July 3, 1951 L. B. MULLOY ET AL 2,558,773

APPARATUS FOR CONTROLLING THE THICKNESS OF A COATING ON A TRAVELING WEB

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Fig. 1

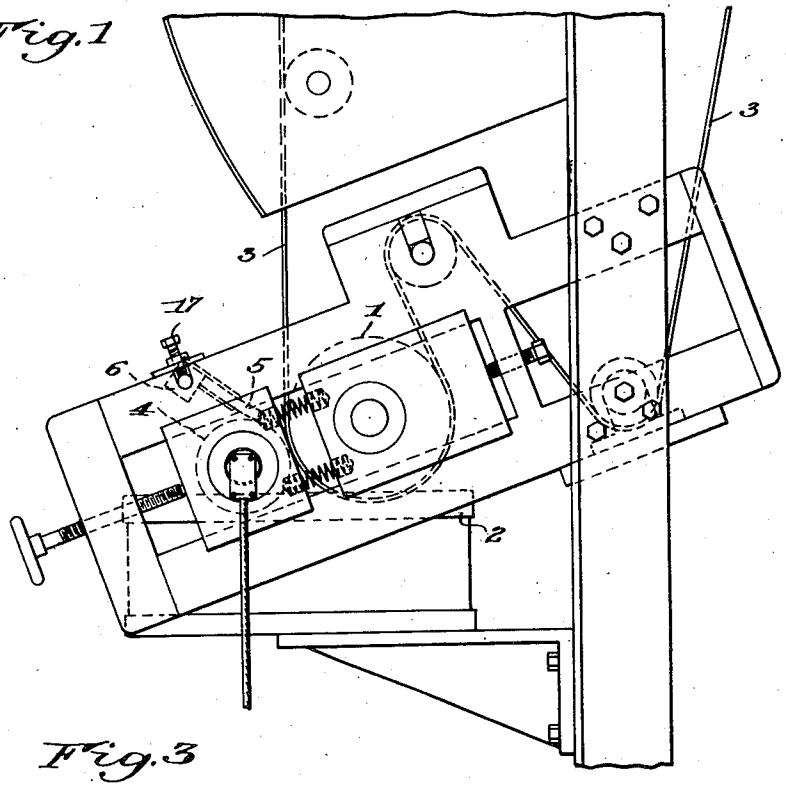
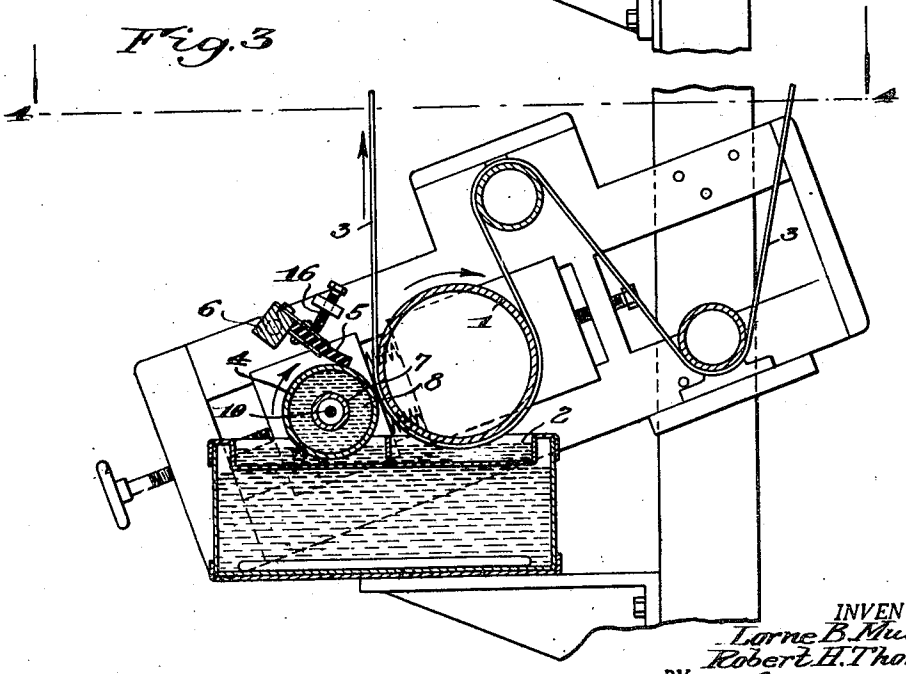


Fig. 3



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Fig. 2

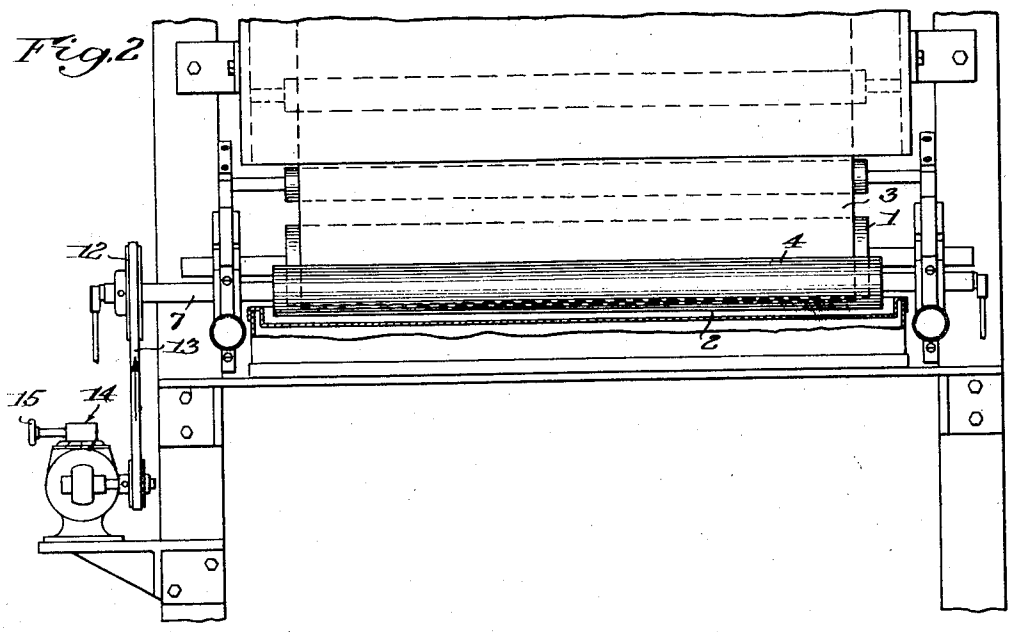


Fig. 4

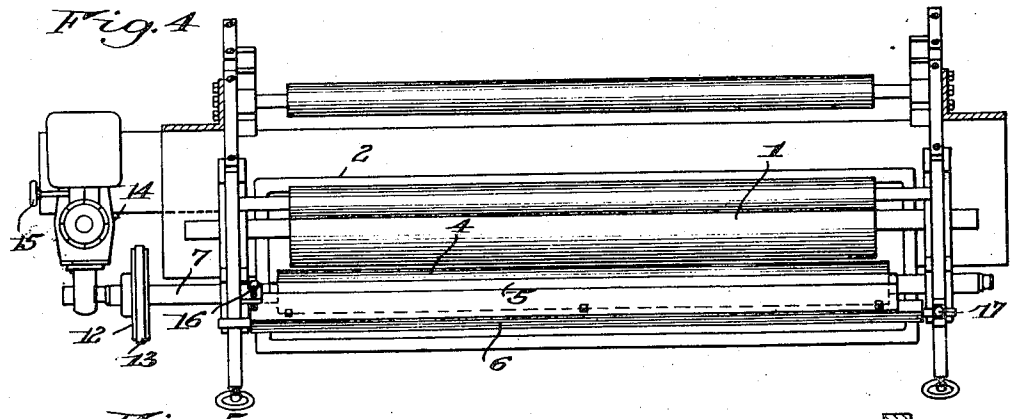
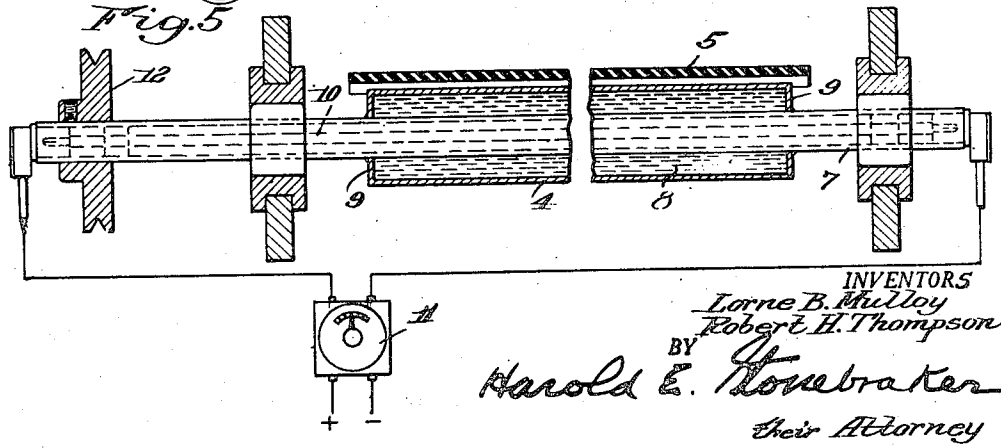


Fig. 5



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APPARATUS FOR CONTROLLING THE THICKNESS OF A COATING ON A TRAVELING WEB

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Application March 6, 1948, Serial No. 13,398

4 Claims. (Cl. 91—10)

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This invention relates to an apparatus for controlling the thickness of a coating on a traveling web, with particular reference to the type of machinery employed in coating paper or film with materials such as light-sensitive gelatin emulsion, and it has for its purpose to provide a more efficient and economical structure than has been possible with machines and procedures heretofore employed, and to produce a superior product.

In a more particular aspect, the invention has for its purpose to afford an apparatus that enables more accurate control of the thickness of the coating than has heretofore been possible and obtaining greater smoothness and uniformity in the surface and also the thickness of the final coating.

In coating machines as heretofore generally operated, the thickness of the coating has been highly variable depending on changes in the viscosity of the coating material which varies from time to time and cannot be held constant, and the speed of travel of the web, and the thickness of coating in photographic paper procedures has generally been controlled by changing the speed of the travel of the web or by changing the viscosity of the coating material as by adding more water, and these procedures have disadvantages because increasing the water content of the coating material increases the drying time required and cutting down the speed of travel of the web cuts down production, both operations being uneconomical, and a given thickness of coating cannot accurately be maintained in this way nor can a uniform surface on the coating be had.

Another method has been proposed involving the use of an air doctor for removing surplus coating material from the web but this is uneconomical because of the necessity of using air compressors, filters, heaters, and pressure control mechanisms, and with such apparatus it is difficult to maintain a uniform air pressure at the point of discharge entirely across the slot through which it emerges on to the coating, and has been found impractical to obtain coatings of uniform thickness and with uniformly smooth surfaces free from streaks or imperfections. It is a purpose of the present invention to afford a procedure and mechanism that is simpler and more economical to operate, more efficient and accurate in the results attained than with an air doctor, and which affords greater uniformity in the surface of a coating and more exact control of the thickness of coating than with the procedures heretofore employed or proposed.

A further purpose of the invention is to afford a

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mechanism that can be easily manipulated and controlled, and which makes it possible to coat a web traveling at a much higher speed than has heretofore been possible, greatly reducing the cost of production and also improving the quality of photographic papers so coated.

Still another object of the invention is to afford a mechanism in which the thickness of a coating can be more readily controlled than heretofore and adjusted to a nicety, irrespective of the speed of travel of the web or the viscosity of the coating material, so that as a consequence the web can be fed at a maximum speed and a coating material with a minimum water content and uniform viscosity can be used, without affecting the thickness of the final coating, while at the same time reducing the required drying time to a minimum.

To these and other ends, the invention consists in the arrangement of parts that will appear clearly from the following description, when read in conjunction with the accompanying drawings, the novel features being pointed out in the claims following the specification.

In the drawings:

Fig. 1 is a side elevation of a machine constructed in accordance with a preferred embodiment of the invention;

Fig. 2 is an end elevation of the same;

Fig. 3 is a longitudinal sectional view taken centrally of Fig. 2;

Fig. 4 is a horizontal sectional view taken on line 4—4 of Fig. 3, and

Fig. 5 is a detail sectional view taken through the doctor roll.

Referring more particularly to the drawings in which like reference numerals refer to the same parts throughout the several views, 1 designates a coating roll located within a reservoir 2 which contains a supply of coating material fed in any suitable manner to the reservoir 2 to maintain a substantially constant level, while 3 designates the web to be coated which in the present instance is paper while the coating material is light-sensitive gelatin emulsion such as used in coating photographic paper, although the invention is not confined in its application to the employment of this particular coating material or to coating on a web of paper since it can be used successfully in the coating of other traveling webs and with various coating materials. The paper is fed from a suitable source of supply around the coating roll 1 and thence to a drying station, not shown, by any suitable feeding mechanism as usual in this general type of coating machinery, and the present invention has to do with remov-

ing surplus coating material from the web in an accurately controlled fashion so as to insure a coating of predetermined and uniform thickness with a surface free from streaks or other blemishes.

Heretofore, the more general practice has been to feed the web through the coating material and depend solely on the viscosity of the coating material and the speed of travel of the web for the thickness of coating, and this has presented practical disadvantages because to attain a thin coating it has been necessary to increase the water content in the coating material necessitating a correspondingly longer drying operation, and the speed of travel of the web must be maintained in a certain relation to the thickness of the desired coating and the viscosity of the coating material.

It has also been attempted to regulate the thickness of a coating by means of an air doctor or air knife, but this presents practical difficulties due to the necessity of maintaining the air under constant pressure, filtering and heating the air, and also the fact that it is impossible to maintain a uniform air pressure at all points of the slot through which the air is discharged into contact with the coating, thus making it difficult to control with any high degree of accuracy the thickness of the coating, and requiring considerable machinery that is costly and difficult to service.

With the present invention, the thickness of the coating can be accurately controlled and maintained irrespective of the speed of travel of the web and of the viscosity of the coating material, and consequently the web can travel at a high rate of speed, much faster than has heretofore been possible, and a coating material can be used with a minimum water content so that the drying operation is reduced to a comparatively short period of time, the cost of production of photographic paper is materially reduced, and its quality improved.

To accomplish this, there is provided a doctor roll **4** located opposite to the coating roll **1**, preferably in the position illustrated within the reservoir **2**, the periphery of the doctor roll **4** being spaced slightly from the coating roll **1** and the web **3**, positioned so as to contact the coating material on the web **3** and to remove surplus coating material from the web whereby the amount of coating material remaining on the web after it passes the doctor roll **4** determines the thickness of the final coating.

The doctor roll **4** is driven in a direction contrary to the direction of travel of the web **3** at the point of contact between the doctor roll and the coating material on the web, and at any selected speed since the speed of travel of the doctor roll determines the thickness of the coating. If the doctor roll **4** is driven at a reduced speed, the thickness of the coating is increased, and if the doctor roll **4** is driven at an increased speed, the thickness of the coating is decreased.

It is essential that the doctor roll be entirely free of coating material at the point where it engages the coating material on the web, and in order to wipe all coating material from the periphery of the doctor roll at a point in advance of its contact with the coating material on the web, there is provided a scraper **5**, preferably of flexible resilient material such as pure gum rubber, Micarta, formica, nylon, tygon, leather, neoprene or other synthetic rubber, steel, cellulose acetate, film base or plastics having similar

characteristics, the scraper **5** being mounted on a supporting bar **6** which is pivotally mounted in the frame of the machine and so positioned as to maintain the resilient scraper in flexed relation against the periphery of the doctor roll **4** as shown.

The flexible resilient scraper can be of any desired thickness from a minimum of approximately $1/64$ of an inch to a maximum of approximately $3/8$ of an inch and successful results have been obtained with a scraper having a thickness of $1/4$ of an inch held in flexed relation against the periphery of the doctor roll. The edge of the resilient scraper toward the doctor roll is formed by cutting the gum rubber body at right angles to its opposite sides and it is then positioned against the doctor roll so that one right angular edge of said cut surface is disposed against the periphery of the doctor roll so as to form a symmetrical angle on both sides of the edge of the scraper between it and the roll. With a flexible, resilient scraper thus disposed and extending entirely across the doctor roll, the coating material is entirely and completely removed by the scraper and a perfectly clean surface of the doctor roll periphery is brought into contact with the coating material on the web. The doctor roll is preferably of metal and has a highly polished periphery engaging the coating material, and by contact therewith removes any surplus material and carries it back into the reservoir.

The amount of surplus material removed is determined by the speed of travel of the doctor roll, and for instance, if the peripheral speed of the doctor roll is increased one foot per minute, the thickness of the coating is reduced by approximately 5%, and a decrease in the speed of the doctor roll results in an increase in the coating thickness of approximately 5%. For any given thickness of coating, the peripheral speed of the doctor roll is increased approximately one foot per minute for every two feet per minute increase in the speed of travel of the web, and for a two feet per minute decrease in the speed of travel of the web, the doctor roll speed is decreased approximately one foot per minute.

For example, if the paper is traveling at a speed of 40 feet per minute, the peripheral speed of the doctor roll is approximately 12 feet per minute, and if the speed of the web is increased to 50 feet per minute, for the same thickness of coating the speed of the doctor roll would be increased to approximately 17 feet per minute.

The speed of travel of the web may vary from a minimum of approximately 30 feet per minute to a maximum of approximately 100 feet per minute or more, and the peripheral speed of the doctor roll may vary from a minimum of approximately 4 feet per minute to a maximum of approximately 50 feet per minute. The clearance between the periphery of the doctor roll and the web or paper is between a minimum of approximately .005 inch and a maximum of approximately .025 inch, and the thickness of the final coating may be had from approximately .002 inch to approximately .012 inch or more.

In order to enable thorough cleaning of the doctor roll by the scraper and to insure a uniformly smooth coating, it is desirable to heat the doctor roll to maintain its periphery at a temperature of approximately 90° F. to 140° F., somewhat above the temperature of the coating material, and to accomplish this, the doctor roll is fixedly mounted on a central tube **7** extending

therethrough and surrounded by a chamber 8 that is sealed at both ends by the plates 9 and contains a body of water that is heated by an electric heating element 10 within the tube 7 and controlled by a suitable temperature regulator 11, the tube 7 and doctor roll being driven through a pulley 12 mounted on tube 7, belt 13, and suitable gearing from an electric motor and change speed gear indicated diagrammatically at 14, while 15 is a manually adjustable handle for regulating the speed gear drive and selecting any desired speed.

The flexible scraper 5 is held flexed at the desired angle against the doctor roll 4 by a screw 16 adjustable on the frame of the machine and 17 is a locking screw also adjustable on the frame and engaging one end of the bar 6 to hold the bar and scraper against endwise movement.

The drive and change speed gear employed to operate the doctor roll is known as a Graham Variable Speed Transmission with Built-in Motor, manufactured by Graham Transmission Company, Milwaukee, Wisconsin, and gives an infinite number of speeds by a simple and quick manual control, although it is to be understood that any drive and change speed gear can be employed that enables driving the doctor roll 4 at any selected speed by a simple adjustment, so that as the speed of travel of the web is increased or the viscosity of the coating material is changed, the speed of travel of the doctor roll can be correspondingly modified quickly, and thus maintain a coating of uniform thickness which is evenly distributed over the surface of the web by the clean contacting smooth surface of the doctor roll, so that the final coating when dry is smooth, uniform in texture, and entirely free from any streaks, blemishes, or other defects.

While the invention has been described with reference to the particular procedure and construction shown, it is not restricted to the exact details herein disclosed and this application is intended to cover such modifications or changes as may come within the purposes of the invention or the scope of the following claims.

We claim:

1. The combination with a coating material reservoir and coating roll mounted therein to receive a web which travels therearound, of a doctor roll having a hard surfaced polished periphery mounted opposite to said coating roll with its periphery spaced from the coating roll and web and adapted to contact the coating on the web, means for driving the doctor roll at varying speeds in relation to the speed of travel of the web to regulate the thickness of the coating, and a scraper of flexible resilient material extending across the periphery of the doctor roll in advance of its point of contact with the coating.

2. The combination with a coating material reservoir and coating roll mounted therein to receive a web which travels therearound, of a doctor roll having a hard surfaced polished periphery mounted opposite to said coating roll with its periphery spaced from the coating roll and web and adapted to contact the coating on the web, means

for driving the doctor roll at varying speeds in relation to the speed of travel of the web in a direction contrary to the direction of travel of the web at the point of contact between the doctor roll and coating to regulate the thickness of the coating, and a scraper of flexible resilient material extending across the periphery of the doctor roll in advance of its point of contact with the coating.

3. The combination with a coating material reservoir and coating roll mounted therein to receive a web which travels therearound, of a doctor roll having a hard surfaced polished periphery mounted opposite to said coating roll with its periphery spaced from the coating roll and web and adapted to contact the coating on the web, means for driving the doctor roll at varying speeds in relation to the speed of travel of the web in a direction contrary to the direction of travel of the web at the point of contact between the doctor roll and coating to regulate the thickness of the coating, and a scraper of flexible resilient material extending across the periphery of the doctor roll in advance of its point of contact with the coating, said scraper being flexed against the doctor roll with one angular edge in contact therewith.

4. The combination with a coating material reservoir and coating roll mounted therein to receive a web which travels therearound and thence in a vertical plane, of a doctor roll having a hard surfaced polished periphery mounted opposite to said coating roll with its periphery spaced from the coating roll and web and adapted to contact the coating on the web, the longitudinal axis of the doctor roll being located in a horizontal plane below that in which the longitudinal axis of the coating roll is located, means for driving the doctor roll at varying speeds in relation to the speed of travel of the web in a direction contrary to the direction of travel of the web at the point of contact between the doctor roll and coating to regulate the thickness of the coating, a scraper of flexible resilient material extending across the periphery of the doctor roll in advance of its point of contact with the coating, said scraper being flexed against the doctor roll with one angular edge in contact therewith, and heating means cooperating with the periphery of the doctor roll.

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