Oct. 2, 1945. F. C. WOODWARD 2,386,156

AIR DOCTOR

Filed Jan. 25, 1943

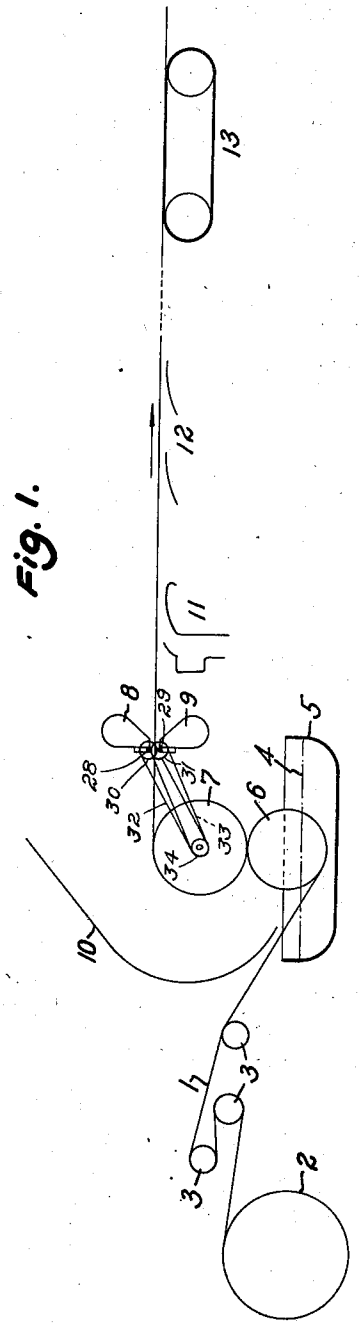


Fig. 1.

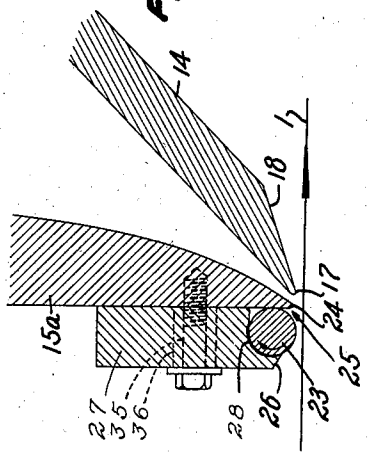


Fig. 3.

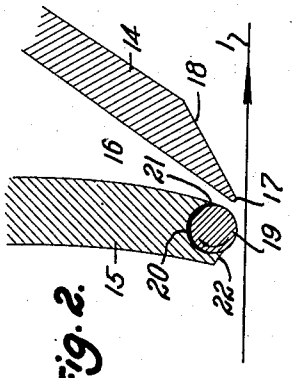


Fig. 2.

Inventor:
Faunce C. Woodward

By Pierce & Scheffler
his Attorneys.

Patented Oct. 2, 1945

2,386,156

UNITED STATES PATENT OFFICE

2,386,156

AIR DOCTOR

Faunce C. Woodward, Westbrook, Maine, assignor to S. D. Warren Company, Boston, Mass., a corporation of Massachusetts

Application January 25, 1943, Serial No. 473,538

7 Claims. (Cl. 91—53)

This invention relates to an air doctor designed for use in the coating of traveling webs such as paper, Cellophane, cloth and the like which are first roughly coated with a surplus of liquid coating such as paper coating composition and the excess coating then removed and the residual coating simultaneously smoothed by the action of the air doctor.

Air doctors of different designs have been used for smoothing liquid coatings on webs, with or without removal of excess coating, as described for instance in prior patents to Lebel No. 1,980,923, Terry No. 2,139,628, Merrill No. 2,176,093 and Goff and Frost No. 2,229,921. The air doctors have been used according to these patents for merely smoothing the coating as well as for both removing excess coating and smoothing the remainder and for treating a web on one side only while the other side is backed by a rigid support as well as for treating both sides of the web simultaneously with the air doctors either opposed to each other or in staggered relationship.

In an application of Lindsay O. Goff, Serial No. 472,234 filed January 13, 1943, there is described a new air doctor designed for use in the coating of webs, said air doctor being particularly designed to provide a smooth action of the air jet so that the coating acted upon shall be free of ripples or defects caused by vibration or fluttering of the web. It will be appreciated that such an air doctor, while useful for removing excess coating and smoothing the residual coating on one side of a web which is rigidly supported on the other side, is practically indispensable in the treatment of a web which is not rigidly supported against the air doctor, as in the simultaneous coating of a web on both sides. In accordance with said Goff application an air doctor is provided having a throat and slot like that disclosed in the Terry patent above referred to or other suitable construction capable of giving a sufficiently strong and uniform jet of air designed to impinge against the web at a suitable oblique angle to remove excess coating and smooth the residual coating or to leave a residual coating having a smooth surface. The air doctor of said application has a leading lip, that is, the lip on the side of the air doctor nozzle on which the traveling web approaches the air doctor, which is longer in the direction of the jet than is the trailing lip, and is provided with a convex curved surface facing the web which extends forwardly so as to provide a divergent outlet for the air issuing from the jet and passing between the leading lip and the web and is separated from the slot by a depression, thereby providing a passage for the air issuing from the slot and passing between the web and the lip first expanding into the chamber formed by the depression, then contracting along the curved surface to a point of nearest approach of the curved surface to the web, and then expanding again along the curved surface into the surrounding atmosphere.

In the use of the air nozzle described in the Goff application the curved or rounded surface of the leading lip of the air doctor tends to become fouled by dried deposits of the coating composition. Drops of the coating composition picked up by the air jet strike this surface and dry thereon until a deposit is built up which interferes with the operation of the air doctor. Heretofore it has been necessary to stop the coating process from time to time and manually clean the air doctor.

The present invention disposes of this difficulty by providing self cleaning leading lips for air doctors of the type disclosed in said Goff application which present a curved surface to the web. It will be understood that in the foregoing and in the following description the term "air doctor" refers to nozzles operated with air, either hot or cold, or steam or other suitable gaseous fluids.

The accompanying drawing illustrates two specific air doctor nozzle structures embodying my invention. Referring to the drawing,

Fig. 1 is a diagrammatic side elevation of a suitable assembly of apparatus for coating both sides of a web such as paper.

Fig. 2 is a diagrammatic vertical section through one modification of the air doctor nozzle, and

Fig. 3 is a diagrammatic vertical section through another modification of the air doctor nozzle.

In the apparatus illustrated in Fig. 1, 1 is the paper web which passes from the unwind reel 2 over tensioning rolls 3 which may be driven if desired and under the roll 6 which submerges it in the liquid paper coating composition 4 in the pan 5. The web then passes between squeeze rolls 6 and 7 which remove a part of the coating composition and leave a relatively smooth coating which is only moderately in excess of the thickness or weight of coating desired on the finished paper. The web 4 then passes between the air doctors 8 and 9 which are set to deliver jets of air obliquely against the web in a direction having a component opposite to the direction of movement of the web. Coating forced back over the web by the air doctors flows down over rolls 6 and 7 into the pan 5 while coating picked off of the web and carried by the air currents created

by the air doctors is caught by the shield 10 and flows therefrom into the pan 5. The web leaving the air doctors is carried by the hot air floater 11 which preferably is of an improved type which holds the web in a fixed path as described in the Merrill patent referred to above and then over more hot air floaters 12 which may be identical with the floater 11 or of any other suitable type. The leading lips of the air doctors 8 and 9 terminate in rollers 28 and 29, as is more clearly illustrated in Figs. 2 and 3, which may be rotated by the pulleys 30 and 31 and belts 32 and 33 which are driven by pulley 34 on the shaft of roller 7.

When the web has been floated until it is dry enough to be touched it passes to the pulling device 13 which may be a suction apron, capable of pulling the web taut. The web is then further processed or reeled up as desired. The apparatus illustrated in Fig. 1 and described above for coating the web and passing it between the air doctors and drying the coating is no part of the present invention and may be replaced in the use of the air doctors of the present invention by any other known or suitable means for supporting and advancing the web carrying coating on either one or both sides past a single air doctor or opposed air doctors or any other desired arrangement of air doctors of the invention.

One embodiment of the invention is illustrated in Fig. 2 in which 14 and 15 are the front and rear or leading and trailing members respectively of an air doctor and define the throat 16 thereof and terminate in lips defining a relatively long and narrow slot through which the air issues in the form of a jet. Member 14 terminates in a conventional lip 17 having a relatively sharp edge and a sharply receding rear face 18. A trailing lip of any other suitable shape may be employed. A lip of the shape illustrated collects very little coating on its edge and although occasional cleaning may be necessary, the provision of special means for cleaning it is not considered to be worth while. The leading member 15 terminates in the roller 19 which is mounted to rotate in the cylindrical socket 20 formed in the end of the member. The socket 20 is so shaped that the inner surface of the member 15, that is, the surface adjacent the throat 16, is substantially tangent to the roller 19 and terminates in the relatively sharp edge 21 which approaches the surface of the roller as closely as is practicable, i. e. it may make rubbing contact with the roller or be spaced from it a few thousandths of an inch. The front face of member 15 terminates in the edge 22 which also approaches the surface of the roller 19 and is so shaped as to constitute a scraper for cleaning the surface of the roller as it rotates in a clockwise direction. Roller 19 may be rotated in the same manner as rollers 28 and 29 as shown in Fig. 1.

The purpose of the roller 19 is to provide a curved surface facing the web so that air issuing from the slot of the air doctor and passing between the web and the leading lip of the air doctor will flow through and issue from said passage without creating eddy currents or other disturbance of sufficient intensity to cause vibration or fluttering of the web.

The shape of the surface of member 15 adjacent the edge 22 is not of importance provided that the curved surface of the cylinder 19 extends well beyond the point of its closest approach to the web. It will be appreciated that little or no coating accumulates on the inner surface of the member 15 and that there is little or no tendency for accumulation of deposit to occur on the portion of the curved surface extending from the slot of the nozzle to the point of closest approach of the curved surface to the web. The slot of the nozzle referred to is the narrowest point of the throat from which the air issues as a jet. The accumulation of deposit of coating occurs principally upon the curved surface from the point of its closest approach to the web forwardly (i. e. toward the source of the web) to the scraper edge 21. It is necessary, therefore, for the scraper edge 22 to be sufficiently spaced from the web so that the curved surface of the roller 19 will extend far enough forward to provide a streamlined outlet for the air passing between the roller and the web. This condition is fulfilled if the roller 19 is about $\frac{3}{8}$ inch or more in diameter and the scraper edge 22 is at least about $\frac{1}{8}$ inch from the web. It is not essential that the curved surface be exposed from the point of its closest approach to the web to the slot of the nozzle. The whole rear side of the roller surface could be covered by an extension of the edge 21. It is only essential that the curved surface of the cylinder 19 be exposed from the point of its closest approach to the web to a point sufficiently forwardly thereof to provide an outlet for the air which will not create eddy currents of sufficient intensity to cause the web to vibrate or flutter. It is convenient to expose about half of the cylinder 19, but it is obvious that either more or less of it could be exposed by decreasing or increasing the depth of the socket 20. With the customary spacing of the lips of the air brush nozzle from each other, e. g. 0.025 inch and the customary spacing of the air doctor from the web, e. g. a clearance of 0.03 inch between the curved surface of roller 19 and the web, and operating at customary air pressures, e. g. 1 pound per square inch, the roller diameter may vary from $\frac{3}{32}$ to $1\frac{1}{2}$ inches. When the roller is of small size in the neighborhood of $\frac{3}{32}$ inch the spacing of the scraper from the web may, of course, be less than $\frac{1}{8}$ inch. A surface having a curvature corresponding to that of a cylinder having a diameter substantially greater than $1\frac{1}{2}$ inches, e. g. 4 inches, has been found to be without appreciable effect in the prevention of fluttering when employing the other conditions of air doctor size and strength and spacing which are conventional in the use of air doctors for smoothing paper coatings. The minimum effective diameter of the cylinder has not been determined, but it appears that $\frac{3}{32}$ inch is about as small as would be practicable.

It is noted before going on to a description of the modification illustrated in Fig. 3 that any suitable type of air doctor nozzle, such as that disclosed in the Terry patent above referred to, may be modified to include the self cleaning curved leading lip of the present invention and further that a similar modification of the trailing lip of the air doctor nozzle is not excluded. It may be pointed out, however, that there is normally no reason for modifying the trailing lip so that it presents a curved surface to the web and there is normally no troublesome accumulation of coating on the trailing lip so that there is normally no reason for providing the air doctor with a self cleaning trailing lip.

It will be appreciated that the member 15 may be either solid or hollow having front and rear walls which provide the edges 21 and 22 or that the member 15 may be a thin sheet of metal or other suitable material providing the edge 21 and

that the bearings for the roller 19 and supports for the cleaning edge 22 may be mounted thereon by means of suitable brackets. The essentials of the air doctor therefore are a member 14 which defines the rear wall of the throat 16 and terminates in a lip 17 and a member 15 which defines the front wall of the throat 16 and terminates in the edge 21, a roller supported in cooperative relation to the edge 21 and a scraper 22 supported in cooperative relation to the roller.

In the air doctor illustrated in Fig. 3 the trailing member 14 is identical with the trailing member 14 of the air doctor illustrated in Fig. 2, and what has been said regarding the latter applies equally to the former. The leading member 15a of the air doctor of Fig. 3 is modified to include a roller 23 similar to the roller 19 of Fig. 2 but so mounted with respect to the edge 24 thereof as to leave the chamber 25 between the front face of member 15a and the roller. This chamber 25 is similar in purpose and effect to the chamber 19 of the air doctor described in the Goff application above referred to. Member 15a with member 14 thus define the throat of the air doctor nozzle and both terminate in lips or edges defining the slot of the nozzle and the roller 23 provides a curved surface facing the web on the leading side of the air jet. Thus when the web moves to the right in a horizontal plane beneath the air doctors of Figs. 2 and 3, as illustrated, the air doctors direct jets of air obliquely against the web, the angle between the web and the direction of the jets on the leading side being an obtuse angle, and the rollers 19 and 23 together with the web define passages for the air which, in the case of the air doctor of Fig. 3, includes the chamber 25.

The roller 23 is provided with a cleaning doctor or scraper 26 which, like the scraper 22 of the air doctor of Fig. 2, is positioned a suitable distance from the web so that it will not interfere with the discharge of the air from the passage between the roller and the web. As illustrated, the roller 23 is carried by the member 27 which also provides the scraper 26, member 27 being suitably attached to the front face of member 15a. It will be evident, however, that member 27 is not essential and that roller 23 and scraper 26 may be mounted in cooperative relation to the edge 24 of member 15a in other ways, e. g. by means of brackets attached to member 15a.

Roller 23 is mounted so that the point or line of its surface nearest the web is substantially the same distance from the web as the edge 24 but this is not a critical relationship. The roller 23 may be either closer to or farther away from the web than the edge 24. Edge 24 as illustrated is about the same distance from the web as is edge 17 but this relationship also is not critical. Edge 24 may be either nearer to or farther away from the web than is the edge 17. The edge 24 should, however, extend somewhat farther in the direction of the air jet than the edge 17. Roller 23 may be rotated in the same manner as rollers 28 and 29 as shown in Fig. 1.

The size of the chamber 25 will be determined by the size of the cylinder 23, its position with respect to the edge 24 and the shape of the front face of the member 15a between the edge 24 and the point of closest approach of said surface to the surface of the cylinder. As illustrated, with the front face of member 15a a plane surface and the curved surface of cylinder 23 about the same distance from the web as is the edge 24, the chamber is roughly triangular in cross section with its base and height each equal to the radius of the cylinder 23. The member 27 may be adjustably attached to member 15a by means of bolts 35 and the elongated openings 36 in the member 27 to permit adjustment of the position of roller 23 with respect to the edge 24. Thus member 27, carrying the roller 23 and the scraper 26, may be advanced in the direction of the air jet until the roller is tangent to the front face of member 15a at the edge 24. Then, by adjusting member 15a with respect to member 14, a substantial duplication of the air doctor of Fig. 2 may be produced.

It follows that all intermediate modifications in which the chamber 25 varies in relative size from that illustrated in Fig. 3 to zero are embraced by the invention. It will be appreciated, therefore, that the invention resides in an air doctor having a leading lip which presents a curved surface to the web, said curved surface being a portion of a rotatable cylindrical surface, the diameter of which lies within the range from about $\frac{3}{32}$ to $1\frac{1}{2}$ inches, and a scraper or doctor member for cleaning the cylindrical surface.

In both embodiments of the air doctor illustrated in Figs. 2 and 3, the rollers 19 and 23 may fit relatively tightly within the sockets 20 and 28 and the contacting surfaces may require lubrication. Normally the lubricating action of the liquid coating composition is sufficient but additional lubrication may be provided, for instance by providing oil ducts through members 15 and 27 to the sockets 20 and 28.

I claim:

1. An air doctor comprising two throat-forming members the opposed surfaces of which define a throat, said members terminating in lips defining a relatively long narrow rectilinear slot, at least one of said throat-forming members having a partial cylindrical socket in its lip end, a cylindrical member fitting into said socket and mounted to rotate on an axis parallel to said slot and means for rotating said cylindrical member, said cylindrical member providing a curved lip surface external to said throat and adjacent to said slot and an edge of said socket serving as a scraper for cleaning said surface.

2. An air doctor comprising two throat-forming members the opposed surfaces of which define a throat, said members terminating in lips defining a relatively long narrow rectilinear slot, at least one of said lips having an edge adjacent said slot, a curved surface external to said throat and adjacent to said edge provided by a cylindrical member mounted to rotate on an axis parallel to said edge, means for rotating said cylindrical member and means associated with said cylindrical member for cleaning the surface thereof, said cylindrical member being adjustable with respect to said edge.

3. An air doctor comprising two throat-forming members the opposed surfaces of which define a throat, said members terminating in lips defining a relatively long narrow rectilinear slot, at least one of said throat forming members being an integral body and having a partial cylindrical socket in its lip end, a cylindrical member fitting into said socket and rotatably mounted on said member and means for rotating said cylindrical member, said socket being substantially tangent to the throat-forming surface of said member and the intersection of the other surface of said throat-forming member with the surface of said socket forming a scraper edge for cleaning the surface of said cylindrical member.

4. An air doctor comprising two throat-forming

members the opposed surfaces of which define a throat, said members terminating in lips defining a relatively long narrow rectilinear slot, at least one of said opposed surfaces terminating in an edge adjacent said slot, the outer surface of said throat-forming member adjacent said slot being a substantially plane surface, a supporting member adjustably mounted on said plane surface, said supporting member having a partial cylindrical socket in its side adjacent said edge, a cylindrical member fitting into said socket and mounted to rotate in said socket with its surface substantially tangent to said plane surface at a line parallel to and spaced from said edge a distance substantially equal to the radius of said cylindrical member, and means for rotating said cylindrical member, the edge of said socket remote from said plane surface constituting a scraping edge for cleaning the surface of said cylindrical member as it rotates.

5. An air doctor comprising two throat-forming members the opposed surfaces of which define a throat, said members terminating in lips defining a relatively long narrow rectilinear slot, at least one of said opposed surfaces terminating in an edge adjacent said slot, a curved surface external to said throat and adjacent said edge provided by a cylindrical member mounted to rotate on an axis parallel to said edge, means for rotating said cylindrical member, and means associated with said cylindrical member for cleaning the surface thereof, said cylindrical member being substantially tangent to the outer surface of said throat-forming member at a line parallel to and at a substantial distance from said edge.

6. An air doctor comprising two throat-forming members the opposed surfaces of which define a throat, said members terminating in lips defining a relatively long narrow rectilinear slot, at least one of said lips having a curved surface external to said throat and adjacent to said slot provided by a cylindrical member rotatably mounted on an axis parallel to said slot, means for rotating said cylinder and means rigidly associated with said throat-forming member and spaced apart from said slot for cleaning the surface of said cylindrical member.

7. An air doctor as defined in claim 6 in which the means for cleaning the cylindrical surface is an integral part of the throat-forming member having the curved surface.

FAUNCE C. WOODWARD.