adapted to form restricted passages for the passage of a thin film of liquid.

41. In a vacuum drying apparatus, the combination of a vacuum chamber having passages for the entrance and exit of the material to be treated, sets of three rolls, one set mounted in each of the passages so as to form a closure therefor, one roll of each set having a yielding periphery to firmly press the material to be dried against one of the other rolls of the set and to form a rolling air-tight closure with the remaining other roll, said other rolls having sliding engagement with adjacent portions of the walls of the opening, and a sealing liquid to form a thin film of liquid on the one of said other rolls contacting with the material, said film being formed at the place of sliding contact of said roll with the wall portion, and means to remove the thin film of liquid from the periphery of the roll, before the periphery comes in contact with the material to be dried.

42. A wiper provided with a contact member formed of yielding material to bear directly upon the surface of a roll and fluid means to press said wiper into contact with the roll to remove liquid from said roll.

43. In a vacuum drying apparatus, the combination of a passage to be sealed, a passage restricting member adapted to bear directly upon the surface of a roll, means to press it against the roll, and liquid means to act as a lubricant between the passage restricting member and the roll and prevent excessive wear and means to create and maintain a vacuum in the vacuum chamber.

44. The combination with a vacuum chamber having an opening, of means for closing said opening, said means comprising a plurality of rotatable members having air-tight rolling contact one with another in series, the rolling contact surfaces of the extreme members of the series also having sliding engagement throughout their axial extents with adjacent portions of opposite walls respectively of the opening, and the non-rolling surfaces of all the members together having similar sliding engagements with portions defining the remaining walls of the opening, the members thus cooperating to form a complete closure for the opening, and liquid sealing means for rendering air-tight the sliding engagements of the rolling surfaces of the extreme members of the series throughout their axial extents.

45. The combination with a vacuum chamber having an opening, of means for closing said opening, said means comprising a plurality of rotatable members having air-tight rolling contact one with another in series, the rolling contact surfaces of the extreme members of the series also having sliding engagement throughout their axial extents with adjacent portions of opposite walls respectively of the opening, and the non-rolling surfaces of all the members together having similar sliding engagement with portions defining the remaining walls of the opening, the members thus cooperating to form a complete closure for the opening, and liquid sealing means for rendering air-tight the sliding engagements of the members of such closure.

46. The method of sealing an opening in a vacuum chamber which consists in causing members to move in sliding engagement with the walls of said chamber and in intimate contact with each other, excluding air from the chamber at certain places by exerting atmospheric pressure and at other places by maintaining a liquid.

47. In a paper web drying machine, the combination with a feed roll, of an adjustable doctor and a cleaner mechanism coacting with said roll.

48. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding engagement with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, fluid operating means cooperating with one or more of said rotatable members adapted to form restricted passages for the passage of a thin film of liquid, and means for removing from the surfaces of the rotatable members the liquid which has passed through said restricted passages.

49. In a vacuum drying apparatus, the combination of a vacuum chamber having entrance and exit passages, rotatable members mounted in the passages in sliding en-

gagement with the walls of said chamber and in air-tight contact relatively to each other to partially seal said passages, a liquid in contact with parts of the relatively rotating members for further sealing said passages, fluid operating means cooperating with one or more of said rotatable members adapted to form restricted passages for the passage of this film of liquid, a wiper provided with a contact member formed of yielding material to bear directly upon the surface of a rotatable member and fluid means to press said wiper into contact with the rotatable member to remove from the surface thereof the liquid which has passed through the restricted passage.

OGDEN MINTON.