July 18, 1944. L. L. McGLADREY ET AL 2,354,033

METHOD AND APPARATUS FOR COATING SHEET MATERIAL

Filed Oct. 13, 1941 4 Sheets-Sheet 1

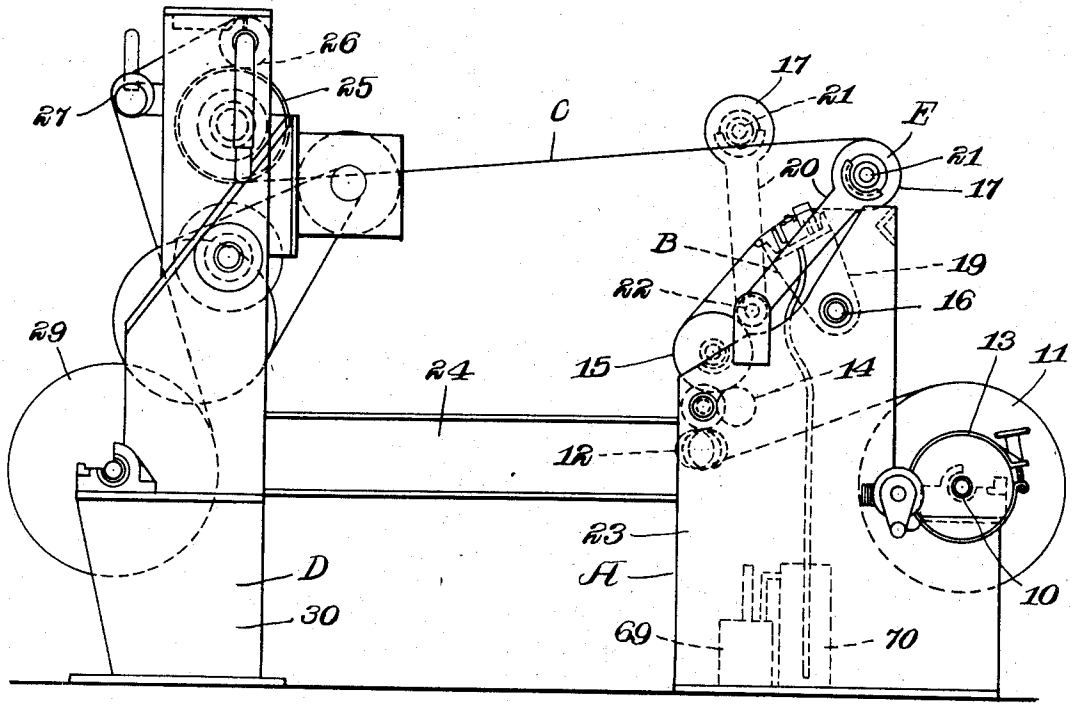



Fig. 1

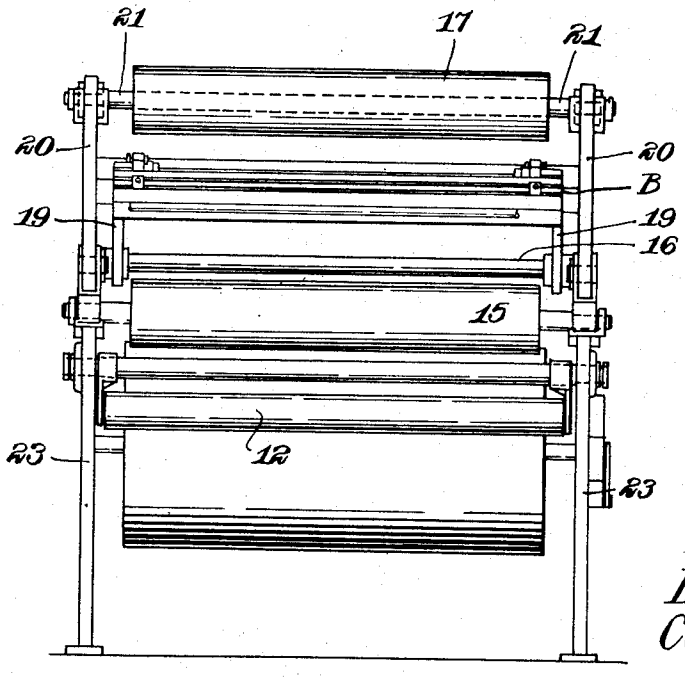



Fig. 2

Lyle L. McGladrey
Cecil M. Rhodes
INVENTOR

BY H. S. Johnson
ATTORNEY

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METHOD AND APPARATUS FOR COATING SHEET MATERIAL

Filed Oct. 13, 1941 4 Sheets-Sheet 2

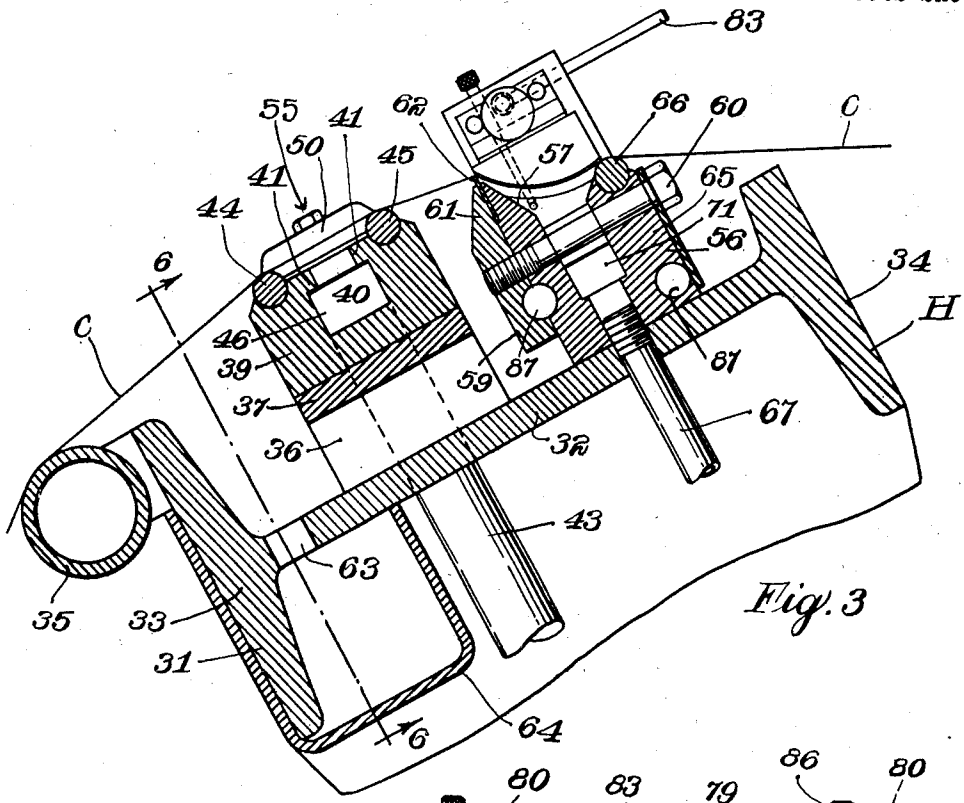



Fig. 3

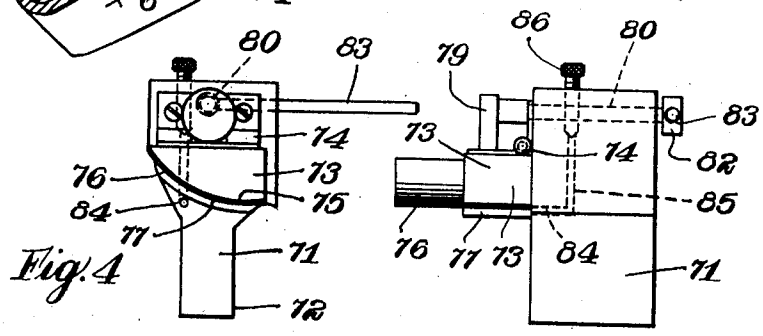



Fig. 4

Fig. 5

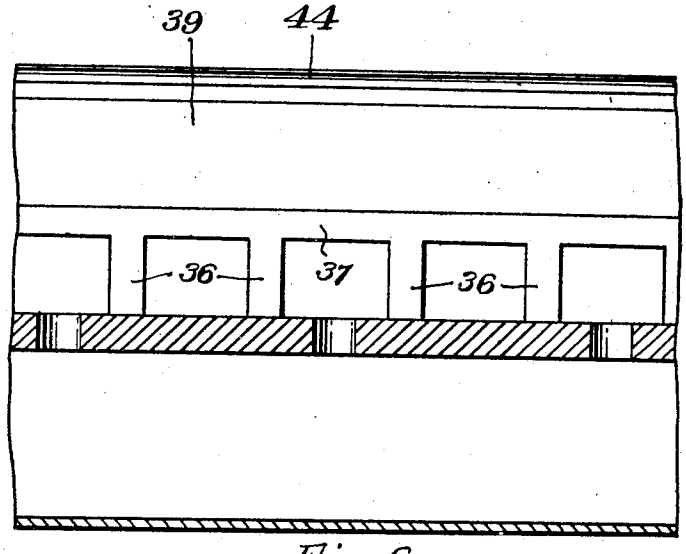



Fig. 6

Lyle L. McGladrey
Cecil M. Rhodes
INVENTOR

BY A. S. Johnson

ATTORNEY

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METHOD AND APPARATUS FOR COATING SHEET MATERIAL

Filed Oct. 13, 1941 4 Sheets-Sheet 3

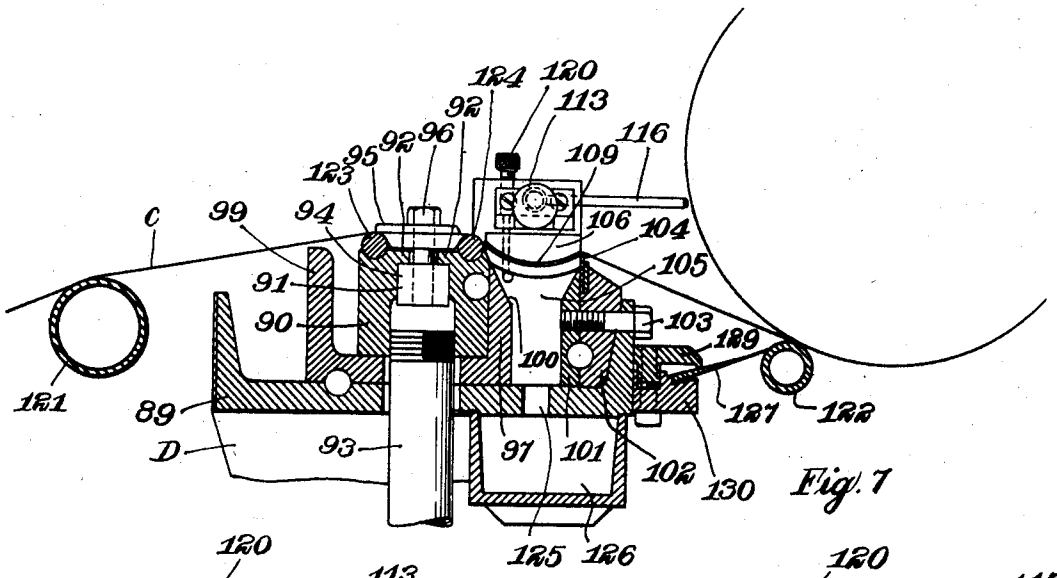



Fig. 7

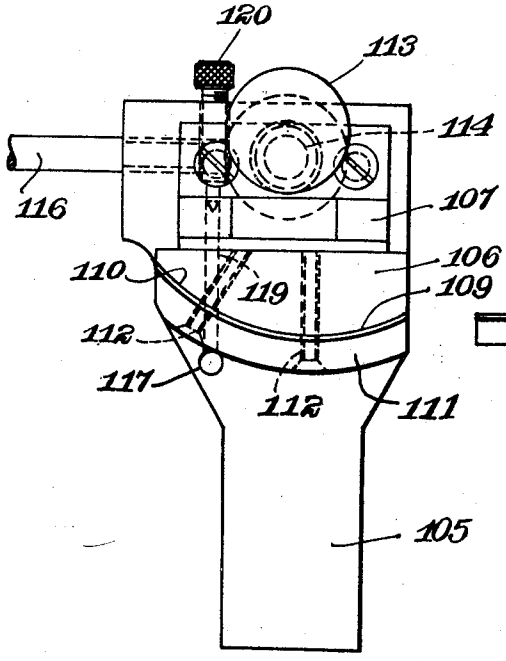



Fig. 8

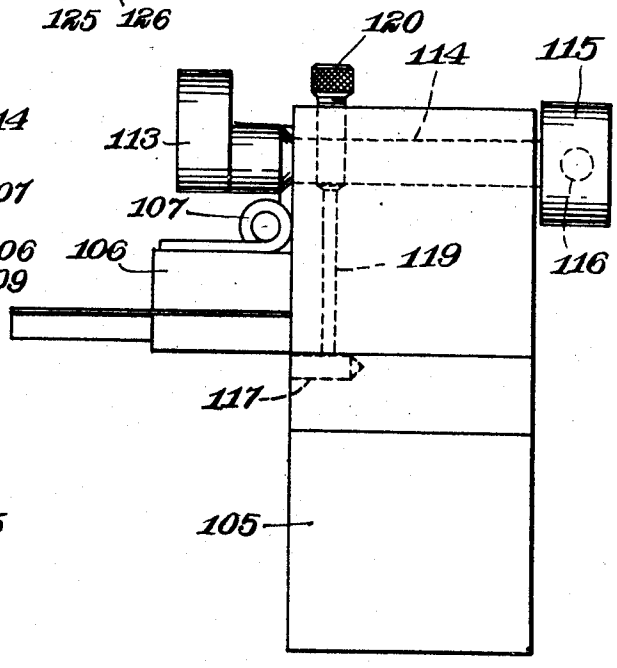



Fig. 9

Lyle L. McGladrey
Cecil M. Rhodes
INVENTOR

BY A. L. Johnson

ATTORNEY

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METHOD AND APPARATUS FOR COATING SHEET MATERIAL

Filed Oct. 13, 1941 4 Sheets-Sheet 4

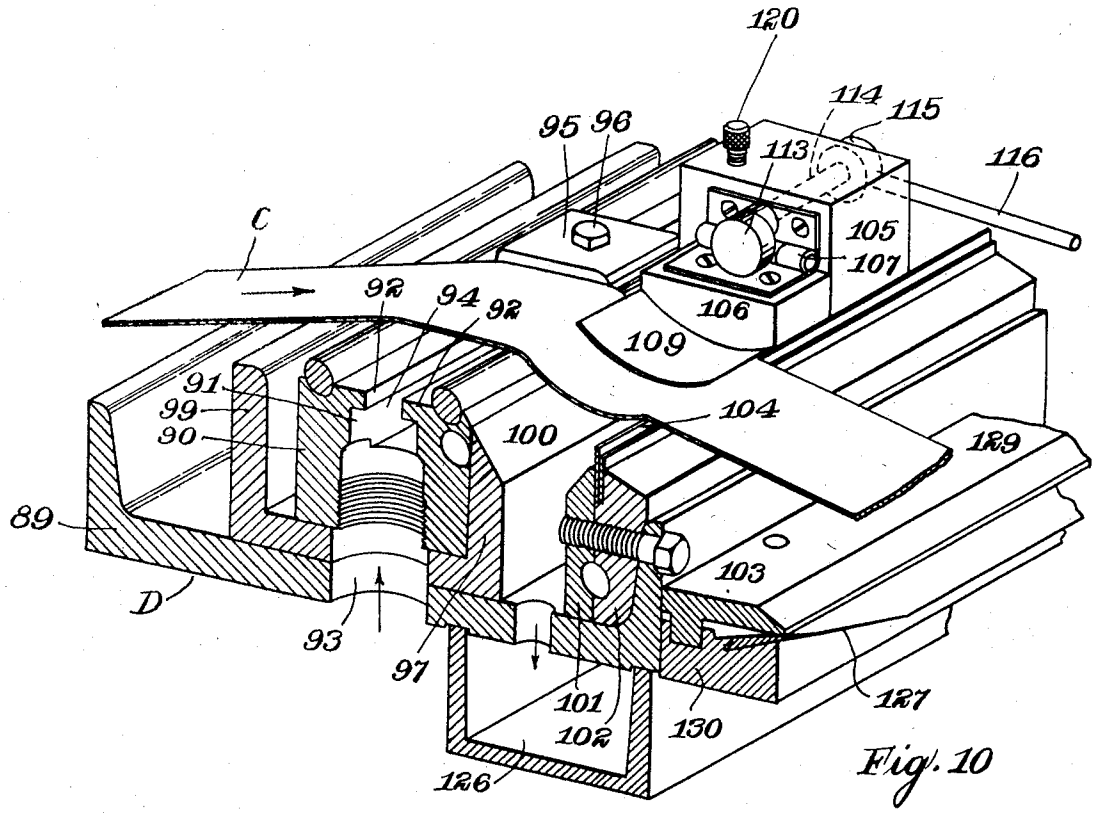



Fig. 10

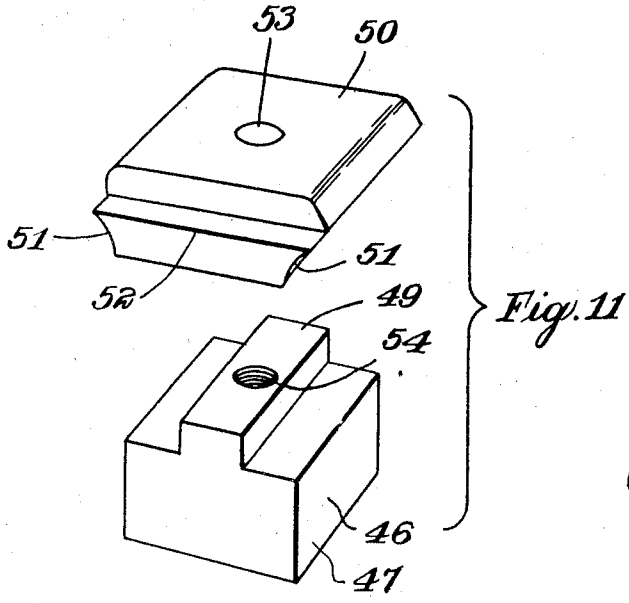



Fig. 11

Lyle L. McGladrey
Cecil M. Rhodes
INVENTOR

BY O. F. S. Johnson

ATTORNEY

Patented July 18, 1944

2,354,033

# UNITED STATES PATENT OFFICE

2,354,033

## METHOD AND APPARATUS FOR COATING SHEET MATERIAL

Lyle L. McGladrey, Minneapolis, and Cecil M. Rhodes, St. Paul, Minn., assignors to Rapinwax Paper Company, Minneapolis, Minn., a corporation of Minnesota

Application October 13, 1941, Serial No. 414,744

14 Claims. (Cl. 117—102)

Our invention relates to an improvement in coating methods and apparatus for coating paper, or other film materials.

In the coating of paper or cellulose films, such as those used for packaging food and other products, it has been difficult to obtain a thin even coating over the paper or film surface. Complicated and expensive equipment has been constructed to regulate the thickness of the coating. Such expensive and complicated mechanism is difficult to maintain and requires considerable expense to keep in operation. As a result, is has, in some instances, been most practical to allow the coating thickness to vary to some extent rather than to use such equipment which is difficult to maintain.

The thickness of the coating on paper or other sheet material is extremely important to both the manufacturer and the consumer. Where the coating is for waterproofing purposes, for example, a coating of constant thickness will provide a finished sheet of known moistureproofness. If the coating thickness varies, the moistureproofness of the sheet will ordinarily also vary.

For the manufacturer a variation for coating thickness presents much more serious problems. In the first place, a variation in thickness of the coating varies the drying time of the coated sheet. Thus if the machine is set to dry the coating of a certain thickness, certain portions of the sheet which are lightly coated might be dried too great an extent with a bed effect upon the finished product. Other parts of the coated sheet may bear a coating of excessive thickness which will not be properly dried during the progress of the sheet, thus producing a product which is not uniform in grade.

To the manufacturer, perhaps the greatest difficulty arises in the expense of the coating upon the sheet. The sheet is manufactured in certain specifications, and must meet certain minimum requirements. For example, if the sheet is to be coated to render the sheet more moistureproof, the coating must be of a certain minimum thickness to produce the proper degree of moistureproofness. If the coating is irregularly applied, and is thicker at some points than at others, the coating must have the necessary minimum thickness to meet the necessary specifications over its entire area. As a result, parts of the sheet are coated much more heavily than is required to meet the specifications, thus considerably increasing the cost. As the coatings are often extremely costly an even coating thickness is of great importance to the manufacturer.

A further difficulty has been encountered in providing an even coating, due to slight changes in tension of the paper as it passes through the coating machine. While constant tension devices are in common use on such machines, it is difficult to hold the paper against the coating appliance with exactly the same tension at all times so as to insure an even coating. Furthermore, as most sheets are somewhat baggy, it is difficult to maintain a constant tension throughout the width of the sheet.

The object of our invention is to eliminate former difficulties with devices of this nature by providing a means of applying the coating to the paper and by passing the coated surface over a vacuum chamber which draws the paper against a suitable doctor blade with constant pressure. Thus, as the coating passes over the blade, it is drawn against the blade with a constant pressure and scrapes or removes from this sheet the excess coating material so as to leave a film of uniform thickness upon the sheet. We have found that such a device may be used to replace metering mechanism which is extremely costly and expensive to maintain, and we have obtained more uniform results than with such prior devices. As a result, our apparatus will coat the sheet with a more uniform coating than has been previously possible.

A purpose of our invention lies in the provision of a sheet coating apparatus which includes an apparatus for applying the coating to the surface of the sheet. A vacuum chamber is then provided over which the sheet travels, and the sheet is drawn into this vacuum chamber to a predetermined extent by the pressure of the outside air. The sheet is thus held against a doctor blade which defines one edge of the vacuum chamber with a predetermined pressure which does not vary to any appreciable degree during the movement of the paper. As a result, the uniform pressure of the paper on the doctor blade acts to remove all but a predetermined thickness of coating from the paper, resulting in a uniform coating over the entire sheet. This vacuum chamber holds the sheet in place with a constant force regardless of the fact that the sheet may be baggy at some points.

A feature of our invention resides in the fact that the coating thickness corresponds to the amount of vacuum applied. There is a definite relation between the vacuum in the chamber as measured by a gauge and the coating thickness. Thus the coating thickness (temperature and viscosity remaining constant) may be measured by

a vacuum gauge in communication with the vacuum chamber.

A feature of our invention resides in the fact that the doctor blade may be positioned on either side of the vacuum chamber so as to either remove the excess coating material before the paper travels over the vacuum chamber, or else to remove the coating with the air leaking into the vacuum chamber. If this latter arrangement is used, a means for separating the excess coating from the air pumped by the vacuum pump is necessary.

A feature of our invention resides in the provision of a coating machine in which the continuous sheet is drawn with a predetermined pressure against a means for removing an excess coating from the sheet and also provides a predetermined angularity between the sheet and the coating removing means. As the sheet travels over the vacuum chamber, the sheet is bowed into the vacuum chamber, thus flexing the paper out of its normal path and deflecting the paper to a predetermined degree. Thus the angle between the paper and the coating removing means, which defines one edge of the vacuum chamber remains constant when the amount of vacuum and the tension of the sheet remains substantially constant.

A further feature of our invention resides in a novel means of sealing the ends of the vacuum chamber so as to permit the threading of the paper through the machine in a minimum of time, and at the same time sealing the ends of the vacuum chamber with respect to the side edges of the sheet. As coating machines of this type are ordinarily required to coat sheets of varying widths, it is necessary that the sealing means and the edges of the sheet be adjustable to seal the edges of sheets of varying widths. This sealing means is designed to accommodate for the bow or curve in the paper caused by air pressure as the sheet travels over the vacuum chamber.

These and other objects and novel features of our invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of our specification:

Figure 1 is a diagrammatic side view of the coating machine for coating a continuous sheet of material, such as paper, or the like.

Figure 2 is a rear view of the coating device illustrated in Figure 1.

Figure 3 is a sectional view through the coating head illustrating the construction thereof.

Figure 4 is an elevation view of one of the sheet sealing members for sealing the ends of the vacuum chamber.

Figure 5 is a side elevation view of the sealing element illustrated in Figure 4.

Figure 6 is a sectional view through the coating head, the position of the section being indicated by the line 6—6 of Figure 3.

Figure 7 is a sectional view through a modified form of coating head in which the excess coating removed from the sheet is exhausted simultaneously with the air leaking into the vacuum chamber.

Figure 8 is a front elevation view of the end seal and the paper sheet for the ends of the vacuum chamber.

Figure 9 is a side elevation view of the vacuum chamber end seal illustrated in Figure 8.

Figure 10 is a perspective view sectionally through the coating head showing a portion of a strip of paper being fed therethrough.

Figure 11 is a perspective view of an end seal and the coating chamber over which the sheet must pass.

The coating machine A is provided with a support for the shaft 10 of a sheet supply roll 11. From the supply roll 11 the paper travels to the flexibly mounted roll 12. This roll 12 is connected by linkage to a brake 13 encircling the shaft 10 of the supply roll 11. Thus a constant tension device is provided so that when tension increases and tends to move the flexibly mounted roll 12, this movement is transmitted to the brake 13 to decrease the tension of the roll 11. Thus any of the variations in tension are corrected before the paper passes over the coating head.

The paper travels over the roller 14 and the roller 15, and is delivered therefrom to the coating head, which is indicated in general by the letter B. The coating head B, in the machine illustrated, is pivotally mounted to rotate about a shaft 16 so that the angle which the sheet assumes between the various portions of the coating head and the roller 15 and the roller 17 may be adjusted. The shaft 16 supports a pair of brackets 19 on which the coating head is mounted.

The roller 17 is mounted upon a pair of arms 20 which support the shaft 21 of the roller 17, and which are supported on pivots 22 on the side frame members 23. Thus the roll 17 may be pivoted from the position shown in full lines in Figure 1 of the drawings, to the position illustrated in dotted outline. With this arrangement the rollers 17 may be pivoted into such a position that the sheet C traveling through the machine will be carried out of contact with the coating head B during threading of the machine.

From the coating machine A, the sheet C travels to the rewind device D, illustrated at the left of Figure 1 of the drawings, and preferably connected in spaced relationship to the coating machine A by beams 24, or other suitable means. The sheet C may travel over rolls 25, 26, and 27 to the receiving roll 28, which is supported on the frame 30 of the rewind machine D. These rolls 25, 26, and 27 may be arranged to heat or to cool the paper, allowing certain coatings to be chilled, if desired, and permitting other coatings to be maintained in a heated condition for drying or setting of volatile materials, or for polymerizing the coatings, if it is desired.

With special reference to the coating head illustrated in Figure 3 of the drawings, it will be noted that an I beam 31 extends transversely of the machine supported by the brackets 19. The I beam 31 includes a central web 32 and end flanges 33 and 34. Secured to the end flanges 33 we provide a roller 35 which may, if desired, contain a preheating liquid, so as to preheat the paper or sheet C, as it travels over the roller 35. Mounted upon the upper surface of the central web portion 32 of the I beam 31, we provide a series of spacer blocks 36 which support the transversely extending bar 37. Mounted upon the bar 37, we provide a cross bar or channel 39 which is closed along its lower extremity and which is provided with a substantially inverted T-shaped slot 40 therein. The slot 40 is defined by a pair of overhanging lips 41, making the exposed surface of the slot narrower than the body of the slot. The coating is fed into the slot 40 through feed supply tubes 43 which are connected to a suitable supply of coating material. This coating ma-

terial is forced through the supply tubes 43 by any suitable means, such as pumps, and is forced against the surface of the sheet passing over the bar or channel 39.

Recessed into the upper edge of the cross bar or channel 39, we provide a pair of spaced rods 44 and 45. These rods form a rounded surface over which the sheet C passes, and define the edges of the coating chamber. Obviously, the coating from the slot 40 will fill the space between the rods 44 and 45 within the sheet C when the machine is in operation.

In order to fill the ends of the coating compartment, we provide an end sealing means which includes an end block 46 which closes each end of the slot 40 and which is shaped similarly to the slots. In Figure 11 of the drawings the end block 46 is illustrated in detail. As illustrated in this figure, the body 47 of the block fits within the larger portion of the slot between the lips 41. In combination with each end block 46, we provide a complementary sealing block 50 which fits between the bars 44 and 45, and which engages the top face of the narrower strip 49 of the end block 46. The block 50 is provided with rounded edges 51 to closely fit the bars 44 and 45, and is provided with a projecting lip 52 which extends beneath the extreme edge of the sheet C. This means, of course, that the extreme edge of the sheet is ordinarily not coated by the coating material, which is actually desirable in most instances, as the edges of the sheet are ordinarily trimmed, and as in some instances the uncoated edge of the sheet is preferable. Obviously the lip 52 could extend over the surface of the sheet C, if it were desired, to coat the paper to its extreme width, but such a construction would have the obvious disadvantage of requiring adjustment of the end blocks after the paper sheet was in place.

The complementary block 50 is provided with an aperture 53 extending therethrough, which is aligned with an aperture 54 in the block 46. The aperture 54 is threaded to engage the end of a bolt passing through the aperture 53, so that the two portions of the block may be secured together when a bolt extending through the aperture 53 and into the threaded aperture 54 is tightened the two portions of the end block are clamped together and held from longitudinal movement in the slot 40. This bolt is indicated in Figure 3 of the drawings by the numeral 55. The manner in which the end blocks 40 and 50 may be adjusted to fit the width of the sheet C is believed obvious from the foregoing explanation.

Secured to the central web 32 of the I beam 31, we provide a channel 56 which extends longitudinally of the I beam 31 and transversely of the coating head. One edge of the channel 56 is tapered, as indicated by the numeral 57, and a bar 59 is secured to the channel 56 by means of the bolt 60. The bar 59 is provided with an oppositely tapered edge 61 which, together with the tapered edge 57, form a rather pointed pair of jaws between which the doctor blade 62 is clamped. The doctor blade 62 is so positioned that the sheet C must pass over the same, and the excess of coating is scraped from the sheet by this blade. The coating runs down over the surface of the bar 59 and between the spacer blocks 36, draining through drain openings 63 into the return channel 64. The return channel 64 is arranged to return the coating to the source of coating supply so that it may again be fed through the inlet tube 43 to the coating head.

The side 65 of the channel 56 opposite to the side of the channel supporting the doctor blade 62 is provided with an inset bar 66 over which the sheet C may pass. The space within the channel is held under reduced pressure and a pipe 67 is connected to the exhaust pump 68, which acts to exhaust air from the inside of the channel. A separator 70 permits separation of any coating which might enter the exhaust chamber from the air exhausted from within the channel.

In order to form end seals for the vacuum chamber, we provide end blocks 71 which are designed to rest in the channel 56 and to close the ends of the channel to confine the exhaust area to the space directly beneath the sheet C. The end blocks 71 are each provided with a lower end 72 of reduced width to fit snugly within the channel 56, and is shaped to fit the channel sides between the edges of the paper sheet C. In other words, the end blocks 71 each form a wall defining the end of the vacuum chamber and sealing the space between the sheet and the channel.

In order that the sheet may be easily positioned in its proper place over the coating head, the end blocks 71 are each provided with a projecting block 73 which is connected to the inner edge of the block 71 by means of a hinge 74. The block 73 is curved along its lower edge 75, and the curvature of the lower surface 75 agrees with the curvature of the paper between the doctor blade 62 and the rod 66 when the coating head is in operation. A light flexible blade 76 is clamped between the arcuated surface 75 of the block 73 and an arcuated clamping block 77 which is bolted to the block 73. An eccentric 79 engages the top of the block 73 to hold this block in position with the flexible blade 76 overlying the edge of the sheet C. The eccentric 79 is secured upon a shaft 80 which extends through the block 71. A collar 82 is mounted on the opposite end of the rod 80 and a handle 83 is secured into the collar 82. By movement of the handle 83 the eccentric 79 may be pivoted from operative position, illustrated in Figures 4 and 5 of the drawings, to an inoperative position in which the eccentric 79 is released from the block 73 so as to allow this block and the blade 76, supported thereby, to pivot out of operative position.

An aperture 84 extends into the block 71 and communicates with a vertically extending aperture 85 which is provided with a needle valve 86. By adjustment of the needle valve 86, air may be bled into the vacuum chamber when it is found necessary or desirable.

Passages 87 extend through the channel 56 providing channels through which heated or cooled liquid may flow. Thus if the coating is of the hot melt type, the channel 56 and the parts attached thereto may be maintained at the proper temperature for keeping this coating in a molten condition. Steam may provide this heating fluid, or if necessary a cooling medium may be employed for certain other types of coating.

The operation of the coating head thus described is believed obvious from the foregoing description. The coating is applied to the under surface of the sheet C, while the sheet is between the rods 44 and 45, and between the end blocks 40. The paper or other sheet material is provided with an excess of coating which is somewhat smoothed by the bar or rod 45 and the excessed coating is scraped off by the doctor

blade 62, this coating running down through the drain opening 63 through the return channel or duct 64. The sheet C is held against the doctor blade 62 with a constant pressure which is produced by vacuum, the vacuum pump 69 providing the source of reduced pressure within the channel 56. After the excess coating has been removed, the sheet passes over the rod 66 which may form a smoothing means for the remaining coating on the sheet C.

In Figures 7 through 11 of the drawings, we disclose a modified form of device in which the coating is removed within the vacuum chamber. In this form of construction the coating head D is supported by a channel 89 to which is bolted, or otherwise secured, an inner channel 90. The channel 90 is provided with an inverted substantially T-shaped slot 91 which is defined by a pair of overhanging lips 92 which define the center or open portion of the slot. A supply pipe 93 is provided for introduction of the coating material into the slot 91, and end blocks 94 provided with complementary end blocks 95, clamp together by clamping bolts 96, are used to seal the ends of the coating chamber. The blocks 94 and 95 are identical with the blocks 46 and 50, illustrated in Figure 11 of the drawings. Thus the paper sheet C is coated with the mechanism illustrated in Figure 7 in the same manner in which the coating has been previously described.

One edge 97 of the channel 99, which supports the inner channel 90 is tapered, as illustrated at 100. A pair of clamping bars 101 and 102 which are held to the end of the channel 89 by clamping bolts 103 support a doctor blade 104 therebetween. End blocks 105 form the ends of the vacuum chamber and seal the vacuum chamber with respect to the sheet C. The end blocks 105 are formed as clearly illustrated in Figures 8 and 9 of the drawings.

A block 106 projects inwardly from each block 105 and is secured thereto by means of a hinge 107. A flexible blade 109 is clamped between the lower arcuated surface 110 of the block 106 and the arcuated clamping plate 111 which is secured to the block 106 by bolts 112, or other suitable means. The flexible blade 109 is designed to rest upon the surface of the sheet C passing over the coating head.

The block 106 is urged against the paper by means of an eccentric 113 which is mounted upon a shaft 114. A collar 115 is mounted on the block 105 on the side of the block opposite to the eccentric 113 and a handle 116 provides a means of adjusting the eccentric 113. When the handle 116 is in the position illustrated in Figure 7 of the drawings, the flexible blade 109 is in engagement with the upper surface of the sheet C, while when the handle 116 is rotated into the position illustrated in Figures 8 and 9, the eccentric 113 is removed from engagement with the block 106, permitting this block to pivot upwardly so as to permit the blades 109 to be pivoted away from the upper surface of the paper for threading purposes and the like.

A passage 117 is provided in the block 105 which communicates with a vertical passage 119 extending through the block in which is positioned a needle valve 120. The needle valve 120 permits air to be bled into the vacuum chamber between the channel side 97 and the clamping bar 101 when it is deemed necessary or advisable. A roller 121 is provided over which the sheet C may pass before passing over the coating head, and fluid may pass through this roller 121 for preheating the sheet C, if it is so desired. A roller 122 is provided on the opposite side of the coating head so as to smooth the coating when necessary, and if desired a heating or cooling fluid may pass through the roller 122 to accomplish its desired purpose.

The operation of the coating head D is somewhat similar to the operation of the coating head previously described. The sheet C passes over the rods 123 and 124 between the end blocks 94 and 95 and is coated with a coating which is supplied through the supply tube 93. The sheet with an excess of coating passes over the rod 124 and over the doctor blade 104. Between the rod 124 and the doctor blade 104, the paper bows downwardly, being drawn in this direction by suction which is created by the suction pump 69, or by other suitable means. The excess coating is removed by the doctor blade 104 and is removed together with air leaking into the vacuum chamber through the passage 125, the coating and air passing through the channel 126 and through suitable communicating pipes to the separating chamber 70 which separates the coating from the air. The coating is then recirculated, if desired, to the supply pipe 93 and again used.

A scraper blade 127 is held by clamping jaws 129 and 130 in communication with the roller 122 to maintain a smooth surface on the smoothing roller 122. The finished paper is found to have an even coating and a continuous coating after passing by the coating head.

In accordance with the patent statutes, we have described the principles of construction and operation of our method and apparatus for coating paper, and while we have endeavored to set forth the best embodiments thereof, we desire to have it understood that obvious changes may be made within the scope of the following claims, without departing from the spirit of our invention.

We claim:

1. The method of coating a sheet through the use of a coating machine, the method consisting in applying an excessive surface of coating to the sheet, passing the coated sheet over a vacuum chamber with the coated surface subjected to vacuum, this vacuum chamber drawing the coated surface of the sheet against the edges of the vacuum chamber and thereby removing the excess coating.

2. An apparatus for coating a sheet consisting in means for applying a coating to the sheet, a doctor blade, and vacuum means for drawing the sheet against the doctor blade and removing a portion of the coating.

3. An apparatus for coating sheets consisting in means for applying coating to a surface of the sheet, a doctor blade, and a vacuum chamber adjacent said doctor blade, said vacuum chamber drawing said sheet against said doctor blade to remove excess coating.

4. A sheet coating device comprising a means for applying coating to a surface of the sheet, a doctor blade, a vacuum chamber adjacent said doctor blade, means for sealing said sheet with respect to said vacuum chamber, said vacuum chamber acting to draw said sheet against said doctor blade with a predetermined pressure.

5. A sheet coating device comprising a means for applying a coating to the surface of the sheet, a vacuum chamber, means for drawing the coated sheet over said vacuum chamber, and means

against which said sheet is drawn by suction for removing excess coating.

6. A coating machine comprising a means for applying coating to the sheet, a vacuum chamber over which the sheet is operated, and means interposed between said vacuum chamber and said coating means for removing excess coating, said vacuum chamber drawing said sheet against said coating removing means.

7. A coating apparatus for a moving sheet, comprising a means for applying coating to one surface of said sheet, a vacuum chamber over which said coated sheet extends with said one surface of said sheet directly subjected to partial vacuum, and doctor blade means interposed between said vacuum chamber and said coating means for removing excess coating.

8. A coating device for a continuous sheet comprising a means for applying coating to a surface of the sheet, a vacuum chamber past which the coated sheet extends with said coated surface directly subjected to partial vacuum, and doctor blade means adjacent said vacuum chamber to remove excess coating from said sheet and to permit said excess coating to drain into said vacuum chamber, said sheet being drawn against said doctor blade by action of said vacuum chamber.

9. A coating machine comprising a means for applying coating to a sheet, a vacuum chamber past which said sheet extends, coating removing means adjacent said vacuum chamber against which said sheet is urged by vacuum in said vacuum means, and flexible sealing means sealing the edges of said sheet with respect to said vacuum chamber.

10. A coating machine comprising a coating applying means, a vacuum chamber adjacent said coating applying means, coating removing means adjacent said vacuum chamber against which said paper is drawn by action of said vacuum chamber, and means securing the ends of said vacuum chamber with respect to the edges of said sheet.

11. A coating device for a continuous sheet comprising a coating applying means, a channel past which the coated sheet extends, a source of vacuum supply to the interior of said channel, a coating removing means adjacent said channel against which the sheet is drawn by vacuum in said channel.

12. A coating machine for a continuous sheet including a means for applying coating to said sheet, a channel past which said sheet extends, a source of supply of vacuum to said channel, coating removing means against which said sheet is drawn by vacuum in said channel, and sealing means for sealing said channel with respect to the edges of said sheet.

13. A coating machine comprising a means for applying coating to the surface of a sheet, a channel past which the coating sheet extends, a coating removing means against which said sheet is drawn by vacuum in said channel, a source of supply of vacuum for said channel, and sealing means adjustable in said channel for sealing the edges of said sheet with respect to said channel.

14. A coating machine comprising a means for applying coating to the surface of a sheet, a channel past which said sheet is moved after coating, a source of supply of vacuum to said channel, a coating removing means adjacent said channel against which said sheet is drawn by vacuum in said channel, sealing means movable in said channel defining the ends of the vacuum chamber within said channel, and flexible means on said sealing means engageable with the opposed edges of said sheet.

LYLE L. McGLADREY.
CECIL M. RHODES.