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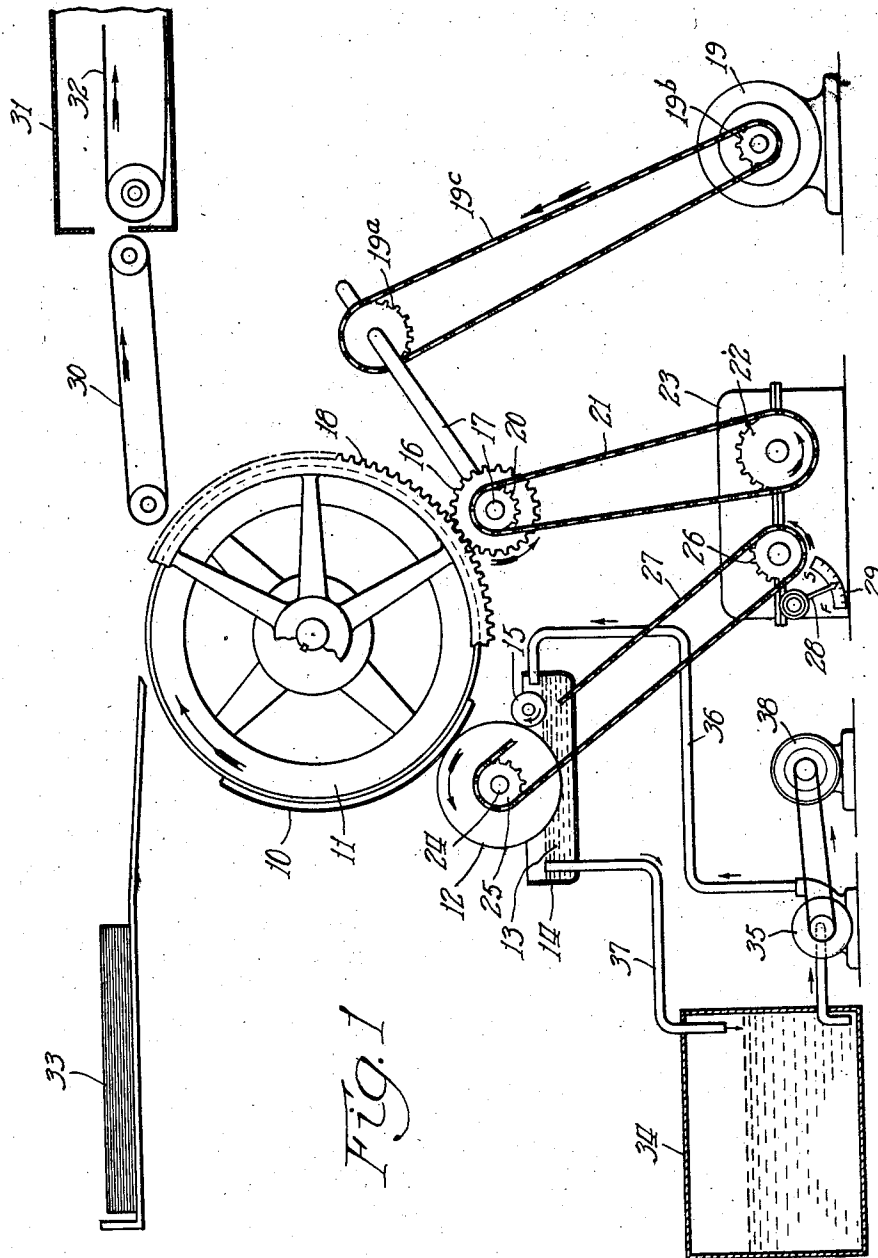
C. E. FAWKES ET AL

2,016,085

PAPER COATING PROCESS

Filed Nov. 30, 1934

3 Sheets-Sheet 1



Inventors
CHARLES E. FAWKES AND
COLIN M. MACKENZIE

[Signature]
Attorney

Oct. 1, 1935.

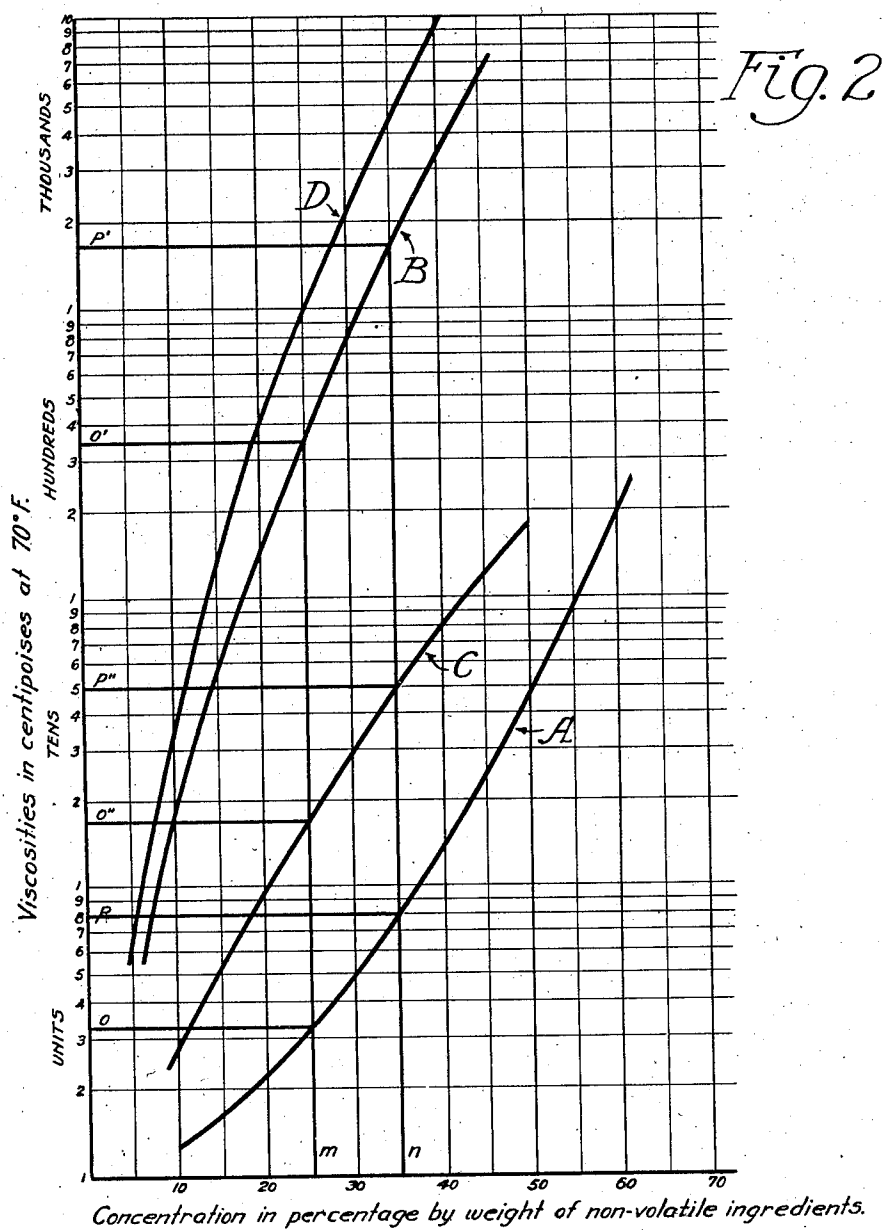
C. E. FAWKES ET AL

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Inventors
CHARLES E. FAWKES AND
COLIN M. MACKENZIE

By

Attorney

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C. E. FAWKES ET AL

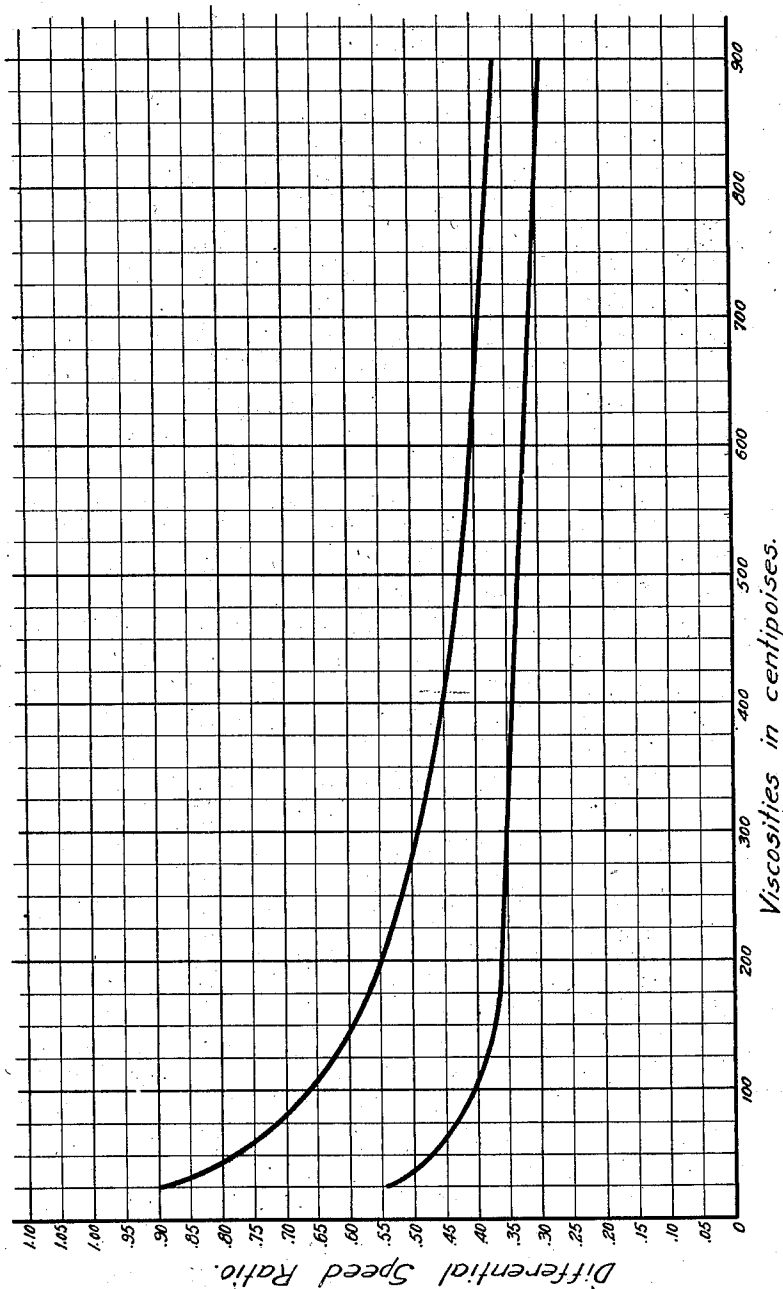
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3 Sheets-Sheet 3

FIG. 3



Inventors
CHARLES E. FAWKES AND
COLIN M. MACKENZIE

Attorney

UNITED STATES PATENT OFFICE

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PAPER COATING PROCESS

Charles E. Fawkes, Chicago, Ill., and Colin Malcolm MacKenzie, Wabash, Ind., assignors to Container Corporation of America, Chicago, Ill., a corporation of Delaware

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9 Claims. (Cl. 91—68)

This invention relates to coated products and their manufacture, and more particularly pertains to lacquer coated paper and paperboard and to the apparatus and process of applying the lacquer coating.

It has long been customary to apply copal spirit varnishes and shellac solutions, and even oleoresinous varnishes, to paper, paperboard, and other sheet materials by means of smooth surfaced applicator rolls, or brushes. Coatings of this type present no particular problem in their application because any ridges or flow lines which may be formed on the sheet as they are applied subsequently disappear due to the inherent tendency of such liquids to "flow out" and assume a smooth level plane. This tendency to "flow out" is in part due to the fact that such varnishes show only a relatively small change in viscosity for a substantial increase or decrease in concentration of film forming constituents. Paper may therefore be readily varnished or shellacked with a solution containing a relatively high percentage of non-volatile ingredients to obtain a coating of such low viscosity that the ridges or flow lines which are formed on the sheets as the coating is applied by the rollers will flow out smooth before the viscosity rises, as a result of the evaporation of the solvents, to a point where the flow stops.

This is not true however of coating compositions such as soluble cellulose lacquers, in which the viscosity concentration relationship is such that a small change in concentration produces a great change in viscosity. Therefore, in general, when it is attempted to apply lacquer of the desired solids, or non-volatile, concentration by means of the conventional varnish and shellac machines, it is found that the ridges and flow lines which are formed on the sheet will not "flow out", as is the case of coatings having a "high flow", such as varnishes and shellacs, and a smooth coating is therefore not obtained. If an excessively thin and limpid lacquer is used in order to get the desired "flowing out" after the coating operation, the cost of laying down a given thickness of film is raised through the increased loss of solvent, and furthermore, the paper, due to its porosity and capillarity, will soak up the lacquer to such an extent that a very poor finish will be obtained. There is, therefore, a practical limit below which it is not advisable to lower the viscosity and non-volatile concentration of lacquers for different kinds of paper and paperboard, and this limit can be defined as being

that point at which the capillary attraction of the paper for the lacquer is greater than the viscous resistance offered by the liquid lacquer to such absorption.

The term "lacquer having a critical viscosity range" as used herein is used to describe any coating composition which before the evaporation of the solvents consists of a non-volatile, film-forming composition dissolved in one or more volatile solvents to provide a flowable solution having viscosity concentration characteristics of such a nature that a small change in concentration produces a relatively great change in viscosity as illustrated in curves B, C and D of Fig. 2 as distinguished from the viscosity concentration characteristics of curve A of Fig. 2.

Heretofore, the practical means by which it has been considered possible to satisfactorily apply a thin, smooth coating of lacquer to paperboard or other relatively smooth faced fibrous sheet materials, as distinct from highly absorptive surfaces such as woven fabrics, has been by means of spray guns and similar spraying devices. However, due to the large amount of waste entailed in such process this method is considered too costly to commercially coat paper and paperboard products.

One object of this invention is to provide a method of operation whereby a relatively thin, smooth and uniform layer of lacquer or equivalent coating may be applied to paperboard or material having surfaces of similar characteristics.

Another object of this invention is to provide a sheet of paperboard or similar material which has a smooth and lustrous coating of lacquer applied thereto with the maximum amount of economy.

Another object of this invention is to apply a thin, smooth layer of lacquer to surfaces such as fibrous paper or paperboard sheets which differ in texture, density, porosity, degree of hydration, and character and efficiency of sizing.

A further object of this invention consists of setting up at the points or regions of liquid transfer in the coating process a critical shear, produced by controlled differential speeds of the moving members.

A further object of this invention is to apply a relatively thin, smooth and uniform coating of lacquer to a sheet of paperboard or similar material by developing a critical shear at the point or region of liquid transfer between the applicator member and the sheet.

A further object of this invention is to obtain a relatively thin, smooth and uniform coating of lacquer upon an applicator member by means of a shearing operation upon the coating liquid produced by a doctor roll operating in conjunction with the applicator roll.

A further object of this invention is to apply a relatively thin, smooth and uniform coating of lacquer to a sheet of paperboard or similar material by developing a critical shear at the point or region of liquid transfer between the sheet and the applicator member and by means of a shearing operation upon the coating liquid produced at other points or regions by cooperating elements.

A further object of this invention is to provide a machine and a process by which lacquer or equivalent coating within a critical viscosity range and of optimum concentration may be used in coating sheets of paperboard or similar material which may differ in porosity, or density, whereby a smooth, continuous film free from ridges and flow lines is provided on the sheet.

A further object of the invention is to provide a method of coating paperboard or similar material with a lacquer or equivalent coating whereby a superior coated product is obtained.

These and other objects not specifically enumerated, though contemplated by this invention, will readily appear to those skilled in the art as the description proceeds.

For a better understanding of the invention, reference may be made to the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of one form of a machine suitable for carrying out the process;

Fig. 2 is a graphic chart illustrating the slight changes of viscosity in varnishes as compared with the substantial changes of viscosity in lacquers when the same changes are made in concentration; and

Fig. 3 is a graphic representation of the conditions associated with the coating operation.

In general, this invention comprises effecting, at a point or points or regions of liquid transfer in the coating process, a critical shear upon a wet film of liquid lacquer or the like of any predetermined and correlated viscosity, when applied in a relatively thin film to any given type of paper, paperboard or other relatively smooth surfaced material, said shear being obtained by proper control, hereinafter described, of the relative surface speeds of the coating and coated elements.

Referring more particularly to the drawings, there is shown at Fig. 1, a suitable coating machine to typify the invention and one way to carry out the process. A sheet 10, representing a sheet to be coated, is carried on a cylinder 11 which is driven to rotate in the direction indicated by the arrow. The liquid coating material is applied to the sheet 10 by means of an applicator roll 12, preferably having a facing of some yieldable composition such as rubber, glue-glycerin or the like, which rotates in a bath of liquid lacquer 13 contained in a fountain 14. The roll 12 is driven to rotate in the direction of the arrow. A doctor member, represented by a roll 15, which is preferably of metal, is positioned adjacent the roll 12 and serves to regulate the amount of lacquer upon the applicator roll when it contacts with the sheet 10 so that same will be in a relatively thin, smooth liquid film and

without ridges or flow marks, and in this condition may be transferred from the applicator roll to the sheet 10. The sheet carrying cylinder 11 in the present machine is driven by means of a pinion gear 16, on a jack shaft 17, meshing with a cylinder gear 18 on the cylinder 11, the jack shaft being connected to a driving motor 19 by sprockets 19a and 19b and a connecting belt or chain 19c.

The jack shaft 17 carries a pulley 20 which is connected by a belt or chain 21 to an in-take sprocket 22 on a positive, infinitely variable gear device 23.

On the shaft 24 on which the applicator roll 12 is mounted, there is also keyed or otherwise fixed a sprocket 25 connected with a sprocket 26 on the positive, infinitely variable gear device by means of a chain or belt 27.

The doctor roll 15 may be non-rotatable or rotatable, and, if rotated, can be advantageously geared direct to the applicator roll 12 or to the jack shaft 17 by conventional means. The positive, infinitely variable gear 23 may be of any conventional type and is so constructed that the speed of rotation of the applicator roll 12 may be regulated at will, by moving ratio change lever 28 to F or S (fast or slow) on the graduated scale 29, while the speed of the sheet carrying cylinder remains constant. The positive, infinitely variable gear is a conventional device and need not be described in detail.

While a positive, infinitely variable gear 23 has been shown as preferable it is obvious that other suitable means may be employed to obtain varying speeds of the applicator roll.

After the sheet 10 has been coated, it is released from the cylinder 11 and carried away by any suitable means, such as a conveyor 30, preferably to a drying oven 31, where it is completely dried. Within the oven, another endless conveyor 32 may be employed for feeding the sheet therethrough. The sheet 10 may be manually or mechanically fed onto the cylinder 11 from any suitable supply, such as a stack 33.

The bath of liquid lacquer 13, in which the applicator roll 12 rotates is maintained in the fountain 14 and is preferably kept in circulation between the fountain 14 and a supply tank 34 by means of a pump 35, that circulates the lacquer through the inlet and outlet conduits 36 and 37. The pump may be driven by a motor 38. This circulation enables the lacquer to be maintained within a predetermined critical viscosity range. If there is any substantial evaporation of solvent from the lacquer before its application to the sheet, more may be added in order to keep the viscosity within the predetermined critical range.

The different conditions existing in lacquers and varnishes when the percentage of non-volatile ingredients in the solution is increased due to the evaporation of the solvent is shown at Fig. 2. Referring to this figure, the axis of abscissae shows the concentration in percentage by weight of the non-volatile ingredients, and the axis of ordinates shows the viscosities in centipoises at 70° F. on a logarithmic scale. The curve A represents an ordinary copal varnish; the curve B represents that of a lacquer with nitro cellulose base having a 5 to 6 second viscosity; the curve C represents that of a lacquer with a nitro cellulose base having a 1/4 second viscosity; and the curve D represents that of a lacquer with a nitro cellulose base having 15 to 20 second viscosity. The formulas for the lacquers B, C, and D rep-

resented at Fig. 2 are set forth below, the numbers having reference to the parts by weight.

	Lacquer B	Lacquer C	Lacquer D
5 Nitro cellulose ¼-sec. viscosity	none	58	none
Nitro cellulose 5 to 6 sec. viscosity	58	none	none
10 Nitro cellulose 15 to 20 sec. viscosity	none	none	58
Castor oil	53	53	53
Diamyl phthalate	14	14	14
Ester gum	22	22	22
Xylol	65	65	65
Naphtha	45	45	45
Butyl acetate	65	65	65
Ethyl acetate	35	35	35
15 Ethyl alcohol	25	25	25

Referring now to Fig. 2, it will be apparent to those skilled in the art that with copal varnishes there is only a slight rise in viscosity for a substantial increase in concentration of the film-forming constituent, due to evaporation, during the application of the varnish to the paper and before the varnish coated paper is moved to the drying zone. Referring specifically to the curve A, let it be assumed that a suitable wet copal varnish solution having a given concentration m is applied by means of a conventional varnish applying machine. This wet varnish loses some of its volatile solvent by evaporation in the coating machine cycle, during which it is applied to the paper and preliminary to drying when all the volatile solvent is evaporated. Due to the loss of the evaporated solvent in the coating machine cycle, that is, before the varnish coated sheet is moved to the drying zone, the concentration rises from m to n . During this period "flow-out" of the varnish is possible because, despite the fact that the concentration has increased from m to n , there has been only a slight rise in viscosity, that is, from o to p . These points are the projection or intercepts of the curve A back on the ordinate axis of viscosity.

For example, if lacquer of composition B is used, and is applied at the same concentration as the previous example of copal varnish, as represented by the same point m on the axis of the abscissae, and if the same machine technique is used, then the rise of viscosity which results from the loss of solvent in the coating operation is shown by the projection back from the curve B to the axis of ordinates, the rise of viscosity being the distance between the points o' to p' . Roughly, it is seen that the viscosity rise is approximately 300 times as great, expressed in centipoises, as that shown by the copal varnish A.

Accordingly, a liquid varnish at a concentration n still has a good "flow out" character or quality while a liquid lacquer at the concentration n has a very poor "flow out" character due to the fact that its viscosity has been so greatly increased.

Due to the inherent characteristics of the lacquer it is therefore impossible to apply a thin, smooth film of lacquer having the desired characteristics to a sheet of paperboard or the like by means of the conventional varnish applying machines.

In order, according to this invention, to obtain a coating of lacquer on the sheet which is of the desired thinness and smoothness, it is necessary to operate the coating machine under certain predetermined conditions. If the doctor roll 15, and the applicator roll 12, travel at the same lineal speed it has been found that with coating liquids having a steep viscosity concen-

tration curve as defined by the above reference to Fig. 2, which includes the conventional lacquers that are solutions of soluble cellulose together with resins and plasticizers in volatile solvents, as shown on curves B, C and D of Fig. 2, ridges and flow lines will form upon the surface of the applicator roll. If the paper sheet 10 or other surface to be coated is moving across the applicator roll 12 at the same surface speed at which said applicator roll is travelling, these 10 same or other similar ridges or flow lines will form on the sheet and, due to the rapid drying qualities of the lacquer and the fact that the viscosity rises so rapidly, will not flow out into a smooth surface but will remain thereon in substantially the same ridged formation in which they were applied.

By increasing the speed of the applicator roll 12, while maintaining the speed of the doctor roll 15 constant, it was found, when the speed 20 of the applicator roll had been increased to such an extent that the doctor roll was travelling at around fifty percentum of the speed of the applicator roll, that the ridges and flow lines which appeared on the applicator roll when the 25 two rolls were travelling at the same lineal speed had substantially disappeared and the lacquer film on the surface of the applicator roll presented a smooth and glossy appearance, substantially free from ridges and flow lines. It was also 30 found that similar results could be obtained by maintaining the doctor roll stationary, in both instances, there being a differential in speed.

It has also been found that even when a smooth coating of lacquer has been applied to 35 the applicator roll, ridges and flow lines have a tendency to appear upon the surface of a sheet which is coated with the lacquer if such sheet is moved across the applicator roll at a lineal speed which is the same as that at which the 40 applicator roll is travelling. By increasing the differential speed between the sheet and the applicator roll, preferably while maintaining the speed of the sheet constant, such ridges and flow lines are found to gradually increase in number 45 per unit of width and decrease in size and visibility until eventually, as the differential speed is further increased, a critical range is reached at which the ridges decrease below the resolving power of the eye and the sheet appears substantially free from ridges and flow lines and 50 presents a smooth and glossy appearance. If the differential speed is still further increased above the critical range, it has been found that the film which is applied to the sheet is broken so 55 that minute pores or pinholes are formed in the coating. It is believed that these breaks in the lacquer film are due to the fact that the lacquer transferred from the applicator roll is spread over a correspondingly greater area of the sheet 60 than is the case when the differential speed is nearer unity, or within the above referred to critical range.

Although it cannot be stated with certainty just why the coating on the applicator roll as 65 well as the final coating on the sheet, is visibly ridged at certain differential speeds or movements and at other differential speeds or movements appear smooth, and while it is not intended that this invention in its broadest aspects 70 be limited to the theories herein set forth, theoretical considerations lead to the belief that, due to the differences in lineal speeds between the applicator roll and the doctor roll, as well as between the applicator roll and the sheet, an ac- 75

tion, which may be called a shearing action, takes place upon the liquid film of lacquer at the point or region of substantial contact between the moving parts. As a result of this shear, when the sheet and applicator roll are travelling within the critical range, the ridges and flow lines which would normally appear are so increased in numbers per unit width and decreased in size and visibility that they are below the resolving power of the eye and the coated sheet presents a smooth and glossy appearance.

It has been found, also, that the thickness of the lacquer film as applied to the applicator roll has an important bearing upon the coating operation, that is, if the doctor roll is in substantial contact with the applicator roll so that a film of around .0013 to .004 inches thickness is applied to the applicator roll, the above referred to shearing action causes such film to be smoothly and satisfactorily applied to the sheet, but if the film applied to the applicator roll becomes much thicker than .004 inches the shearing stress is not sufficient to completely overcome the tendency of the lacquer to ridge and hence, the lacquer on the coated sheet will appear ridged rather than smooth. The thickness of the film that is to be applied to the applicator roll can be easily controlled by simple adjustments of the doctor roll toward and from the applicator roll. When a yieldable composition faced applicator roll is employed it is found that the setting between the doctor roll and the applicator roll must be closer for lacquers of higher viscosities than is necessary for lacquers of lower viscosities due to the fact that the rotation of the applicator roll in the bath of lacquer causes a certain amount of pressure at the nip or plane of contact between the two rolls, and that this force apparently continuously deforms the pliable composition face of the applicator roll at this point and thereby increases the effective spacing between it and the doctor roll and permits more lacquer to be applied to the applicator roll.

If the viscosity of the lacquer is increased or decreased it has been found that a greater or lesser shear, respectively, is required between the applicator roll and the sheet in order to obtain a satisfactory, smooth coating; lacquers of higher viscosities having a more pronounced tendency to ridge than lacquers of lower viscosities and hence, more shear being required to overcome such tendency.

For varying grades of paperboard, that is, paperboards which vary in degree or quality of sizing, it has been found that lacquers of different viscosities should preferably be used inasmuch as a sheet which is relatively highly sized does not have the same tendency to absorb the lacquer as does a sheet which is relatively poorly sized and, therefore, when a highly sized sheet is used a satisfactory, glossy coating of lacquer of the desired thickness can be obtained by using a lacquer having a lower viscosity than would have to be used in order to obtain a similar result on a sheet which was not so highly sized, since, on a poorly sized sheet a lacquer of a higher viscosity would tend to remain upon the sheet rather than be absorbed by it.

There are certain practical considerations which have been found to be important in the selection of lacquers suitable for application to paperboard; in general, the lacquer which lays down the glossiest film, with the minimum amount of

solvent loss, for any particular type of board, being the most desirable. Ordinary commercial soluble cellulose lacquers are made from cellulose esters and ethers of widely different viscosity characteristics. To obtain a lacquer of any given viscosity considerably more solvent is required if nitro cellulose of a high viscosity is used than is required if nitro cellulose of a lower viscosity is employed. For example, if a lacquer of 100 centipoise viscosity is prepared by using nitro cellulose having a 15 to 20 second viscosity, the solvent required will amount approximately to 81% of the mixture, while if the lacquer is prepared by using nitro cellulose of $\frac{1}{4}$ second viscosity, the solvent required will amount to only approximately 57% of the mixture, and the resulting dry film when lacquer made from $\frac{1}{4}$ second viscosity nitro cellulose is applied will be glossier and about two and two-tenths times as thick as that of the 15 to 20 second viscosity nitro cellulose. It has been found that nitro cellulose at and below the viscosity known as 5 to 6 seconds is preferable for application to paperboard inasmuch as the films are glossier and the solvent loss is less.

The selection of the viscosity at which the prepared lacquer is to be applied is also of importance, the desirable viscosity varying for different types of paperboard, the more porous or less highly sized boards requiring lacquer of a higher viscosity than those which are more highly sized. The particular problem in any given case being the selection of a viscosity at which, or above which, no appreciable absorption takes place into the structure of the paper. It has been found that lacquers varying in viscosity from 25 centipoises to about 900 centipoises can be satisfactorily applied to different types of paperboard.

The relative ranges of differential speeds or movements within which it has been found by numerous tests that smooth films of lacquer of the desired thinness can be obtained for any given viscosity of lacquer when applied to a relatively highly sized sheet, such as a clay coated sheet which when subjected to an ordinary Penescop water absorption test will absorb .24 grams of water per each 5.6 square inches of surface in two minutes time, are shown graphically at Fig. 3. In this figure, the axis of abscissae represents the viscosity of lacquer in centipoises and the axis of ordinates represents the percentage of lineal speed of the applicator roll in comparison with the lineal speed of the sheet. Fig. 3 indicates that in order to obtain a smooth coating of lacquer of any given viscosity, the applicator roll should travel at a peripheral differential speed within the critical range, defined by the curves for any such viscosity. Thus, for example, if a lacquer of 25 centipoises viscosity is used, a satisfactory, smooth coating can be obtained by rotating the applicator roll at a peripheral speed corresponding from about ninety per centum (90%) to about fifty-four per centum (54%) of the speed of the sheet. It will be noted from Fig. 3 that as the viscosity of the lacquer increases a greater shear is required between the applicator roll and the sheet, hence the peripheral speed of the applicator roll must be a smaller percentage of the speed of the sheet. Thus, for example, if a lacquer of about 900 centipoises is used, a smooth coating can be obtained by rotating the applicator roll at a peripheral speed corresponding from about thirty-six per centum (36%) to around twenty-nine per centum (29%) of the speed of the sheet.

In coating boards which are not so highly sized as that defined above, it has been found that the ranges of differential speed shown at Fig. 3 are slightly increased, that is, the range within which smooth coatings can be obtained extends slightly above and below the points shown on Fig. 3.

As the differential speed between the applicator roll and the sheet is decreased below the point shown in Fig. 3 for any given viscosity, that is, as the speed of the applicator roll approaches the speed of the sheet, the film of lacquer which is applied to the sheet will tend to become ridged, the ridges becoming more and more pronounced as the speed between the applicator roll and the sheet approaches unity. If the differential speed between the applicator roll and the sheet is increased beyond the critical range shown in Fig. 3 for any given viscosity, the film of lacquer applied to the sheet is broken and pores or pinholes appear in the lacquer coating.

The maximum speed at which the sheet material can be made to travel depends a great deal on the manner in which the sheet material is fed through the coating machine, that is, if the sheets are intermittently fed through manually, the sheet speed is, of course, limited to the number of sheets an operator can feed through the machine which amounts to approximately 380 board feet per minute. However, if the sheet is in roll form and is mechanically fed through continuously, then a speed of as high as 600 to 800 feet per minute can be obtained.

The transition from a ridged film to a substantially smooth film is somewhat gradual but it has been found that at a given viscosity the range of differential speeds within which smooth coatings can be obtained is quite definite, even for varying grades of paperboard, and knowing the differential speed range for any particular viscosity, a satisfactory differential speed can be readily obtained by means of preliminary tests, for any particular type of board or set of conditions.

It is considered desirable, at times, to apply a distinctive colored coating rather than the clear coating which is obtained when ordinary lacquer is applied. This colored coating can be readily obtained by dispersing, in the clear lacquer, coloring material such as pigments, dyestuffs or metal powders such as gold and silver and the like. Such colored lacquers are well known in the art and can be readily applied in the same manner as that heretofore set forth.

It will thus be seen, from the above, that the present invention teaches how a film of lacquer of a predetermined thinness can be economically applied to paper, paperboard or material having surfaces of similar characteristics, to form a smooth and glossy coating, by means of rolls, by setting up at points and regions of liquid transfer in the coating process a critical shear which for predetermined liquid viscosities operates and provides a smooth, uniform and satisfactory coating on the sheet.

While the present description sets forth a preferred embodiment of the invention, certain changes and variations can be made without departing from the spirit of the invention and it is therefore desired that the present embodiment shall be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the foregoing description to indicate the scope of the invention.

We claim:

1. A process of applying a smooth coating of

lacquer having a critical viscosity range to a sheet of paper which comprises delivering a film of said lacquer to an applicator roll, moving a sheet of paper across the surface of said applicator roll, and rotating said applicator roll in the direction of travel of said sheet at a predetermined lineal speed less than the lineal speed of the sheet whereby the lacquer film is sheared from the applicator roll at a rate sufficient to overcome the tendency of the lacquer coating to form distinctive ridges or flow lines on the sheet as it is being transferred.

2. A process of applying a smooth coating of lacquer having a critical viscosity range to a sheet of paper which comprises delivering a quantity of said lacquer to an applicator roll, removing all but a smooth film of said lacquer of a predetermined thickness from the applicator roll by means of a doctor, moving a sheet of paper across the surface of said applicator roll, and rotating said applicator roll in the direction of travel of said sheet at a predetermined lineal speed less than the lineal speed of the sheet whereby the lacquer film is sheared from the applicator roll at a rate sufficient to overcome the tendency of the lacquer coating to form distinctive ridges or flow lines on the sheet as it is being transferred.

3. A process of applying a smooth coating of lacquer to a sheet of paper which comprises delivering to an applicator roll a film of said lacquer having a predetermined viscosity sufficiently high with regard to the paper to be coated that the viscous resistance of the lacquer relative to the capillary attraction of the paper causes a film of lacquer of appreciable thickness to remain unabsorbed on the surface of the paper, moving a sheet of paper across the surface of said applicator roll, and rotating said applicator roll in the direction of travel of said sheet at a predetermined slower lineal speed in connection with the speed of the paper above that at which pinholes are left in the lacquer coating and below that at which ridges or flow lines are formed in the lacquer coating.

4. A process of applying a smooth coating of lacquer to a sheet of paper which comprises delivering to an applicator roll a film of liquid lacquer having a predetermined viscosity sufficiently high with regard to the paper to be coated that the viscous resistance of the lacquer relative to the capillary attraction of the paper causes a film of lacquer of appreciable thickness to remain unabsorbed on the surface of the paper, moving a sheet of paper across the surface of said applicator roll, and rotating said applicator roll in the direction of travel of said sheet at a predetermined lineal speed less than the lineal speed of said sheet whereby the liquid lacquer film is sheared from the applicator roll at a rate sufficient to overcome the tendency of the lacquer coating to form distinctive ridges or flow lines on the sheet as it is being transferred.

5. A process of applying a smooth coating of lacquer to a sheet of paper which comprises delivering to an applicator roll a quantity of said lacquer having a predetermined viscosity sufficiently high with regard to the paper to be coated that the viscous resistance of the lacquer relative to the capillary attraction of the paper causes a film of lacquer of appreciable thickness to remain unabsorbed on the surface of the paper, shearing all but a film of said lacquer of a predetermined thickness from the applicator roll by

means of a doctor, moving a sheet of paper across the surface of said applicator roll, and rotating said applicator roll in the direction of travel of said sheet at a predetermined lineal speed less than the lineal speed of said sheet whereby the said lacquer is sheared from the applicator roll at a rate sufficient to overcome the tendency of the lacquer to form distinctive ridges or flow lines on the sheet as it is being transferred.

6. A process of applying a smooth coating of lacquer to a sheet of paper, which comprises delivering to an applicator roll a quantity of said lacquer having a predetermined viscosity sufficiently high with regard to the paper to be coated that the viscous resistance of the lacquer relative to the capillary attraction of the paper causes a film of lacquer of appreciable thickness to remain unabsorbed on the surface of the paper, shearing all but a film of said lacquer of a predetermined thickness from the applicator roll by means of a doctor, moving a sheet of paper across the surface of said applicator roll, and rotating said applicator roll in the direction of travel of said sheet at a predetermined lineal speed of more than twenty-nine percentum but less than equal to the lineal speed of the sheet whereby the said lacquer is sheared from the applicator roll at a rate sufficient to overcome the tendency of the lacquer to form distinctive ridges or flow lines on the sheet as it is being transferred.

7. A process of applying a smooth coating of lacquer to a sheet of paper, which comprises delivering to an application roll a quantity of said lacquer having a predetermined viscosity sufficiently high with regard to the paper to be coated that the viscous resistance of the lacquer relative to the capillary attraction of the paper causes a film of lacquer of appreciable thickness to remain unabsorbed on the surface of the paper, shearing all but a film of said lacquer of a predetermined thickness from the applicator roll by means of a doctor, moving a sheet of paper across the surface of said application roll, and rotating

said applicator roll in the direction of travel of said sheet at a predetermined lineal speed of less than ninety percentum of the lineal speed of said sheet, whereby the said lacquer is sheared from the applicator roll at a rate sufficient to overcome the tendency of the lacquer to form distinctive ridges or flow lines on the sheet as it is being transferred.

8. A process of applying a smooth coating of lacquer to a sheet of paper which comprises delivering to an applicator roll a quantity of said lacquer having a predetermined viscosity sufficiently high with regard to the paper to be coated that the viscous resistance of the lacquer relative to the capillary attraction of the sheet causes a film of lacquer of appreciable thickness to remain unabsorbed on the surface of the sheet, moving a sheet across the surface of said applicator roll, rotating said applicator roll in the direction of travel of said sheet at a predetermined lineal speed between ninety to twenty-nine percentum of the lineal speed of said sheet, whereby the said lacquer is sheared from the applicator roll at a rate sufficient to overcome the tendency of the lacquer to form distinctive ridges or flow lines on the sheet as it is being transferred and drying the said lacquer.

9. A process of applying a smooth coating of lacquer to a sheet of paper which comprises delivering a film of said lacquer having a predetermined viscosity range between twenty-five and nine hundred centipoises to an applicator roll, moving a sheet of paper across the surface of said applicator roll, and rotating said applicator roll in the direction of travel of said sheet at a predetermined lineal speed between ninety to twenty-nine percentum of the lineal speed of said sheet to cause the lacquer film on the applicator roll to be transferred to the paper free from ridges or flow lines.

CHARLES E. FAWKES.
COLIN MALCOLM MACKENZIE.