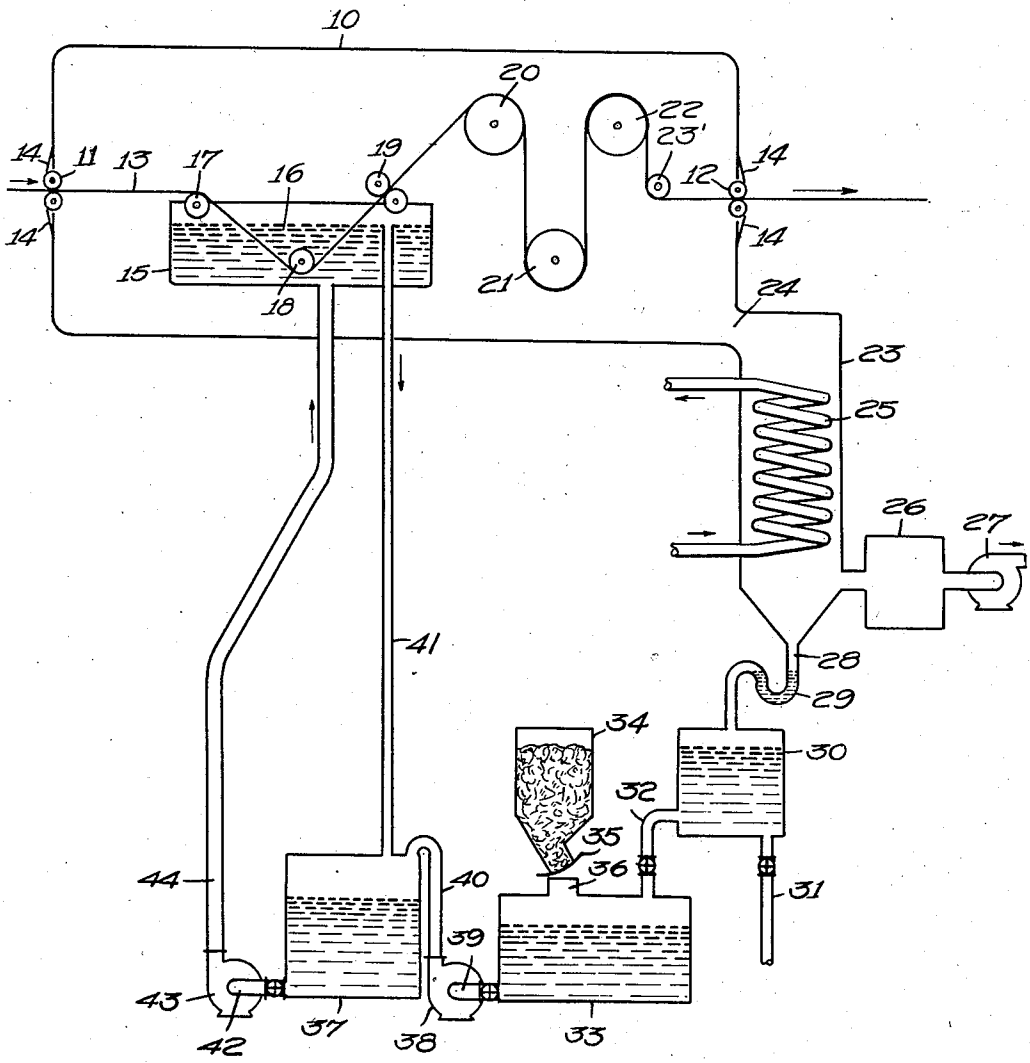
Dec. 17, 1935. H. R. RAFTON 2,024,248

PAPER TREATING MEANS

Filed Nov. 1, 1932 2 Sheets-Sheet 1

Fig. 1.



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Filed Nov. 1, 1932 2 Sheets-Sheet 2

Fig. 2.

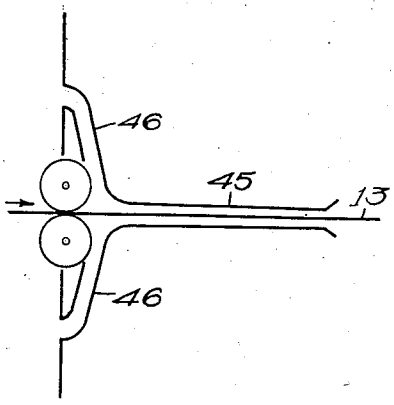


Fig. 3.

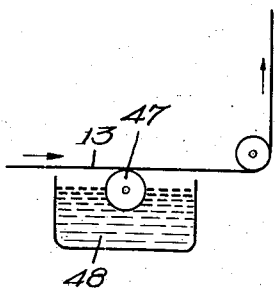


Fig. 4.

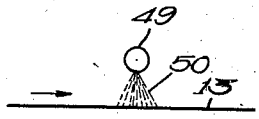


Fig. 5.

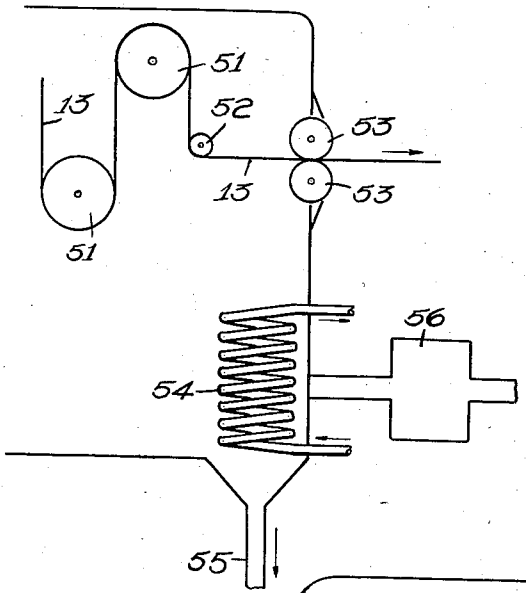
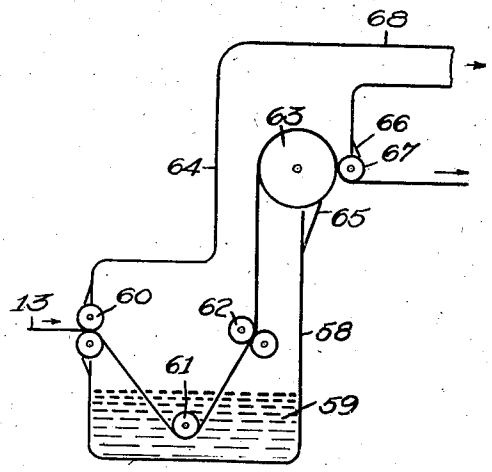


Fig. 6.



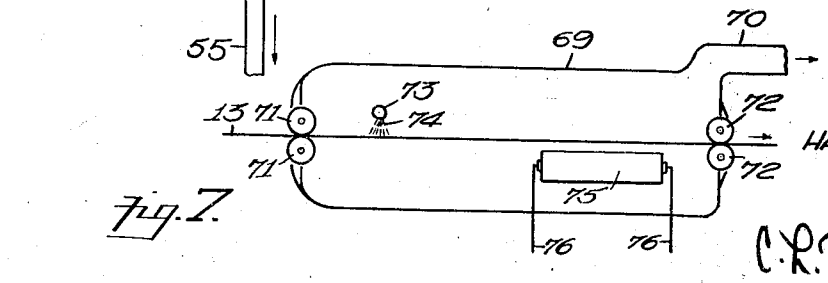


Fig. 7.

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2,024,248

PAPER TREATING MEANS

Harold Robert Rafton, Andover, Mass., assignor to Raffold Process Corporation, a corporation of Massachusetts

Application November 1, 1932, Serial No. 640,714

3 Claims. (Cl. 91—55)

My invention relates to means for treating a paper web.

The principal object of my invention is to provide means for treating a paper web with an agent dissolved or emulsified in a liquid.

An important object of my invention is to provide means for treating a paper web with an agent dissolved in or emulsified with an organic solvent and to provide means for recovering the solvent.

A further object of my invention is to provide means for applying sizing to a paper web by means of a solution of sizing agent in an organic solvent and recovering the solvent for reuse.

A further object of my invention is to provide means for sizing paper filled with alkaline filler by means of sizing agent dissolved in or emulsified with solvent and recovering said solvent.

Other objects and advantages of my invention will become apparent during the course of the following description.

In my copending application, Serial No. 487,377, filed October 8th, 1930, I have described a method for sizing paper filled with alkaline filler by the application of thermoplastic material in liquid association to a paper web containing alkaline filler. When this liquid association of the thermoplastic material comprises a solution of said material in an organic solvent, it becomes necessary, as explained in my copending application referred to, to evaporate the said solvent after application of the solution to the paper web, and it is in the interest of economy to recover the same. When the solvent is miscible with water the solution may be applied either to the wet or to the substantially dry web, but where the solution is substantially immiscible with water, it is preferable, as described in the said copending application, to apply the solution to the substantially dry web.

As stated in my copending application, the solution of thermoplastic material may be applied to the web either directly on the paper machine or as a separate process subsequent thereto. In either case the solvent may be removed from the paper web either by the application of heat or reduced pressure or both. While the evaporation of the solvent under reduced pressure is a satisfactory method, heat ordinarily being supplied to the web in quantity at least sufficient to equal the latent heat of evaporation of the solvent, such method requires for its functioning an apparatus of considerable size, which may appropriately comprise a vacuum chamber, suitably reinforced structurally, in combination with a system for maintaining vacuum such as a pump, and associated with solvent recovery mechanism. Not only is such an apparatus very expensive, but the power requirement thereof is necessarily substantial.

However, as indicated in my copending application, the solvent may be evaporated by heat without using reduced pressure, and of course under such conditions it is also desirable to recover the solvent. It is an object of the present invention to provide suitable equipment for carrying out the process of applying thermoplastic material in solution in a solvent, or emulsified with a solvent, to a paper web containing alkaline filler and of evaporating said solvent by the means of heat alone without the use of vacuum apparatus, and of recovering said solvent. It will of course be understood that such equipment may be employed for sizing paper webs other than those containing alkaline filler, and also for applying either to alkaline filled paper webs or other paper webs, agents dissolved in solvents, or emulsified with solvents, such as organic solvents which agents may be used to impart treatment to the paper web other than that of sizing, such treatment comprising for example the imparting to the paper of waterproofness, greaseproofness, electrical resistance, strength, pliability and the like. It also will be understood that such equipment may be employed for applying to the paper web non-thermoplastic agents, whether for sizing purposes or otherwise, when in association with an organic solvent, such as in solution or emulsion. In this connection cross reference is hereby made to my copending application Serial No. 609,555, filed May 5, 1932.

The equipment disclosed herein has the advantage over vacuum equipment of being relatively more simple, of requiring less power, of being much less expensive, and of being easier to operate and more economical to maintain.

Expressed in simple terms, my invention comprises the combination of means for guiding a continuously advancing paper web, means for applying to the web a solution or emulsion of an agent in a solvent, means for supplying the heat required to evaporate said solvent substantially at atmospheric pressure, and recovery means for said solvent, the system being maintained with a minimum and/or desired content of air. With the above referred to means may be combined means for utilizing said solvent for the solution of a further quantity of said agent to be eventually supplied to the solution applying means.

More particularly, one suitable illustrative example of my invention comprises a casing which serves to enclose the guiding, solution applying, and heating means. From this casing leads a duct in which may be suitably placed the solvent recovery means, which conveniently may comprise cold or chilled surfaces on which the solvent may be condensed, and in addition if desired other solvent recovery means, such as active absorbent material e. g. silica gel or the like. Means connected to the duct is provided for leading therefrom the condensed solvent, which may be used for dissolving further quantities of the agent to be applied to the web, and then returned cyclically to the solution applying means. The duct is also provided with means for creating a moderate eduction current in said duct, such means being suitably a fan, blower or the like. The object of this eduction current is to lead away from the casing the evolved vapors of the solvent, together with such quantities of air or other gas as may be associated therewith. It is considered an equivalent structure if the duct be connected to independent solvent recovery means, since in such case the wall or walls enclosing the recovery means are in effect a continuation of the duct.

It is desirable that the casing be made in such a manner as to be substantially air tight except at the points where the paper web enters and leaves. This permits the withdrawal of the solvent vapor by the fan with minimum dilution of the vapors with air, and thus much smaller volumes are required to be handled by the fan than if free leakage of air were permitted. This is also of great advantage in that it enables a much simpler and easier recovery of the solvent to be effected, and also in the case where inflammable solvents are used, the composition of the vapor air mixture in the casing can be controlled within safe limits. However, there may be provided an inlet controlled by a suitable valve or gate to admit regulated amounts of air, which may be heated if desired, or other diluent gas, such as steam for example.

In the drawings I have shown several embodiments of the invention. In this showing,

Figure 1 is a diagrammatic view of one form of apparatus,

Figure 2 is a fragmentary diagrammatic view showing a modified form of means for feeding a paper web from the casing,

Figure 3 is a similar view showing a modified form of solution applying means,

Figure 4 is a similar view of a further modified form of solution applying means,

Figure 5 is a modified form of the apparatus wherein the condensing means is arranged in the heater casing,

Figure 6 is a similar view showing the use of a single heating roll for an eduction duct arranged above the heating means, and,

Figure 7 is a similar view showing a modified form of the apparatus wherein a different form of heating means is employed.

Referring to Figure 1, the numeral **10** designates a casing having openings at its ends in which are arranged pairs of rolls **11** and **12** respectively. The paper web **13** is fed into the casing between the rolls **11** and passes from the outlet end of the casing between the rolls **12**. One or both of the rolls of each pair, if desired, may be covered with resilient material. The outer surfaces of the rolls of both pair may contact with suitable sealing devices such as strips of flexible material **14**, which may be formed of felt or similar material, and these strips serve to effect reasonably air-tigh seals for the rolls. If desired, similar sealing means may be provided for the ends of the rolls.

It will be noted that the web inlet and outlet means referred to permits a web to be passed through the casing without bringing in or taking out with it substantial amounts of air or gaseous fluids. However, it is a feature of my invention that it is not necessary to form absolutely air-tight joints at the inlet and outlet ends of the casing as it is not desired to maintain any substantial degree of negative pressure within the casing (which would tend to draw in air), the pressure in the casing being maintained at substantially atmospheric pressure or just sufficiently below such pressure to prevent any passage of gas or vapor from within the casing into the air of the room in which the casing is installed. Under such conditions, except for adventitious leaks which should be avoided, substantially the only air introduced into the casing is that contained in the entering web itself, unless it be desired to admit extra air or other gas as indicated above.

The solution applying means may be of any convenient form, one of which is shown in Figure 1 and comprises a trough **15** for containing the solution **16**, together with a guide roll **17** at the inlet end of the trough for leading the web into the solution, a second guide roll **18** disposed in the solution, and a pair of rolls **19** disposed at the exit side of the trough. The rolls **19** act as squeeze rolls, thus serving to remove the excess solution applied to the web, and preferably being capable of regulation. In addition, it will be apparent that the rolls **19** serve as guide rolls for the web.

From the rolls **19**, the web is led over or exposed to means of any desired type for supplying heat, and in Figure 1 the heating means is illustrated as comprising rolls **20**, **21** and **22**. The number of heating rolls employed will depend largely upon the nature of the solvent, and the apparatus is not limited to any particular number or arrangement of heating rolls. With the arrangement illustrated in Figure 1, the web passes upwardly over the roll **20**, downwardly around the roll **21**, and thence upwardly around the roll **22**, and after passing from the roll **22**, the web may pass around a guide roll **23'** preferably arranged in the plane of the line of contact between the rolls **12** to feed the paper web between such rolls.

The heat supplied by the heating means employed serves to evaporate the solvent from the web, and such heating means may be heated by any suitable means such as a hot liquid, steam, electricity or the like. The amount of heat required to be applied to these rolls depends upon the amount of heat required to evaporate the solvent at the speed at which the machine is operated, and also depends upon whether it is desirable to heat the web above the point at which the solvent will be evaporated, such as if it be desired to flux the agent applied to the web and such fluxing takes place at a temperature higher than that required for the mere evaporation of the solvent. For this purpose, one or more of the heating rolls may operate at a higher temperature than the others, if desired.

It will be noted that, in combination, the web inlet and outlet rolls, the rolls of the solution applying device, and the heating rolls may comprise the web guiding means, but it will be ap-

parent that other web guiding means such as additional rolls or supporting felts may be provided if desired. It also will be apparent that known carriers for the web may be provided, such as ropes or the like.

Suitable eduction means for the vaporized solvent is provided, and such means may be located at any convenient point in the casing depending upon the nature of the solvent. For example, if the vapor of the solvent is a heavy one, it is desirable to have the eduction means near the bottom of the casing, while on the other hand, the eduction duct may be placed higher if the vapor of the solvent is of low specific gravity. In Figure 1, the eduction duct is shown as being connected to the bottom of the casing adjacent the outlet end thereof and is indicated by the numeral **23**. This duct communicates with the casing through a suitable opening **24** and suitable solvent recovery means is placed within the duct **23**. In the present instance the recovery means is illustrated as comprising a cooling coil **25** through which passes a suitable cold fluid.

The size of the coil **25** and the temperature of the fluid passing therethrough are regulated so as to substantially completely condense the solvent. In certain cases, it is desirable to provide additional recovery means which may comprise a silica gel absorbing unit **26** communicating with the duct **23** near the bottom thereof, but such unit is not always necessary. A fan **27** is connected to the unit **26** to draw air therefrom and exhaust it to the atmosphere. Such fan, of course, will affect the pressure in the casing **10** and provides a moderate eduction current in the duct **23**. Inasmuch as the solvent recovery system should be adjusted so as to recover substantially all of the solvent, the discharge duct of the fan may be suitably vented to the open air.

Preferably directly beneath the coil **25** the duct **23** is provided with a draw-off conduit **28** which preferably leads through a liquid seal **29** to a container **30** which may provide intermediate storage means for the recovered solvent. It will be apparent that vapors condensed by the coil **25** flow into the container **30** through the pipe **28**. A valved draw-off pipe **31** is provided for the container **30** to provide for the removal of water from the bottom thereof. If the solvent used has a higher specific gravity than water this pipe is placed near the top of the side of container **30** instead.

A valved outlet pipe leads from the container **30** to a solution make-up tank **33** to deliver the condensed solvent thereto. A hopper **34** containing the desired treating agent may be arranged above the tank **33** and may have its outlet spout controlled by a suitable valve or gate **35**. The opening of this gate permits the agent to flow downwardly in suitable quantities into the tank **33** through a normally closed inlet spout **36** in the top thereof. A solution of suitable strength thus may be maintained in the tank **33**. As will be apparent, a solution of the appropriate strength may be produced continuously instead of intermittently, if desired, by continuously feeding agent and solvent in proper proportions into tank **33**, by means of suitable known devices.

Suitable means may be provided for feeding the solution in the tank **33** to a supply tank **37**. As shown, a pump **38** has its inlet side connected to the bottom of the tank **33** through a valved conduit **39**, and a second conduit **40** is connected from the outlet side of the pump **38** to the top of the tank **37**. An overflow pipe **41** has its upper end arranged in the solution applying trough **15** and its lower end communicating with the tank **37** to prevent the accumulation of solution in the trough **15** above a predetermined level, as will be apparent.

A valved conduit **42** communicates between the bottom of the tank **37** and a supply pump **43**. The outlet side of the pump **43** is connected to the trough **15** by a supply conduit **44** and accordingly it will be apparent that a suitable supply of the solution **16** is maintained in the solution applying trough.

Several variations of the apparatus may be employed under certain conditions. For example, instead of but preferably in addition to, providing rolls as at the point of exit of the web from the casing, a narrow nozzle-like duct **45** may surround the outgoing web for some little distance from the tank, as shown in Figure 2. Such nozzle may communicate with the casing through suitable small ducts **46**, and the object of such construction is to introduce a small amount of air into the casing, such air passing over the already dried web coming out of the casing in order to remove by the counter-current action of the air any last trace of solvent which still may remain in or near the web. The small amount of air thus introduced into the casing may be finally exhausted through the fan **27** into the open air, as previously indicated. A similar arrangement may be used at the point of inlet of the web if desired, or a mere slit in the casing may serve in certain cases as a substitute for the inlet and/or exit rolls. Likewise the apparatus is not limited to any particular type of solution applying means, such as the immersion type previously described, but may be of any other suitable type for example such as that illustrated in Figure 3. In such modified type, a roll **47** may revolve while partially immersed in the solution **48**, and contact with one side of the paper web. It will be apparent, of course, that applying rolls may contact with both sides of the web, if desired. It also will be apparent that the solution applying means may be of the spray type shown in Figure 4 wherein an apertured pipe **49** is adapted to spray the solution against the paper web, as indicated at **50**.

Another suitable and somewhat more compact arrangement of the apparatus is shown in fragmentary form in Figure 5. In this arrangement, the web passes around heat rolls **51** and thence around a guide roll **52** to be fed from the casing between rolls **53**, similar to the rolls **12** previously described. Instead of the solvent recovery means previously referred to, however, a cooling coil **54** may be placed directly within the casing itself and the condensed solvent passes from the bottom of the casing through a conduit **55** disposed beneath the coil **54**. A silica gel unit **56** also may be employed in connection with this form of apparatus, and may be connected to a fan, if desired.

In certain cases, the cycle of evaporation and condensation of the solvent may be so conducted as to maintain substantially an equilibrium of pressure between the casing and the atmosphere surrounding it, so that there is substantially no transfer of air or solvent vapor in or out of the casing in which case the eduction fan and outlet may be dispensed with. However, it is difficult in most cases to maintain this exact equilibrium, and while I may operate my invention at pressure slightly superatmospheric, I do not prefer to. So in order to provide for occasional slight excess of pressure developed within the casing, it is desir-

able to have an outlet communicating with the atmosphere for the purpose of withdrawing any slight excess air which may exist in the casing and which by maintaining a slight outward flow from the casing will prevent any escape of gas or vapor from the casing through the web inlet and outlet. Such an outlet may suitably exist, as shown, at the outlet side of unit **56**, even though a fan be not connected therewith.

It will be understood that although in any of the several modified forms of my apparatus illustrated there may be maintained a slight negative pressure within the casing by means of the fan, for example, one disposed in the eduction duct from the casing, it is not intended that this negative pressure should be present in any substantial degree. In certain cases it may amount to from a fraction of an inch to an inch or thereabouts of water, or somewhat more if desired, and would not be such as substantially to lower the boiling point of the solvent employed or as to require any substantial reinforcement of the casing against any inward pressure of the atmosphere. As will be apparent, this is entirely different from a vacuum system in which a heavily reinforced structure must be employed with substantially air-tight seals, together with vacuum pumps and associated apparatus for exhausting the vacuum chamber.

A simplified form of my invention is illustrated in Figure 6 and is adapted for use under certain conditions such as where only one heating roll is employed, and the solvent vapors are of light specific gravity. In this form of the invention, a tank **58** is employed and a body of the solution is maintained in the bottom of the casing as at **59**. A paper web is fed into the casing between rolls **60** and passes downwardly around a roll **61** immersed in the solution. The paper web passes upwardly from the solution between squeeze rolls **62**, and thence around a heating roll **63** arranged in a vertically extending portion **64** of the casing. The roll **63** may be arranged adjacent the outlet opening of the casing, and the latter may be provided with a sealing strip **65** cooperating with the roll **63**, and similar in construction to the strips **14** previously described. A similar strip **66** cooperates with a guide roll **67** around which the paper web passes after leaving the heating roll **63**. The upwardly extending portion **64** of the casing is provided with an eduction duct **68** with which is associated the vapor condensing and collecting means previously described.

In the form of the invention illustrated in Figure 7, a casing **69** is employed having an eduction duct **70** similar to the duct **68** just described. The paper web passes into and out of the casing between suitable pairs of rolls **71** and **72**, similar to the pairs of rolls **11** and **12** previously described. In this form of apparatus the solution applying means may be in the form of a spray pipe **73** apertured to spray the solution upon one side of the paper web as at **74**, and it will be apparent that both sides of the web may be treated if desired. Instead of the heating rolls described in connection with the other forms of apparatus, the apparatus shown in Figure 7 may be provided with a flat electrically heated plate **75** connected to a suitable source of current through the wires **76**. The web may pass over the heating plate in contact therewith, but preferably passes over the plate slightly spaced therefrom.

Another variation of the apparatus is to provide in the casing of any of the forms of the apparatus described a partition between the solution applying means and the heating means and provided with a slot or pair of rolls through which the web may pass. The object of such variation is to maintain the solution applying means in a relatively cool enclosure. A further extension of the same idea is to provide an independent casing for the heating and solvent recovery means, and to apply the solution to the web outside this casing. The solution applying means then may be suitably enclosed in an independent casing conveniently connected to the eduction duct of the main casing or the solution applying means may be conveniently used without requiring enclosure in a casing, or requiring at most only a hood to provide suitable ventilation, if the solution be kept cool so as to minimize evaporation.

In all of the casings described, suitable substantially air-tight manholes and/or hand holes (not shown) may be provided, as will be apparent.

The solvent recovery tank may be fitted with a draw-off conduit in order that any water which may condense out with the solvent may be withdrawn from the system, and such a conduit has been illustrated in Figure 1 in the form of the pipe **31**. This is especially useful if steam be introduced into the casing such as in the case of a wet web and/or inflammable solvent being used, the use in the casing of an inert gas such as steam minimizing danger of ignition of the solvent vapor, and at the same time preventing large excess gas volumes in the system by its mutual condensation with the solvent. It also will be apparent that any of the systems may be provided at one or more points with a safety or control device or devices for the regulation of the pressure within the system.

In certain cases it may be desired to evaporate the solvent from the web with heating means comprising hot gas such as air, instead of, or in conjunction with, heated rolls. In such case heated air, for example, may be admitted into the casing through a suitable induction duct and thus be contacted with the paper web to evaporate the solvent therein, whereupon the solvent laden air will pass out and be subjected to the solvent recovery means. The air may be reheated and cyclicly returned to the casing if desired. The exposure of the web to the heated air may be effected by providing a suitably extended portion of the web within the casing for such exposure, as by passage of the web over stretch rolls, or by festooning the web, or the like. Such heating means, however, is not my preferred method owing to the complications involved in handling the large volume of air required.

It will be understood from the previous description that my apparatus may be made a part of the paper machine proper, being situated suitably just after the driers and before the calenders, in the case where water immiscible solvent is used (the solution being thus applied to the substantially dry web), or it may be employed as a mechanism independent of the paper machine, treating the web as a separate process. Where water miscible solvent is used, of course, the web may be wet when treated and in this case more drying capacity, e. g. drying rolls, should be provided, in the casing, as well as more condensing capacity in the solvent recovery means. Also where water miscible solvent is used and water contacts with it, appropriate means must be provided for removing such water in whole or in part from the solvent before reintroducing it into the system to serve to dissolve further agent.

Where in the claims I speak of material "dis-

solved" in a volatile solvent, I mean this expression to include the case where material is emulsified in or with a volatile solvent; and where I speak of "solution" I mean to include the case where an emulsion exists, as well as the case where a true solution exists.

While I have described in detail certain illustrative examples of my invention, it will be understood that I do not intend to be limited in any way by such examples, as my invention may be practiced with widely varying forms and constructural changes, all within the scope of my invention, as set out in the subjoined claims.

I claim:

1. Apparatus of the character described comprising a casing having restricted communication with the atmosphere whereby the interior of the casing remains substantially at atmospheric pressure, said casing having means for continuously feeding a paper web therethrough, means in said casing for applying to the web a solution of a material dissolved in a volatile solvent, heating means for the paper web after said solution has been applied thereto by said applying means, an eduction duct communicating with said casing, means for recovering solvent evaporated from the web, a conduit having its inlet arranged to receive gaseous fluids which have passed said recovery means without having been recovered thereby, said conduit having its outlet end connected to the atmosphere, means operative for producing an eduction current through said conduit, a recovery container connected to said duct to receive recovered solvent therefrom, a solution container connected with the recovery container and having means for supplying additional material thereto, and means for transferring solution from said solution container to said solution applying means.

2. Apparatus of the character described comprising a casing having restricted communication with the atmosphere whereby the interior of the casing remains substantially at atmospheric pressure, said casing having means for continuously feeding a paper web therethrough, means in said casing for applying to the web a solution of a material dissolved in a volatile solvent, heating means for the paper web after said solution has been applied thereto by said applying means, an eduction duct communicating with said casing, means for recovering solvent evaporated from the web, a conduit having its inlet arranged to receive gaseous fluids which have passed said recovery means without having been recovered thereby, said conduit having its outlet end connected to the atmosphere, means operative for producing an eduction current through said conduit, a recovery container connected to said duct to receive recovered solvent therefrom, a solution container connected with the recovery container and having means for supplying additional material thereto, a supply container, means for transferring solution from said solution container to said supply container, and means for transferring solution from said supply container to said solution applying means.

3. Apparatus of the character described comprising a casing having restricted communication with the atmosphere whereby the interior of the casing remains substantially at atmospheric pressure, said casing having means for continuously feeding a paper web therethrough, means in said casing for applying to the web a solution of a material dissolved in a volatile solvent, heating means for the paper web after said solution has been applied thereto by said applying means, an eduction duct communicating with said casing, means for recovering solvent evaporated from the web, a conduit having its inlet arranged to receive gaseous fluids which have passed said recovery means without having been recovered thereby, said conduit having its outlet end connected to the atmosphere, means operative for producing an eduction current through said conduit, a body of absorbent material arranged in said conduit, a recovery container connected to said duct to receive recovered solvent therefrom, a solution container connected with the recovery container and having means for supplying additional material thereto, and means for transferring solution from said solution container to said solution applying means.

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