May 24, 1949. G. D. KNIGHT ET AL 2,471,330

METHOD OF CONTINUOUSLY COATING POROUS SHEETS

Filed Feb. 17, 1947

Fig. 1.

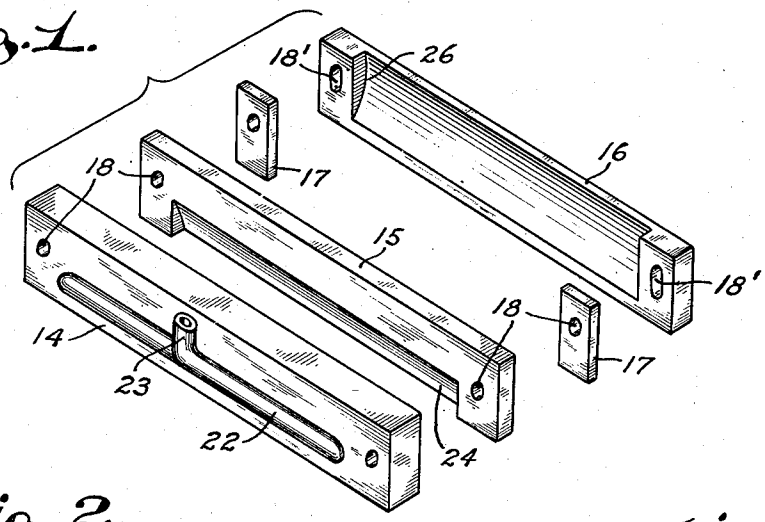


Fig. 2.

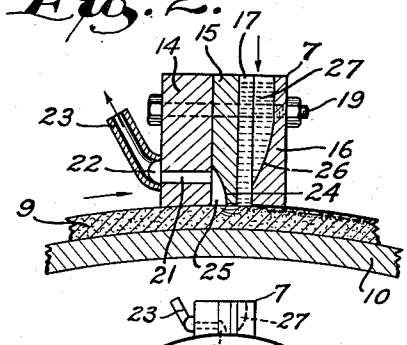
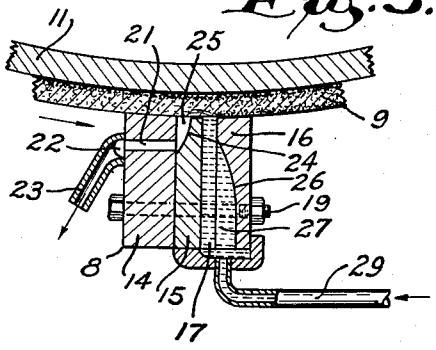


Fig. 3.



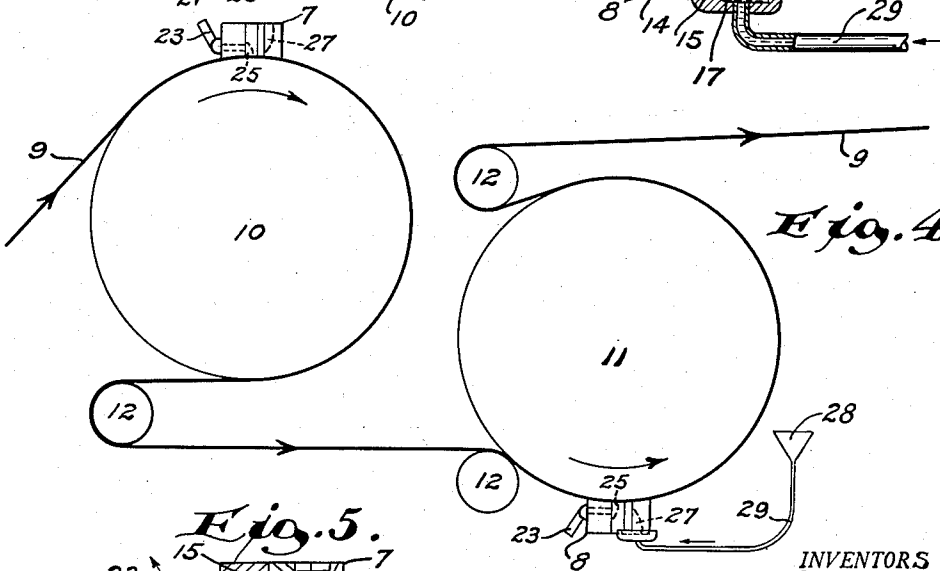
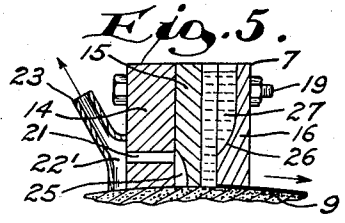


Fig. 4.

Fig. 5.



INVENTORS
G. D. Knight
BY B. W. Rowland
Lieber & Lieber
ATTORNEYS.

Patented May 24, 1949

2,471,330

UNITED STATES PATENT OFFICE

2,471,330

METHOD OF CONTINUOUSLY COATING POROUS SHEETS

George D. Knight and Ben W. Rowland, Appleton, Wis., assignors to The Institute of Paper Chemistry, Appleton, Wis., a corporation of Wisconsin

Application February 17, 1947, Serial No. 729,062

4 Claims. (Cl. 117—61)

1

The present invention relates generally to improvements in the coating art, but relates more specifically to an improved method for applying surface coatings of diverse types to various kinds of materials having a relatively porous or permeable nature.

The primary object of our invention is to provide a highly efficient method of effecting surface treatment of porous materials, together with simple means for facilitating exploitation of the improved method.

Surface coating has long been practiced in many different industries, and especially in the paper making and textile manufacturing industries wherein numerous methods and varied types of equipment have heretofore been proposed and utilized for the purpose of continuously coating sheets, webs, or ribbons of paper and cloth. In order to most effectively coat paper for printing purposes, it is necessary to provide flexible, smooth and relatively soft coatings uniformly and permanently applied to either one or both sides of the sheets with the aid of simple and dependable apparatus adapted to function at high speed, and none of the prior coating systems meet all of these primary requirements.

Most of the paper coating methods or processes now in vogue, not only necessitate the use of relatively complicated and unreliable equipment usually associated with the paper making machines, but some of them result in the production of hard coatings which have been so compacted by the calender rolls that receptivity to printer's ink has been materially impaired, while others produce spotty coatings which have not been properly anchored to the web and tend to "pick-off" on the printing presses under the influence of tacky inks. Although some of the prior coated papers have and are being sucessfully printed with proper and extreme caution on the part of the pressmen, they are expensive to manufacture and result in considerable waste of stock, and improved qualities of cheaper coated printing papers are greatly in demand.

It is therefore a more specific object of our present invention, to provide an improved process of surface coating porous sheets of paper or the like, on either one or both sides and at minimum cost, with uniform and smooth coatings which will permanently adhere to the materials to which they have been applied.

Another specific object of the invention is to provided a simplified and more efficient method of coating paper webs or the like immediately following production thereof, in a rapid and most

2

reliable manner, with minimum attention and human effort.

A further specific object of this invention is to provide an improved paper coating process involving a new and highly effective principle of uniform application of aqueous coating solutions, and which may be utilized for efficient application of various types of coatings to the surfaces of continuous ribbons of stock advancing at high speed.

Still another specific object of our invention is to provide an automatic coating system for travelling webs of porous material, wherein the coating substances are most effectively anchored to the surfaces of the material with the aid of suction or a vacuum applied in a manner whereby complete penetration of the web by the substance is avoided while objectionable air is in fact removed from the vicinity of the coatings.

An additional specific object of the present invention is to provide an improved porous material coating method which is extremely flexible in its adaptations for the purpose of surface coating diverse porous materials with different substances so as to meet various requirements.

Another specific object of the invention is to provide simple and effective instrumentalities for carrying on the several steps of our improved coating process, in an expeditious and automatic manner.

A further specific object of this invention is to provide compact coating apparatus for effectively treating either or both sides of a continuous advancing web of paper, cloth, or the like having relatively porous or fibrous nature.

Still another specific object of our invention is to provide durable and reliable equipment cooperable directly with standard paper making machines of various types, for rapidly and effectively coating the products of such machines with minimum attention and at moderate cost.

The above and other objects and advantages obtainable with the aid of the present improvement, will be apparent from the following detailed description; and the improved apparatus disclosed but not claimed herein constitutes subject matter of our application Serial No. 17,434, filed March 27, 1948.

A clear conception of the several steps involved in our improved method, and of the construction and operation of typical paper coating apparatus for carrying on the said method steps, may be had by referring to the drawing accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

Fig. 1 is an exploded perspective view of a typical vacuum coater adapted to apply aqueous coating solutions to diverse porous or fibrous materials such as paper sheets or cloth;

Fig. 2 is a transverse vertical section taken through the medial portion of a downward feed coater assembled from parts such as shown in Fig. 1;

Fig. 3 is a transverse vertical section taken through the medial portion of an upward feed coater assembled from parts such as shown in Fig. 1;

Fig. 4 is a diagram of a typical paper coating system embodying coating units such as shown in Figs. 2 and 3 and adapted to coat both surfaces of a continuously traveling paper web; and

Fig. 5 is a transverse section through the medial portion of a slightly modified coater.

While the invention has been shown and described herein as being especially advantageously applicable for the specific purpose of coating paper sheets, it is not our desire or intent to unnecessarily limit the scope or the utility of the improved method and apparatus for use in coating other materials having a relatively porous or fibrous nature.

In accordance with our present improved process of coating the surfaces of materials having relatively porous texture, we create a vacuous condition adjacent to the surface area which is to be coated and apply fluent coating substance under pressure to the surface area in question in close proximity to and laterally of the vacuum zone so that air withdrawn from within, and along the surface of, the porous material, will be replaced by fluent coating substance which also spreads over the evacuated surface area to produce a coating layer firmly anchored to the material. In order to uniformly coat relatively extended surface areas, the vacuum should preferably be maintained of constant intensity, and the vacuous zone and the material may be moved or shifted relative to each other; and when the method is applied to sheets or webs of the material, the vacuum and coating applying zones may be maintained in fixed position and caused to coact with the constantly advancing or travelling webs, and the latter may be coated either on one side only, or on both of the opposite sides thereof. When coating relatively thin sheets or webs, it is necessary to provide a non-porous or impervious backing surface coacting with the web along the surface thereof opposite to the coating zone; and when the opposite surfaces of such thin sheets are coated in succession, the previously coated areas may be utilized as impervious backings for the areas which are subsequently coated. The several steps of the improved method of coating may be automatically and continuously exploited or carried on with the aid of relatively simple apparatus, typical embodiments of which are shown more or less diagrammatically in the accompanying drawing.

Referring to Figs. 1 to 4 inclusive of the drawing, the typical paper web coating system shown therein by way of illustration, comprises in general two reversely disposable vacuum actuated coaters or coating units 7, 8 cooperable with the opposite surfaces of a constantly advancing porous paper web 9 which coacts with reversely revolving main rolls 10, 11 respectively and with a series of auxiliary guide rollers 12. The units 7, 8 may be of generally similar construction, each consisting primarily of a series of elongated

elements or bars 14, 15, 16 and a pair of spacer blocks 17 of suitable thickness, these bars and blocks being provided with alineable holes 18, 18, for the reception of clamping bolts 19 for holding the elements in assembled condition. Each end bar 14 is provided with a series of through openings 21 and with an evacuating manifold 22 communicating with all of the openings 21 and having a central outlet 23 adapted to be connected to a vacuum pump or other locality of reduced pressure, and the bar 14 of each unit 7, 8 coacts with one side of the intermediate bar 15 which is provided with a cut-out 24 in open communication with the openings 21 and which forms a suction or vacuum chamber or nozzle 25 exposed to the adjacent surface of the advancing web 9.

The opposite face of the medial bar 15 of each unit 7, 8, coacts with the adjacent sides of the spacer blocks 17 and the opposite sides of these blocks coact with the other end bar 16 which is likewise provided with a cut-out 26 cooperating with the space created by the blocks 17 to produce a coacting substance supply chamber or receptacle 27 of considerable capacity exposed at its larger outer end to atmospheric pressure and also exposed at its smaller end, to the surface of the advancing web 9 in close proximity to but laterally of the adjacent suction nozzle 25. In order to permit convenient variation in the thickness of the coating and the depth of penetration of the solution, the holes 18' in the bar 16 may be elongated as shown in Fig. 1, thus providing simple means for effecting adjustment of this bar toward and away from the web 9. When the unit 7 is disposed above the web 9 for downward feed, the receptacle 27 may be directly supplied with an abundance of aqueous coating solution containing starch, glue, dye, clay or other suitable ingredients, from above and from any convenient source exposed to atmospheric pressure, as indicated in Fig. 2; and in cases where the unit 8 is located below the web 9 for upward feed, the receptacle 27 may be likewise supplied with an abundance of similar coating solution from below, with the aid of a similarly exposed supply reservoir 28 and a feed pipe 29 communicating with the lower extremity of the chamber 27.

The main rollers 10, 11 preferably and in certain cases necessarily, have non-porous or impervious peripheral surfaces contacting the web 9, and these rollers may also be heated in order to effect drying of the web as it travels in contact with the roller peripheries. The web 9 may be subjected to continuous coating while being delivered from the web forming equipment of the paper making machine, and may be delivered from the roller 11 to the calender rolls or other finishing equipment, in a well known manner. It should be apparent that the coating unit 7 coacts with the roller 10 to continuously coat the upper surface of the rapidly advancing web 9, while the inverted coating unit 8 coacts with the roller 11 to likewise continuously coat the opposite or lower surface of the same web. It is alsc to be noted that the coaters or units 7, 8 preferably cooperate with the rollers 10, 11 to apply the coatings by subjecting the web 9 to vacuum or suction in advance of the zones of application of the coating solutions; and in certain cases where maximum vacuum action is desirable in order to increase the depth of penetration, an additional vacuum nozzle or slot may be provided in the manifold 22', in

advance of the bar 14 as shown in Fig. 5, rather than to increase the width of the nozzle 25, so as to prevent the web from being pulled way from its backing roll. The units 7, 8 should rather snugly engage the surfaces of the web 9, and should also be of sufficient length to completely span this web, and the plate 16 should also be adjustable in order to vary the coating thickness.

During normal operation of the typical porous paper web coating equipment while carrying on our improved method, the outlets 23 which communicate with the suction nozzles 25 and with the auxiliary nozzles of Fig. 5 if utilized, should be connected to a suitable source of vacuum, and the chambers 27 should be constantly supplied with an abundance of suitable coating solution. As the porous web 9 subsequently travels between the coating units 7, 8 and the adjacent rollers 10, 11, the nozzles 25 withdraw air from within the advancing adjacent zones and these evacuated zones partially fill up with coating solution from the laterally adjacent chambers 27 which also deposit a film of coating substance upon the adjacent external surfaces of the web 9. The impervious backings afforded by the rollers 10, 11 however prevent air from being drawn directly through the relatively thin web 9 and also prevent the coating solution from passing entirely through this web; and when the coated areas have passed beyond their respective units 7, 8, the heated rollers 10, 11 quickly dry the coatings sufficiently to insure permanent application and setting of the solution. The coatings are thus interlocked with the porous or fibrous surface areas of the web, and may be effectively finally smoothed and finished by calendering or otherwise.

From the foregoing detailed description of a typical embodiment of the improvement as specifically applied to the treatment of paper, it should be apparent that our present invention provides an improved method of and apparatus for coating any material having a porous nature adjacent to the surfaces to which the coatings are applied, with coatings which are firmly anchored to the bodies of the material. The improved process merely involves the creation of a vacuous condition or suction at the surface area which is to be coated, and the application of fluent coating substance under pressure to the surface of the material laterally adjacent to the evacuated zone and in close proximity thereto. The coatings thus applied are uniformly thick and smooth, and may obviously be applied either by maintaining the coating units in fixed position while moving the material relative to the stationary applicators, or by moving the coating units along the coat receiving material, or by relatively moving both the coating units and the material.

In cases where the material which is to be coated consists of a relatively thin sheet or web, it is necessary to provide the opposite side with a non-porous or impervious backing; but after a coating has been applied to one side of the sheet, the pre-coated side may be utilized as a backing when coating the opposite side. Coating by our improved method may be effected when the material receiving the coat is travelling at relatively high speed as in the case of advancing webs produced in paper making machines, and the characteristics of the coatings may be readily varied by changing the composition of the coating media, by increasing or reducing the vacuum, and by adjusting the bar 16 toward or away from the web 9. The improved method thus becomes highly flexible in its adaptations for diverse coating purposes, and is especially useful in the arts of paper and textile coating.

The improved apparatus or units 7, 8 for effecting exploitation of our coating process, are obviously simple, compact and durable in construction, and may be readily assembled and dismantled for inspection and cleaning. These coating units may be conveniently installed with comparatively minor alterations in connection with standard paper making and cloth treating machines, to automatically and effectively coat either one or both sides of rapidly travelling continuous webs or ribbons or material, with coatings of various materials and of any desired thickness. The degree of vacuum and the distribution of the evacuated area may also be varied by utilizing nozzles as in Figs. 2 or 5, and the invention has proven highly satisfactory and successful especially for the purpose of coating paper webs in the production of coated paper for printing purposes.

It should be understood that it is not desired to limit this invention to the exact steps of the method or to the precise construction of the apparatus, herein shown and described, for various modifications within the scope of the appended claims may occur to persons skilled in the art; and it is also contemplated that specific descriptive terms used herein be given the broadest possible interpretation consistent with the disclosure.

We claim:

1. The method of continuously coating a porous sheet, which comprises, evacuating fluid ingredients from a region adjoining and within a surface of the sheet, removing the evacuated region from the zone of evacuation to a coating zone and promptly thereafter applying fluent coating substance to said removed region under at least atmospheric pressure before direct exposure of the region to the ambient atmosphere, and relatively moving the sheet and the evacuation and coating application zones to enlarge the coated area.

2. The method of continuously coating a porous sheet, which comprises, evacuating fluid ingredients from a region adjoining and within a surface of the sheet, removing the evacuated region from the zone of evacuation to a coating zone and promptly thereafter applying fluent coating substance to said removed region under at least atmospheric pressure before direct exposure of the region to the ambient atmosphere, leveling the applied coating substance to provide a coating of predetermined thickness, and moving the sheet relative to the evacuation, coating application and leveling zones to enlarge the coated areas.

3. The method of continuously coating a porous sheet, which comprises, causing one side of the sheet to coact with an impervious backing, evacuating fluent ingredients from a region adjoining and within the opposite side of the sheet, removing the evacuated region from the zone of evacuation to a coating zone and promptly thereafter applying fluent coating substance to the removed region under at least atmospheric pressure to provide a surface coating having portions embedded within the adjacent side of the sheet, and advancing the sheet past the zones of evacuation and coating fluid application into the ambient atmosphere.

4. The method of continuously coating a

porous sheet, which comprises, causing one side of the sheet to coact with an impervious backing, evacuating fluent ingredients from a region adjoining and within the opposite side of the sheet, removing the evacuated region from the zone of evacuation to a coating zone and promptly thereafter applying fluent coating substance to the removed region under at least atmospheric pressure, leveling the applied coating substance to provide a coating of predetermined thickness, and advancing the sheet past the zones of evacuation and coating fluid application and leveling into the ambient atmosphere.

GEORGE D. KNIGHT.
BEN W. ROWLAND.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,667,408	Allen	Apr. 24, 1928
1,810,424	Hawley	June 16, 1931
2,257,373	Franselow	Sept. 30, 1941
2,279,553	Bradt	Apr. 14, 1942
2,293,125	Fanselow	Aug. 18, 1942
2,324,787	Lundgren	July 20, 1943
2,346,523	Vincent	Apr. 11, 1944