March 26, 1940. J. G. SWAB 2,195,101

COATING MACHINE

Filed April 29, 1937 3 Sheets-Sheet 1

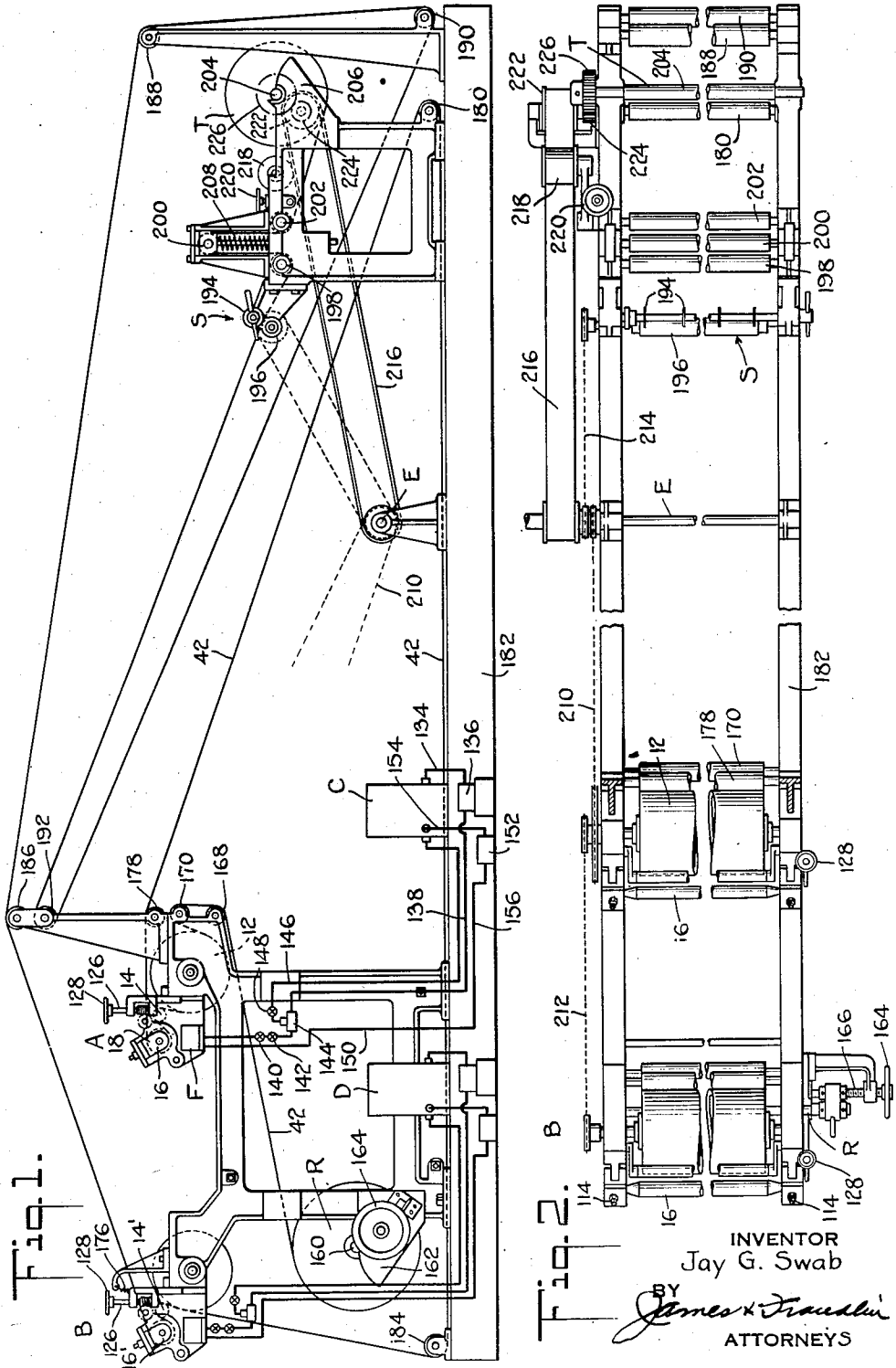

Fig. 1.

Fig. 2.

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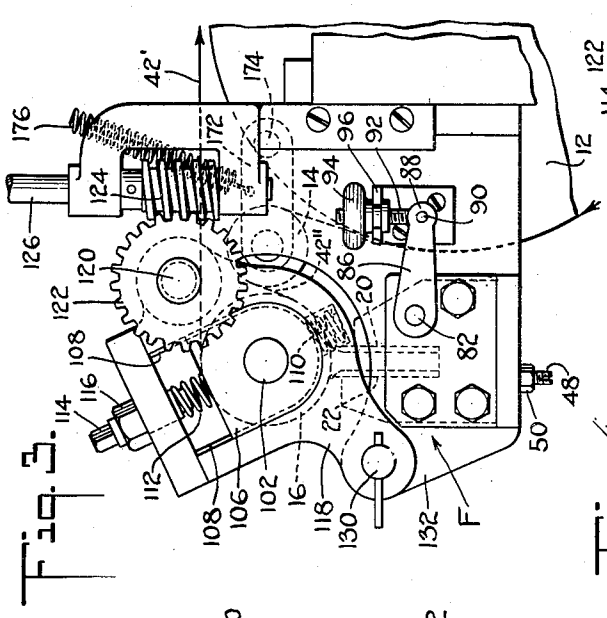

Fig. 3.

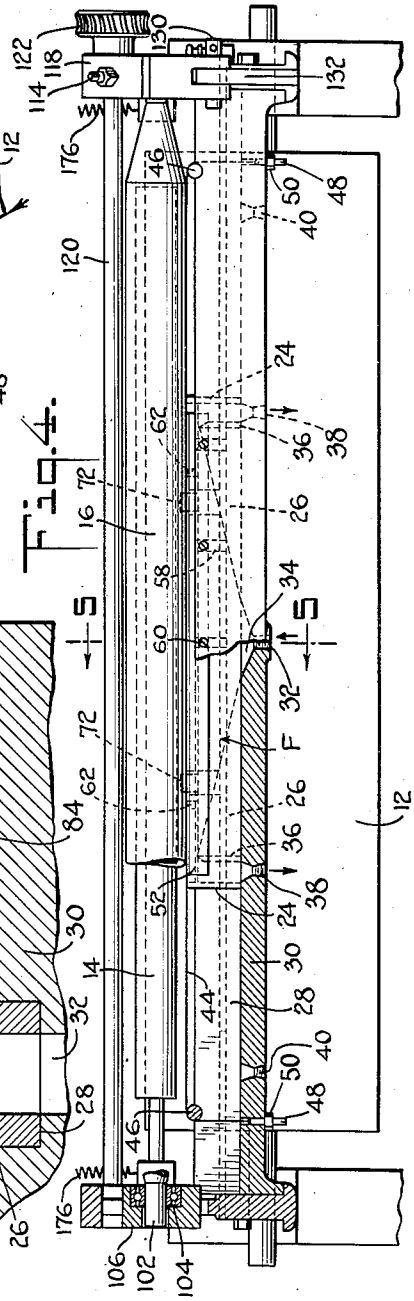

Fig. 4.

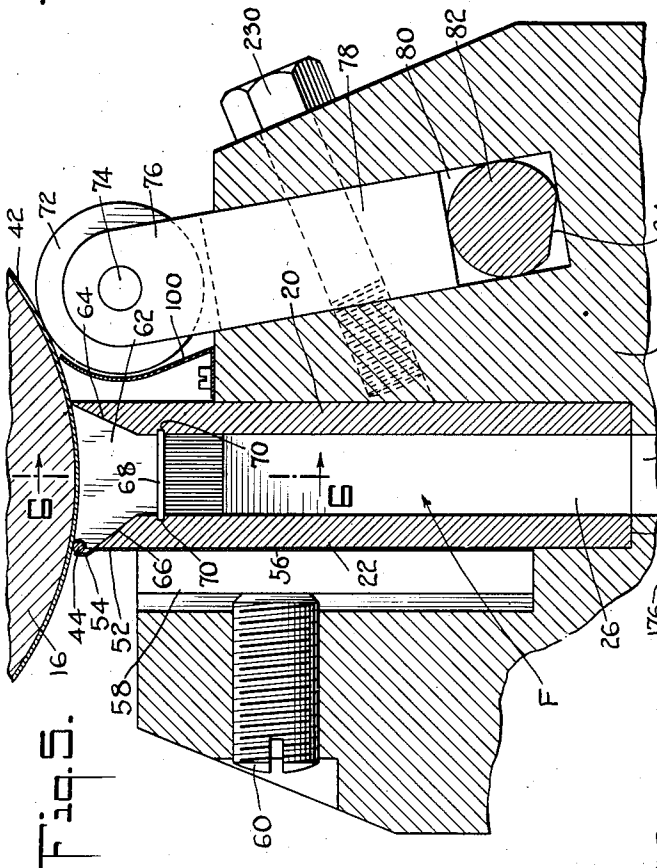

Fig. 5.

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COATING MACHINE

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Fig. 6.

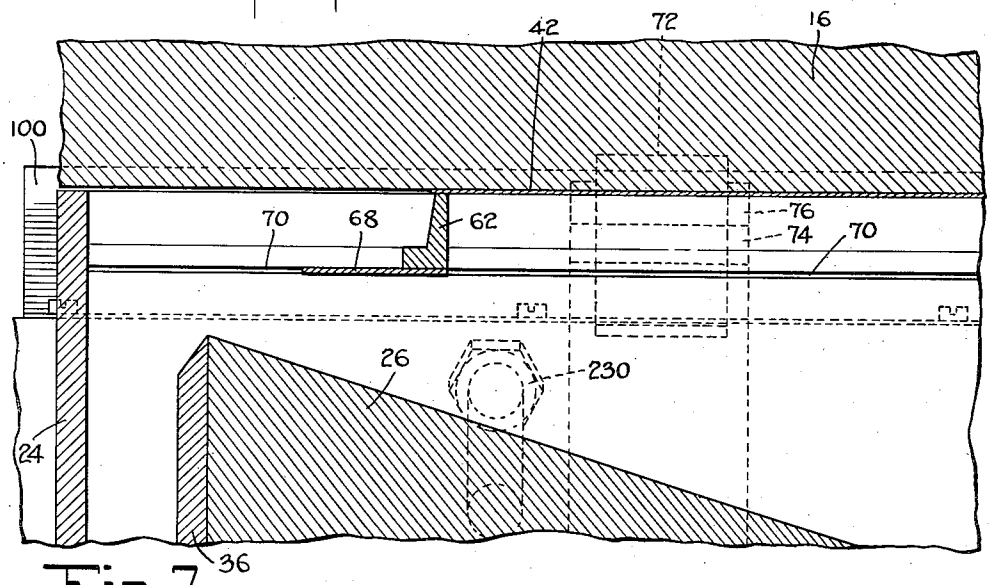
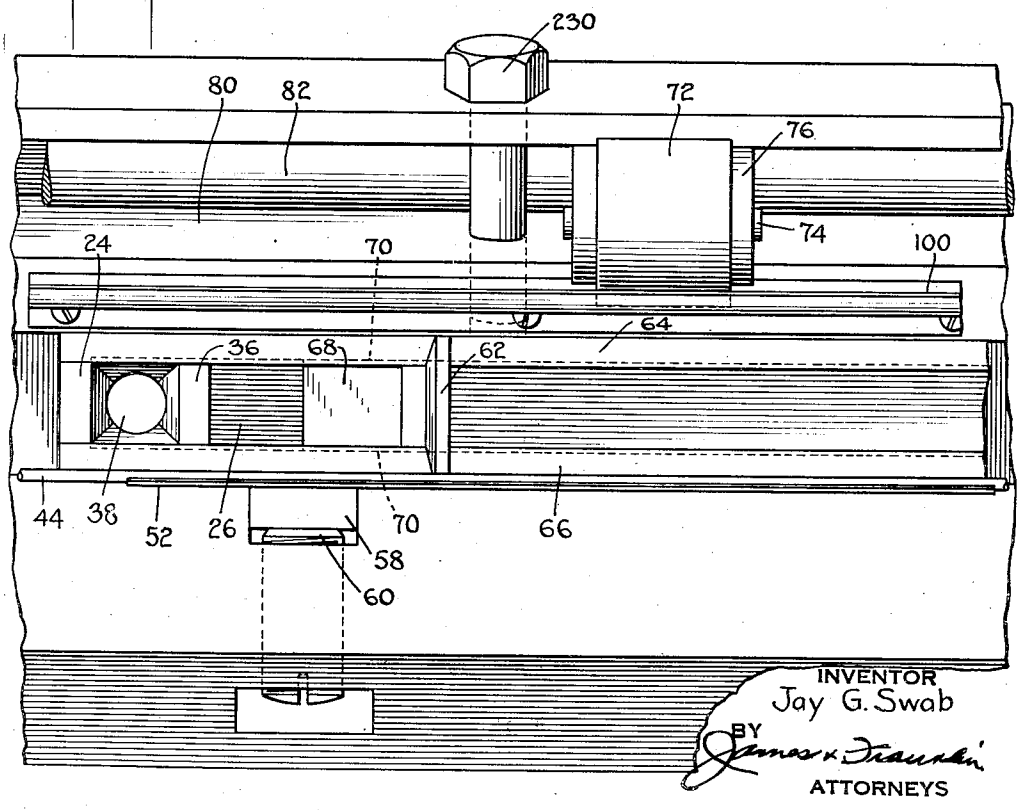


Fig. 7.



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2,195,101

UNITED STATES PATENT OFFICE

2,195,101

COATING MACHINE

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Application April 29, 1937, Serial No. 139,698

18 Claims. (Cl. 91—43)

This invention relates to coating machines, and more particularly to apparatus for coating a web with a thin uniform film of liquid.

The primary object of my invention is to generally improve coating machines. A more particular object resides in the provision of a coating machine adapted to apply to a traveling web of paper of any desired weight or quality, a film of liquid, especially a viscous liquid, said film being exceedingly thin and uniform.

The coating to be applied to the paper web may have a thickness of, say, several ten-thousandths of an inch. The paper web itself, however, may vary in thickness anywhere from one-half to a full thousandth of an inch. To make the coating or film thick enough to accommodate these variations in paper thickness would require the use of an excessive quantity of the coating material, and inasmuch as the coating material may be very expensive, as when dealing with cellulose esters or regenerated cellulose, this procedure would be prohibitive in cost. If, on the other hand, the film is made very thin, say a desired dimension of one-fifth of a thousandth of an inch, the variations in thickness of the paper may lead to many parts of the web being uncoated. It is accordingly an object of my invention to compensate for variations in web thickness. To this end, the web is passed between a web support on one side and coating means on the opposite side of the web, and the thickness of the web is constantly gauged, the relative position of the web support and the coating means being so varied in response to changes in thickness of the web as to maintain the coating at a constant thickness. An ancillary object resides in the provision of precision adjustment means for regulating or determining the thickness of the film being applied to the web.

Still another object resides in the provision of an improved fountain or coating device for applying the liquid to the web. The thick or syrupy liquid here dealt with presents special difficulty, particularly so because the solvents employed are of a highly volatile nature, and the liquid dries almost instantaneously on exposure to air. In accordance with the present invention, the machine is provided with an elongated trough or fountain, closed on all sides but open at the top to form a discharge slot or throat extending longitudinally of the fountain. The web is fed directly over and nearly rests upon the top or throat of the fountain, thus practically sealing the same. The liquid is pumped into the fountain and is preferably continuously circulated by the use of internally housed overflow dams within the fountain. The rate of supply is so regulated as to keep the liquid in the fountain directly in engagement with the web. Subordinate objects concerning the fountain are to make it possible to readily vary the width of the coating being applied to the web; to drain the liquid away from the throat of the fountain whenever the machine is stopped in order to prevent solidification at the throat; and, for the same reason, to keep the pumps of the circulating system permanently submerged in the liquid.

Further objects of my invention center about the doctor for regulating the film thickness. For the present purpose, the doctor must be a precision instrument, and it cooperates with a roll which is ground to be perfectly smooth and true. The edge of the doctor must mate with the roll with an accuracy of one ten-thousandths of an inch, for, as above mentioned, we deal here with a film which may itself be only several ten-thousandths of an inch in thickness. Because the web may have imperfections and lumps therein even when dealing with a good grade of paper, and particularly so when dealing with a cheap quality of paper, it is essential that the doctor be readily yieldable to pass any bumps or projections reaching the same. Unless the doctor yields freely, the paper web will be torn at such surface irregularities, and this will result in a deposit of the liquid on the rolls of the machine, which, of course, is destructive to successful operation, and difficult and time-consuming to correct. Now if the doctor blade is made so thin and delicate as to yield with the necessary ease, it becomes too delicate for the necessary degree of precision. Moreover, it is readily injured and permanently spoiled by any accidental blow or contact by a tool or the like when working around the machine.

If, on the other hand, the doctor is made rigid enough to obtain and maintain the desired precision, it cannot yield with sufficient ease to avoid tearing of the web. It is accordingly an important object of my invention to overcome the foregoing difficulties and to provide a doctor which, while simple and inexpensive, presents a dependable straight precision edge which is readily yieldable but which always instantly returns to its initial correct position. I have discovered that the desired object may be fulfilled by pulling the ends of the doctor in order to place the same under tension. A broad blade may be used, but even more simply an ordinary round wire may be used, this wire being supported solely at

its ends and tensioned to maintain the same in perfectly straight condition. The wire is, of course, located immediately at and acts as the trailing edge of the fountain; and in order to seal the wire against leakage between the wire and the fountain, a thin spring blade may be placed from the outside of the wire to the side of the fountain, said blade being so light and so readily yieldable as not to interfere with the free yieldability of the tensioned wire. This doctor readily yields to lumps or surface irregularities, but instantly springs back to initial position, and its normal position is always perfectly straight.

To the accomplishment of the foregoing and other objects which will hereinafter appear, my invention consists in the coating machine elements and their relation one to the other, as hereinafter are more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by drawings in which:

Fig. 1 is a side elevation of a two-unit coating machine embodying features of my invention;

Fig. 2 is a plan view of the same;

Fig. 3 is a side elevation of one of the coating units;

Fig. 4 is a partially sectioned front elevation of a coating unit;

Fig. 5 is an enlarged section through the fountain of a coating unit, and is taken in the plane of the line 5—5 of Fig. 4;

Fig. 6 is an enlarged section taken in elevation through one end of the fountain, and is taken in the plane of the line 6—6 of Fig. 5; and

Fig. 7 is a plan view of one end of the fountain and associated mechanism, with the web and floating roll removed.

The particular apparatus here described is intended to apply two successive coatings to the web. The precise nature of the coatings need not be gone into for the present purpose, other than to state that the first coating penetrates the paper and quickly dries to a permanently tacky or plastic flexible condition, and that the second coating quickly dries to provide a hard glossy surface, the two coatings being soluble and blending together to form in effect a single coat. The outer coat may, for example, comprise a cellulose ester or cellulose ether or regenerated cellulose, and both coats employ solvents of a highly volatile nature, and both may be relatively syrupy or viscous in character when in liquid form.

Referring to the drawings and more particularly to Figs. 1 and 2, the paper web is drawn from a supply roll R and is led to a coating unit A where the first film is applied. After an interval for drying, the web is led to a coating unit B where the second film is applied. After another interval for drying, the web is fed through a slitting device S and is then wound upon one or more take-up rolls T. Liquid for coating unit A is stored in a sealed tank C and is circulated by appropriate submerged pumps schematically indicated beneath the tank. Similarly, the liquid for the coating unit B is stored in sealed tank D and is circulated by submerged pumps located therebeneath. The coating units A and B, the slitting mechanism S, and the take-up roll T, are all driven from an appropriate countershaft E, the latter in turn being driven by any suitable motor, not shown.

Considering the coating unit A in greater detail and referring first to Fig. 1 of the drawings, the unit comprises a heating cylinder 12, a guide and tensioning roll 14, and a roll or presser 16 the surface of which is ground perfectly true. This roll 16 is journaled in bearing blocks 18 arranged to rise or fall, and, for convenience, the roll may be referred to as a floating roll. The fountain F is located directly beneath the floating roll 16, and the primary function of roll 16 is to guide the web directly over and to press or hold the same very close to the top or throat of the fountain.

Referring now to Figs. 3 through 7 of the drawings, the fountain F comprises side walls 20 and 22 (Fig. 5), end walls 24 (Fig. 4) and bottom walls 26, said walls being secured together to form a fountain assembly which is bodily inserted in a receptive channel 28 cut in a main support or casting 30, said channel extending from one end of the support to the other, as is shown in Fig. 4. The fountain is supplied with liquid through an appropriate inlet 32 passing through the bottom of support 30 and communicating with the fountain at 34, there being a space or gap between the two triangular bottom members 26. These members are made triangular in order to give the bottom of the fountain a configuration which slopes upwardly and outwardly to overflow dams 36. Liquid spilling over dams 36 flows downwardly near the ends of the fountain and is discharged through outlets 38 passing through support 30. In the present case the fountain has a length of approximately half the width or maximum capacity of the machine. It will be understood, however, that the short fountain here shown may, if desired, be removed and replaced by a long fountain the construction of which is generally similar to that of the short fountain, but the overflow dams of which will discharge into a more widely spaced pair of outlets 40. Of course, the discharge pipe connections must run to both the outlets 38 and 40, or else the pipe connections must be changed from outlets 38 to outlets 40 when changing from the short to the long fountain.

The fountain is filled with liquid until the surface of the liquid reaches the surface of the web or paper 42 passing over the fountain. A doctor 44 (Figs. 5 and 7) keeps excess liquid from leaving the fountain with the web. Doctor 44 is mounted on and in effect forms the upper edge of the trailing fountain wall 22. In the specific example here shown, the doctor comprises an ordinary round wire, preferably made of high-grade tempered or spring steel. The location of the wire is fixed by supports or blocks 46 (Fig. 4) mounted on the casting or main support 30 and bridging the channel 28 which receives the fountain. The doctor wire 44 is tensioned, and for this purpose the end of the wire is secured to a threaded rod 48 over which a tensioning nut 50 is screwed. By tightening the nuts 50, the doctor wire may be made as taut as desired. The lower ends of threaded rods 48 are preferably slotted so that they may be prevented from turning while tightening nuts 50. While not essential, it is desirable, particularly when the ends of the wire are bent and pulled downwardly instead of sidewardly, to make the locating blocks 46 cylindrical, so that the supports may turn somewhat as the wire is tightened. It will be understood that the blocks 46 are preferably peripherally grooved to receive the doctor wire, and are vertically adjustable by means of suitable screws or the like.

As has already been explained, the advantage

of tensioning the doctor is to obtain a dependable self-restoring straight edge which combines the precision and dependability of a sturdy doctor and the ready yieldability of a thin flexible doctor. It will be understood that the supports **46** which fixedly locate the ends of the wire, should be located well outside the maximum width of web to be handled by the machine, for if the supports are located immediately at the edges of the web, the doctor will lack yieldability at the marginal portions of the web.

The idea of tensioning the doctor may, of course, be applied to a strip or blade as well as to a round wire. However, I find it simpler and preferable to employ a round wire, and to seal the fountain against possible leakage between the wire and the upper edge of the trailing fountain wall **22**, by using an additional sealing blade or strip. This strip **52** is best shown in Figs. 5 and 7. It is preferably made of spring metal having a thickness of only, say, four ten-thousandths of an inch, so that it is readily yieldable and does not undesirably interfere with free movement of the doctor wire. The upper edge **54** of the blade is preferably grooved or stepped outwardly somewhat to better fit around the doctor wire, and the top edge of the blade is somewhat lower than the top of the doctor wire so that it is the latter which nearly contacts the paper web **42**. The lower edge **56** of blade **52** is secured to the fountain by a plurality of blocks **58** (Figs. 5 and 7) pressed against blade **52** by lock screws **60**. These function to lock the blade **52** in proper relation to the fountain, and further function to lock the fountain against movement within channel **23**. The blocks **58** may be moved vertically, thus varying the width of the free or bendable part of the blade, and this in turn varies its stiffness. If the doctor wire is too freely yieldable at one part, say the center, as when the wire is long or slender or not heavily tensioned, it is desirable to stiffen blade **52** at the center more than at the ends, in order to there help support the wire. To do this one or more center blocks **58** are raised higher than the end blocks.

The web to be coated may vary in width from a few inches up to the maximum capacity of the fountain. This width may be freely changed without at all changing the fountain. In fact, the width of coating may be regulated solely by regulation of the rate of supply of liquid to the fountain, for I find that by gradually increasing the rate of supply to the fountain, the liquid level may be raised in the fountain until the web begins to be coated at the center thereof, and by then gradually increasing the rate of supply, the width of the coating may be increased until a desired width is obtained. However, I find it desirable to provide the fountain with adjustable ends or stops which more definitely limit the width of coating applied to the web, for if the liquid escapes beyond the web, it reaches the floating roll, with consequent inconvenience.

The stops are best shown in Figs. 5, 6, and 7, in which it will be seen that each stop **62** fits between the sloping edges **64** and **66** at the top of the fountain. The top of each stop **62** comes very close to the web **42**. It need not actually contact the web, because the liquid is viscous and is under no pressure at the end stops, and therefore will not escape even though an appreciable clearance exists between the end stop and the web. The building up of pressure in the fountain is prevented by the overflow dams **36** previously referred to. Each stop is mounted at its lower end on a plate or slide **68**. The plate **68** is received in grooves **70** extending longitudinally of fountain walls **20** and **22**. It will be understood that while only one stop is shown in the drawings, two such stops are employed, one at each edge of the web **42** being coated. The stops are readily slidable toward or away from one another, and may thus be disposed at the edges of the web regardless of the width of the particular web being coated.

The sealing of the fountain against free escape of liquid is completed by the upper edge of fountain wall **20**, the said edge being higher than the upper edge of fountain wall **22** and being brought as close as practicable to the bottom surface of web **42**. Here, as in the case of the end stops **62**, true contact is not needed, for the liquid is viscous and is not under pressure. Moreover, in connection with this leading edge of the fountain, it will be kept in mind that the direction of movement of the web is away from the said edge. When examing Fig. 5, it will be noted that the curvature of the floating roll **16** helps immerse the web in the liquid filling the fountain.

The overflow dams **36** are shown separate from the bottom walls **26**. This construction makes it possible to vary the height of dams **36** and thus to vary the overflow level. I find that the height of the dams is not critical, and it is entirely feasible to omit the separate dams **36** and to instead use the outer ends of the bottom pieces **26** as the overflow dams. One important function of the dams is to establish a low liquid level in the fountain, to which the liquid falls whenever the supply to the fountain is stopped, as is done whenever the coating machine is stopped, as upon tearing of the web, or starting up a new roll of paper, etc. The liquid thus drains promptly downwardly away from the doctor wire and sealing blade assembly, and this prevents solidification of a mass of the coating material on the doctor, the sealing blade, and the throat of the fountain.

As so far described, the thickness of the film applied to the web would depend upon the spacing of roll **16** above the doctor, and would vary upon variation in thickness of the web. In order to obtain a constant film thickness, the roll **16** is floatingly mounted and is moved up and down to compensate for any change in web thickesss. For this purpose, I provide feelers **72** mounted at fountain F and bearing against the web **42**. The feelers determine the position of the lower face of the web with respect to the fountain or doctor. The position or elevation of the feelers being fixed, any change in thickness of the web must be accommodated by a corresponding rise or fall of the floating roll **16**.

The feelers **72** are preferably made in the form of small-diameter wheels. Each wheel **72** is rotatable on pin **74** mounted in the bifurcated upper end **76** of a block **78** which accurately fits within but is slidable along a channel **80** extending throughout the length of the main support or casting **30**. Block **78** is wide enough at its base to prevent tilting from side to side. The adjustment of the elevation of wheels **72** determines the thickness of the film, and this adjustment must be made with extreme precision. For this purpose, I provide a hardened and accurately ground adjusting rod **82** (Fig. 5) extending along the bottom of channel **80**. Rod **82** may be made eccentric in cross-section, or more simply as here disclosed, may be a cylindrical rod ground away to form one

flattened face 84, the latter bearing against the bottom of channel 80. Referring now to Fig. 3, the outer end of rod 82 has mounted thereon an arm 86 the movable end 88 of which is pivotally connected at 90 to a screw 92 threadedly received in an adjusting handle 94. Handle 94 is rotatably mounted on but fixed against axial movement relative to bracket 96 which in turn is stationarily mounted on the frame of the coating unit. It will be manifest that by turning handle 94, the flattened rod 82 may be slightly oscillated, and this in turn will simultaneously and uniformly raise or lower the wheels 72. Clamp bolts 230 are tightened to lock the blocks 78 in adjusted position, by drawing together the opposite sides of slot 80.

Because the weight of floating presser or roll 16 is counterbalanced, as is subsequently described, the pressure of wheels 72 on the web 42 is slight. The wheels may therefore be made comparatively small, say one inch in length, without indenting the surface of a soft paper web, and without loss of dependability in gauging the film thickness. For this same reason, only two wheels 72 are necessary, and I have used only two wheels when dealing with webs up to, say, 21 inches in width, but when dealing with webs of, say, 42 inches in width it may be found desirable to employ additional wheels between the two wheels at the margins of the web. It will be understood that wheels are preferable to a long continuous roller (aside from the difficulty and expense of constructing a truly ground rod which will be small in diameter and yet rigid), and a few narrow wheels are preferable to many wide wheels in order to minimize the chance of the floating roll 16 being elevated by a mere bump or projection on the web instead of a true change in over-all web thickness. The wheels 72 are minimized in diameter in order to dispose the same as closely as possible to the fountain, and theoretically the wheels should be located directly at the fountain (as may be done if the fountain construction is modified and strengthened to make it possible to mount the vertically adjustable feeler wheels directly on the fountain end stops).

If desired, a splash shield 100 (Figs. 5 and 7) may be disposed between the fountain and the wheels 72, thus additionally guarding against any accidental flow of liquid onto the wheels. This splash guard 100 preferably extends across the entire width of the machine in order to guard the wheels regardless of where disposed from side to side in the machine.

As shown in Figs. 2 and 4, the roll 16 is tapered at its ends in order to reduce the diameter to that of the journals 102. These are received in appropriate anti-friction bearings 104 which in turn are carried by bearing blocks 106. The bearing blocks 106 are independently slidable on guides 108 (Fig. 3). Bearings 104 are preferably radial ball bearings, and each end of the roll is movable independently of the other. This takes care of parts of the web thicker at one edge than the other, that is, tapering in thickness across the web. To relieve the weight of cylinder 16, compression springs 110 are disposed beneath the bearing blocks 106. For convenience of adjustment, I prefer to make the springs 110 more than adequate to counteract the weight of the cylinder and bearing blocks, and I then provide lighter compression springs 112 at the top of the bearing blocks, the pressure of the said springs being adjustable by means of adjusting screws 114 locked by lock nuts 116. It will be understood that by varying the adjustment of spring 112, the effective pressure of spring 110 may be varied, and this is preferably made such as to give the roll 16 some but almost negligible weight, say one pound. This keeps the paper web in contact with the thickness-gauging wheels 72, but the pressure is so light that the web is not scored by the wheels, and the response of the floating cylinder is sensitive.

It will be noted that the movement of bearing block 106 in the guides 108 is not truly vertical, but instead is at an angle. This angle is so selected that the movement of roll 16 is at right-angles to the resultant pull of the paper web on the roll. Specifically, in Fig. 3 the web portion 42' leaving roll 16 is approximately horizontal, but the web portion 42'' approaching roll 16 is disposed at a relatively sharp angle, the said web having passed around guide roll 14. The bearing guides 108 are substantially perpendicular to a line bisecting the angle between web portions 42' and 42''. With this arrangement, the resultant pull of the web on the roll has no tendency to move the roll up or down.

For ready access to the fountain, the doctor, and associated mechanism, the machine is preferably so arranged that roll 16 may be swung upwardly well out of the way of the fountain. This is useful for inspection, cleaning, and repair. Referring to Fig. 3, the bearing guides 108 are formed on an oscillatable bearing arm 118, the said arm being secured to and oscillatable with a shaft 120. One end of shaft 120 carries a worm gear 122 meshing with a worm 124 mounted on a spindle 126. The upper end of spindle 126 carries a handle 128, not shown in Fig. 3 but clearly shown in Figs. 1 and 2. The lower ends of the bearing arms 118 are each locked in normal position by means of a locking pin 130 which passes through the lower and preferably bifurcated end of arm 118 and through a mating part 132 (Figs. 3 and 4) of the machine frame. To swing roll 16 upwardly out of the way, it is merely necessary to remove the locking pins 130 and to then rotate handle 128 which, through the worm gear mechanism, oscillates arms 118 and roll 16 upwardly out of the way.

Reverting now to Fig. 1, the liquid feed system for fountain F is preferably a circulatory system. Specifically, I provide a tank C which is preferably sealed and enclosed. Liquid is supplied from the tank to the fountain by pipe 134 leading to pump 136 discharged into pipe 138 which in turn leads upwardly to the center opening or inlet 32 of the fountain (Fig. 4). Pipe 138 has two valves, 140 and 142, connected in series. One of these, say the valve 140, is used as a shut-off valve, and the other, say the valve 142, is used as a regulating valve. The use of two valves makes it possible to shut off the supply line without losing the previously set adjustment of the regulating valve.

The rate of supply of liquid to the fountain is preferably controlled by bleeding a part of the liquid back into the tank. Specifically, liquid is bled from line 138 to point 144 preceding the valves 140 and 142, and the liquid bled from line 138 flows back through line 146 to the tank C. Line 146 is provided with a regulating valve 148. By proper relative adjustment of valves 142 and 148, the rate of supply of liquid to the fountain may be accurately adjusted.

In addition to circulation of liquid through the bleed line, there is also circulation of some of

the liquid supplied to the fountain. Any liquid flowing over the dams in the fountain runs down through a drain pipe 150 leading to a pump 152 which discharges through pipe 154 into the tank. It will be noted that both of the pumps are submerged and are therefore constantly filled with liquid. This prevents the access of air and solidification of the liquid in the pump. It will also be noted that when the supply of liquid to the fountain is stopped by shut-off valve 140, the pump 136 is not opposed but instead continues to circulate liquid from the tank through lines 138 and 146. The drain pipe 150 is larger than is actually needed for the amount of liquid normally overflowing the dams, and the action of pump 152 is not primarily that of a suction pump attempting to empty the fountain, but rather is merely for elevating or returning to the tank whatever overflow liquid trickles or drains into the drain pipe, the horizontal part 156 of the drain acting as a sump.

It will be evident from inspection of Fig. 1 that the supply tank and circulatory system, as well as the control valve arrangement for coating unit B, is identical with that provided for coating unit A. Two separate tanks and separate circulating systems are preferably provided because ordinarily the first and second coats will differ in composition.

Due to this difference in coating composition, it may in some instances be desirable to modify the construction of the fountain. In a specific case in which the paper was first coated with a tacky plastic film acting as an elastic adhesive bond between the paper and the second coat, and in which the first coat was chemically soluble in the second coat, it proved desirable to limit the amount of time during which the first coat was exposed to the body of liquid in the second fountain. In this case it was merely necessary to narrow the width of the throat at the top of the second fountain, and more specifically, while the first fountain was provided with a throat three-eighths of an inch wide, the throat of the second fountain was narrowed to approximately one-eighth of an inch.

Coming now to the complete apparatus layout shown in Figs. 1 and 2, the paper to be coated comes in a roll R the supporting spindle 160 of which is readily removably mounted on appropriate brackets 162. A handwheel 164 is provided which, through a screw 166, functions to axially shift the position of roll R in order to center the web in the machine. Web 42 leaving roll R is passed around guide rolls 168 and 170, then downwardly around the relatively large-diameter heating cylinder 12, then upwardly around the guide roll 14, and thence around the floating cylinder 16. The mounting of guide roller 14 is more clearly shown in Fig. 3, in which it will be seen that the roller is preferably mounted on an arm 172 pivoted at 174 and normally urged upwardly by a pull spring 176.

Before leaving unit A, it may be explained that heating cylinder 12 is unnecessary when dealing with certain liquids of a quick-drying nature. In the present apparatus the units have been shown provided with heating cylinders in order to make the apparatus more universally useful. Where heat is unnecessary, the steam supplied to the cylinder may be shut off, or, as is shown in unit B by way of example, the web may be threaded without passing around the heating cylinder. Of course, it goes without saying that if a machine is to be constructed solely for use with a coating material which does not require heating, the steam cylinders may be omitted in the original design of the machine, thus reducing the size and cost of the machine.

Reverting now to Fig. 1, the web leaving coating unit A passes over a guide roll 178 and thence to a remote guide roll 180 from which the web returns along the bottom girders 182 of the machine to a guide roll 184 and thence upwardly to unit B. The web passes around a guide roll 14', then around floating roll 16', and then sidewardly over guide roll 186, thence to remote guide roll 188 downwardly to roll 190, thence sidewardly around roll 192, and back to the slitting apparatus S. It will be observed that the path of the traveling web is so arranged that the coated side of the web is kept out of contact with the rolls. Moreover, there is a substantial length of web between the first and second coating units and between the second coating unit and the slitting and rewinding apparatus, thus insuring thorough drying of the web. The indicated travel of the web may be more than is needed with certain coatings which dry almost instantaneously on exposure to air, but the error on the side of safety adds to the range of usefulness of the machine.

The slitting mechanism S may be conventional and requires no detailed discussion other than to say that it comprises a series of cutting discs 194 cooperating with a cylinder 196. From the slitting mechanism the web passes downwardly around guide roll 198, then upwardly and around a vertically reciprocable roll 200, and thence downwardly around guide roll 202 from which the web runs to the take-up roll T the supporting spindle 204 of which is readily removable from the brackets 206. Roll 200 is normally urged upwardly by springs 208, and functions to take up slack in the web and also acts as an indicator to warn the operator if the web tension is becoming too great.

The parts of the machine are driven from a countershaft E which in turn is driven by any suitable source of power. Countershaft E is connected to coating unit A by an appropriate chain and sprocket drive 210. Coating unit A and coating unit B are in turn connected by an appropriate chain and sprocket drive 212. This arrangement functions, of course, to keep the coating units in synchronism. The slitting mechanism S is driven from countershaft E by a chain drive 214. The take-up roll T is driven by a slip belt drive 216, the tension of the belt being adjusted by an idler pulley 218 the pressure of which may be regulated by a handwheel 220. The driven pulley 222 turns a gear 224 meshing with a gear 226 on the spindle 204 of the take-up roll. The slip belt drive accommodates the change in diameter of the take-up roll during operation of the machine.

It is believed that the construction and operation as well as the many advantages of my improved coating apparatus, will be apparent from the foregoing detailed description thereof. The coating units are simple in construction, dependable in operation, yet are capable of handling coating liquids even though viscous and syrupy in character and so volatile as to be almost instant-drying. The machine may be used with a coating liquid which, because of expense or for other reasons, must be limited to a definite uniform thinness, say only several ten-thousandths of an inch, and while coating paper of any de-

sired type and grade, the said paper being itself quite variable in thickness. The fountain is a dry or sealed fountain, and the spacing between the fountain and the coated side of the web is maintained at a constant value during variations in thickness of the web. The doctor presents a precision straight edge to the web, yet is inexpensive and sturdy. It is readily yieldable and extremely sensitive to bumps or projections on the web, but always instantly returns to normal position and is insensitive to accidental damage. The width of the web being handled by the machine may be varied from a few inches to the full width of the machine, and the width of the coating applied to the web may similarly be varied from only a small part of the web to substantially the entire width of the web. It is desirable to leave a small uncoated margin on the web in order to guard against the deposit of coating liquid on the rolls, but this margin may be as little as a sixteenth of an inch and in all ordinary cases is anyway discarded because of the slitting of the web into a plurality of smaller webs each of which is coated from edge to edge. The liquid supply system is readily regulated; is sealed against exposure to air; is of the circulating type, thus maintaining the liquid in the fountain at uniform consistency; and may be shut off without losing the valve adjustments and without opposing or freezing the circulating pump.

It will be understood that the liquid coating need not be viscous, and that it need not be quick-drying, for the machine is of general application in any case where it is important to determine the film thickness and to compensate for changes in thickness of the paper, whether the said changes are uniform across the width of the web or, as is equally common, where such changes occur at one side or the other of the web, thus giving the same a tapered thickness. The fountain and circulation system is enclosed and sealed, and this may be of value not only for a coating which is volatile but also for coatings which deteriorate on exposure to air because of oxidation or any other reason.

It will be apparent that while I have shown and described my invention in a preferred form, many changes and modifications may be made in the structure disclosed without departing from the spirit of the invention, defined in the following claims.

I claim:

1. A coating machine for coating a web of paper or the like with a relatively viscous liquid, said machine comprising an elongated trough or fountain closed on all sides but open at the top to form a slot or throat extending longitudinally of the fountain, means to feed the web directly over the top or throat of the fountain, means to supply liquid to the fountain, an overflow dam for said fountain disposed at a level near but somewhat below the top of the fountain, and a drain-pipe for removing any excess liquid flowing over the dam.

2. A coating machine comprising an elongated trough or fountain closed on all sides but open at the top to form a slot or throat extending longitudinally of the fountain, means to feed a web directly over the top or throat of the fountain, means to supply liquid to the bottom of the fountain, overflow dams housed within said fountain near the ends of said fountain at a level somewhat below the top of the fountain, and drain-pipes for removing any excess liquid flowing over the dams.

3. In a coating machine, a flexible doctor supported at the ends thereof, said ends bing pulled to place the doctor under tension.

4. In a coating machine, means to apply a liquid to a web, means to move the web past the coating means, and a doctor for regulating the thickness of t'e coating, said doctor comprising a round spring wire, and means pulling the ends of said wire in order to place the wire under such longitudinal tension that it springs back to original position if displaced by a bump or projection on the web.

5. In a coating machine, a fountain, and doctor means associated therewith, said doctor means comprising a wire supported at its ends and pulled to place the wire under tension, and a thin readily yieldable blade disposed with one edge along the wire and having its opposite edge secured to the fountain, said blade forming a flexible seal between the wire and the fountain in order to prevent escape of liquid between the wire and the fountain.

6. A coating machine comprising a fountain closed at all sides but open at the top to form an elongated slot or throat, a presser disposed directly over said fountain, means to feed a web to be coated between the fountain and the presser, means to supply liquid to the fountain, means so mounting the presser that it may move toward or away from the fountain, and thickness-determining feelers disposed at the fountain beneath the web and bearing through the web against the presser.

7. A coating machine comprising a fountain closed at all sides but open at the top to form an elongated slot or throat, a roll disposed directly over said fountain to support a web to be coated between the fountain and the roll, means to supply liquid to the fountain, means so journaling the roll that it may move toward or away from the fountain, thickness-determining feelers disposed at the fountain beneath the web and bearing through the web against the roll, and precision adjustment means for accurately determining the elevation of the feelers and thereby determining the thickness of the coating applied to the web.

8. A coating machine comprising a fountain, a roll disposed over said fountain, means to feed a web to be coated between the fountain and the roll, means to supply liquid to the fountain, means so journaling the roll that it may move toward or away from the fountain, counter-balancing means for counteracting nearly all of the weight of the roll, whereby said roll readily rises or falls, and thickness-determining feelers disposed at the fountain and bearing through the web against the roll.

9. A coating machine comprising a fountain, a roll disposed over said fountain, means to feed a web to be coated between the fountain and the roll, means to supply liquid to the fountain, means so journaling the roll that it may move toward or away from the fountain at an angle displaced somewhat from vertical, counter-balancing means for counteracting nearly all of the weight of the roll, whereby said roll readily rises or falls, and thickness-determining feelers disposed at the fountain and bearing through the web against the roll, the path of movement of the roll being approximately perpendicular to the direction of resultant pull of the web on the roll.

10. A coating machine comprising a fountain, a roll disposed directly over said fountain, means

to feed a web to be coated between the fountain and the roll, means to supply liquid to the fountain, means so journaling the roll that it may move toward or away from the fountain, counterbalancing means for counteracting nearly all of the weight of the roll, whereby said roll readily rises or falls, thickness-determining wheels disposed at the fountain and bearing through the web against the roll, said wheels being mounted on studs which are slidable along the fountain to accommodate varying widths of web, and precision means for simultaneously and uniformly adjusting the elevation of the wheels.

11. A coating machine comprising a fountain closed at all sides but open at the top to form an elongated slot or throat, a roll disposed directly over said fountain, means to feed a web to be coated between the fountain and the roll, means to supply liquid to the fountain, means so journaling the roll that it may move toward or away from the fountain, counter-balancing means for counteracting nearly all of the weight of the roll, whereby said roll readily rises or falls, thickness-determining feelers disposed at the fountain and bearing through the web against the roll, said feelers being slidable along the fountain to accommodate varying widths of web, and means for simultaneously and uniformly adjusting the elevation of the feelers, and stops acting as the ends of said fountain for determining the width of coating applied to the web, said stops being slidably adjustable along the throat of the fountain.

12. A coating machine comprising a fountain, a roll disposed directly over said fountain, means to feed a web to be coated between the fountain and the roll, means to supply liquid to the fountain, means so journaling the roll that it may move toward or away from the fountain, adjustable resilient means for counteracting nearly all of the weight of the roll, whereby said roll readily rises or falls, thickness-determining wheels disposed immediately preceding the fountain and bearing through the web against the roll, said wheels being mounted on studs which are slidable longitudinally of the fountain to accommodate varying widths of web, and means for simultaneously and uniformly adjusting the elevation of the wheels, including a somewhat flattened rod extending longitudinally of the fountain beneath the studs, and appropriate screw control means for slightly oscillating said rod, the thickness of the coating remaining constant despite changes in thickness of the web because the roll rises or falls to compensate for changes in web thickness.

3. In a coating machine, a fountain closed at all sides but open at the top to form an elongated slot or throat, a presser disposed directly over said fountain to feed a web to be coated between the fountain and the presser, means to supply liquid to the fountain, a flexible doctor for limiting the quantity of liquid applied to the web, said doctor being supported at its ends, and said ends being pulled to place the doctor under tension, means so mounting the presser that it may move toward or away from the doctor, and thickness-determining feelers disposed at the fountain beneath the web and bearing through the web against the presser.

14. In a coating machine, a fountain closed at all sides but open at the top to form an elongated slot or throat, a roll disposed directly over said fountain to feed a web to be coated between the fountain and the roll, means to supply liquid to the fountain, doctor means for limiting the quantity of liquid applied to the web, said doctor means comprising a wire disposed at and acting as the trailing edge of the throat, said wire being supported at its ends and pulled to place the wire under tension, and a thin yieldable blade extending between the wire and the side of the fountain in order to form a flexible seal to prevent escape of liquid between the wire and fountain, means so journaling the roll that it may move toward or away from the doctor, and thickness-determining feelers disposed at the fountain beneath the web and bearing through the web against the roll.

15. In a coating machine, doctor means comprising a wire supported at its ends and pulled to place the same under tension, a thin readily yieldable blade disposed with one edge in supporting engagement along the wire and having its opposite edge secured to the coating machine, and adjustable stiffening means for determining the stiffness or yieldability of the blade at one or more points along the blade in order to help determine the relative yieldability of one part of the wire relative to that of another part of the wire.

16. A coating machine for applying a thin uniform film of liquid to a web of paper or like material of variable thickness, said machine comprising means to support and move the web, coating means including a doctor substantially contacting the web on the side opposite the supporting means to apply a coating to said web, means to continuously gauge the thickness of the web at or near the support, and means responsive to said thickness-determining means to vary the spacing between the web support and the doctor in such direction as to tend to maintain the film applied to the web at a uniform thickness.

17. A coating machine for applying a thin uniform film of liquid to a web of paper or like material of variable thickness, said machine comprising means to support and move the web, means substantially contacting the web on the side opposite the supporting means to apply a coating to said web, one of said means being movably mounted with respect to the other, means to continuously gauge the thickness of the web at or near the support, and means responsive to said thickness-determining means to vary the spacing between the web support and the coating means in such direction as to tend to maintain the film applied to the web at a uniform thickness.

18. A coating machine for applying a thin uniform film of liquid to a web of paper or like material of variable thickness, said machine comprising means to support the web, means substantially contacting the web on the side opposite the supporting means to apply a coating to said web, one of said means being movably mounted with respect to the other, and means resting against the web on the same side as the coating means and bearing through the web against the web support, said means being connected to the coating means to vary the spacing between the coating means and the support in response to changes in thickness of the web, whereby spacing between the coating means and the side of the web being coated is kept constant.

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