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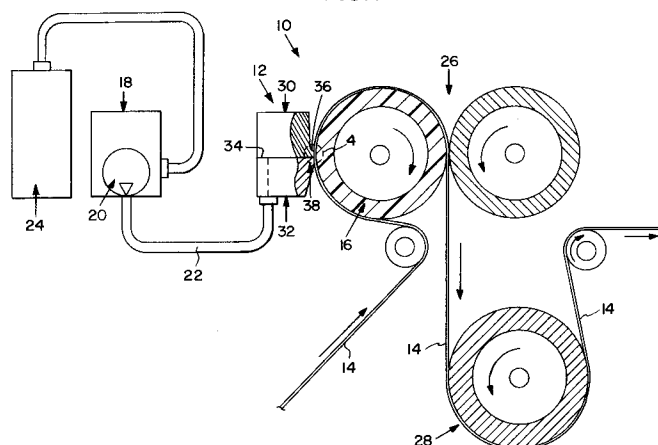
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D-28195 Bremen (DE)(54) **Slot coating die configuration.**

(57) A new and useful configuration for a slot coating die is provided, which is designed to apply a substantially streakless coating of a hot melt material (e.g., hot melt varnish) to a moving substrate such as a web of printed label stock. The coating die is specially configured to (i) provide a substantially smooth, streakless coating of a hot melt material onto a moving substrate, and (ii) allow small particles in the hot melt material to be released from the coating die and the web so that the particles should not accumulate in the coating die or cause streaking of the coating. The coating die has an upper lip (36), a lower lip (38), and a slot (34) disposed between the upper and lower lips. The upper lip (36) is undercut (or offset) relative to the lower lip (38), and has a front face which is configured to form (i) a wiping surface (60), (ii) a release surface (62) which extends beyond the wiping surface (60) and curves away from the moving substrate, and (iii) a relief surface (64) which extends from the slot (34) to the wiping surface. During operation of the slot coating die, hot melt material is extruded through the slot (34), and the configuration of the upper die member (i) guides the hot melt material in the direction of movement of the substrate and toward the wiping surface, (ii) gently wipes the hot melt material to a smooth, streakless state, and (iii) enables small particles in the hot melt material to be released from the slot coating die in a manner designed to avoid accumulation of particles in the coating die and/or streaking of the coating.

FIG. 1**EP 0 650 769 A1**

Technical Field

The present invention relates generally to a slot coating die for applying a coating of hot melt material to a moving substrate, and particularly to a slot coating die for applying a substantially streakless coating of hot melt varnish to a web of printed label stock.

Background

In an earlier application (Serial No. 08/005,237 filed January 15, 1993 for "System and Method for Applying a Desired, Protective Finish to Printed Label Stock) which is assigned to the assignee of the present invention, a method and apparatus are disclosed for applying a coating of hot melt varnish to a moving web of printed label stock. The method and apparatus utilize a slot coating die for applying the hot melt varnish to the web of printed label stock. The preferred slot coating die disclosed in that application is a Nordson model EP-51-2 slot coating die.

The Nordson model EP-51-2 slot coating die is believed to be effective for applying a substantially streakless coating of hot melt varnish to a web of moving label stock for significant periods of time. The slot coating die has upper and lower lips and a slot formed between the upper and lower lips. The hot melt varnish is extruded through the slot and onto the printed side of the web of printed label stock. The upper lip has a distal edge that functions as a doctor blade to wipe the varnish coating to a substantially smooth, streakless state as the web of printed label stock leaves the slot coating die.

Summary of the Present Invention

The present invention discloses an improved configuration for a slot coating die, to further enhance its ability to apply a substantially streakless coating of a hot melt material (e.g., hot melt varnish) to a moving substrate such as a web of printed label stock. Specifically, in a label coating system with the Nordson model EP-51-2 slot coating die, the hot melt varnish is extruded through the slot (in a direction which is generally perpendicular to the web) and onto the web. The distal edge of the upper lip has a relatively sharp (knife-like) configuration, and is located closely adjacent the web, in order to wipe (or scrape) the coating to a substantially smooth, streakless state. However, over time small particles in the varnish may accumulate near the distal edge of the upper lip. Those particles, if not periodically removed, could cause streaking of the coating. In order to remove the particles, it is necessary to interrupt the coating operation, and to back the slot coating die away from the substrate, to clear such particles.

The present invention provides a slot coating die specially configured to (i) apply a substantially smooth, streakless coating of a hot melt material to a moving substrate, and (ii) allow small particles in the hot melt material to be released from the coating die and the moving substrate in a manner designed to minimize (or eliminate) the need to interrupt the coating process to clean such particles from the coating die and to avoid streaking of the coating.

According to the invention, the coating die has an upper lip, a lower lip, and a slot disposed between the upper and lower lips. The substrate moves progressively past the coating die (i.e., the substrate moves progressively past the lower lip, the slot, and the upper lip of the coating die). A layer of hot melt material (e.g., hot melt varnish) is extruded through the slot and applied to the substrate, as the substrate moves progressively past the slot coating die. The upper lip is configured to (i) at least partially guide the hot melt material to flow in the direction of movement of the substrate, (ii) gently wipe the hot melt material to a substantially smooth state as the substrate moves progressively past the coating die, and (iii) enable small particles in the coating material to be released from the slot coating die in a manner designed to avoid accumulation of those particles in the coating die and to avoid streaking of the coating.

According to a preferred embodiment, the upper lip of the slot coating die has a front face which is configured to define (i) a wiping surface, (ii) a relief surface extending between the slot and the wiping surface, and (iii) a release surface which extends beyond the wiping surface and curves away from the moving substrate. The relief surface and the wiping surface are configured to (i) at least partially guide coating material extruded through the slot in the direction of movement of the substrate and (ii) gently wipe the coating to a substantially smooth state. The release surface is configured to enable small particles in the hot melt material be gently released from the slot coating die. Those particles may remain as relatively harmless specks on the coating, but since they do not accumulate in the slot coating die, they are unlikely to cause streaking of the coating.

A slot coating die according to the present invention is particularly useful in applying a coating of hot melt varnish to a web of printed label stock, in a system according to application Serial No. 08/005,237 filed

January 15, 1993 for "System and Method for Applying a Desired, Protective Finish to Printed Label Stock".

Further, features of the present invention will become further apparent from the following detailed description and the accompanying drawings.

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Brief Description of the Drawings

Figure 1 is a schematic illustration of a portion of a printed label coating station, with a slot coating die constructed according to the principles of the invention;

10 Figures 2 and 3 are cross sectional views of the upper die member according to the invention, taken along the lines 2-2 and 3-3 of Figure 5;

Figure 4 is an enlarged view of the area 4-4 of the slot coating die of Figure 1, and schematically illustrating the manner in which particles are released from the slot coating die as the varnish is being wiped to a smooth, streakless state; and

15 Figure 5 is a bottom view of the upper die member of Figures 2 and 3.

Detailed Description of the Preferred Embodiment

As discussed above, a slot coating die according to the present invention is particularly useful in a system for applying a hot melt varnish to a web of printed label stock. Application Serial No. 08/005,237, filed January 15, 1993 entitled "System and Method for Applying a Desired, Protective Finish to Printed Label Stock", and assigned to the assignee of the present invention, discloses a printed label coating system which can advantageously utilize a slot coating die according to the present invention, and that application is incorporated herein by reference.

25 As illustrated in Figure 1, a label coating station 10 includes a slot coating die 12 which is adapted to apply a coating of hot melt varnish to a web 14 of printed label stock. A transfer roll 16 engages the unprinted side of the web 14 of printed label stock, and carries the web 14 of printed label stock at a relatively constant speed past the slot coating die 12. As the web 14 of printed label stock is carried past the slot coating die 12, hot melt varnish is extruded through the slot coating die 12 and applied as a coating 15 (Figure 4) to the printed side of the web 14 of printed label stock. The slot coating die 12 is configured in accordance with the present invention and oriented relative to the transfer roll 16 such that a substantially streakless coating of hot melt varnish is applied to the printed side of the web 14 being moved by the transfer roll 16 past the slot coating die 12.

The label coating station 10 also includes (i) a hot melt applicator tank 18 in which the varnish is melted to a substantially liquid (molten) state, (ii) a positive displacement, metering gear pump 20 which is located in the manifold of tank 18 and which pumps a metered amount of the melted varnish from the hot melt applicator tank 18, and (iii) a flexible conduit 22 which directs the molten varnish to the slot coating die 12. The metering gear pump 20 can be driven at a substantially constant speed, to pump a metered amount of molten varnish, at a substantially constant flow rate, to the slot coating die 12. The speed of the metering gear pump 20 can be selectively changed, to change the rate of flow of varnish to the slot coating die 12. A metering device (not shown), of a type which is well known for metering hot melt adhesives, can be placed in the flexible conduit 22 which directs the molten varnish to the slot coating die 12, to further meter the amount of molten varnish directed to the slot coating die 12. Preferably, the hot melt applicator tank 20 comprises a Nordson Model 6000 hot melt applicator tank, which is a known type of hot melt applicator tank for use with hot melt adhesives. Further, a combined drum melter/drum unloader 24, also of known construction for use with hot melt adhesives, may be provided, if desired, for feeding a supply of the hot melt varnish from a storage drum (not shown) to the hot melt applicator tank 18.

The thickness of the coating 15 of hot melt varnish applied to the web 14 is determined by factors such as (i) the flow rate of varnish from the metering gear pump 20 to the slot coating die 12, (ii) the speed at which the web 14 is moved past the slot coating die 12, and (iii) the spacing between the slot coating die 12 and the web 14. The thickness of the coating 15 of varnish can be readily adjusted by changing (i) the flow rate of varnish from the metering gear pump 20 to the slot coating die 12, (ii) the speed at which the web 14 is moved past the slot coating die 12, and to a lesser extent (depending upon the porosity of the web), (iii) the spacing between the slot coating die 12 and the web 14.

55 After the coating 15 of hot melt varnish is applied to web 14, the coating is processed in accordance with the system and method of application Serial No. 08/005,237, filed January 15, 1993, and entitled "System and Method for Applying a Desired, Protective Finish to Printed Label Stock". Specifically, the web 14 is wrapped substantially about the transfer roll 16, and is transferred by the transfer roll 16 from the

slot coating die 12 through a working station 26 at which the coating of varnish is worked to a smooth, glossy finish. The web 14 is then transferred to a finishing station 28 at which the glossy finish is fixed in the coating of varnish and the web is conditioned to a state in which it can be processed as finished label stock. In the finished label stock, the coating of varnish (i) provides a desired glossy finish to the web of printed label stock, (ii) protects the web of printed label stock from damage or deterioration from ambient conditions, and (iii) protects the web of printed label stock from scratches or abrasions. Moreover, if the label stock is used in certain types of packaging (e.g., food packaging), the coating may also provide a barrier which resists passage of odors through the packaging.

The slot coating die 12 comprises an upper die member 30, a lower die member 32, and a slot 34 formed between the upper and lower die members (see Figures 1, 4). The upper and lower die members are made of tool steel, preferably type P-20 tool steel. The slot coating die 12 has a mouth comprising an upper lip 36 formed in one piece with the upper die member 30 and a lower lip 38 formed in one piece with the lower die member 32. The slot 34 extends between the upper and lower lips 36, 38. The lower lip 38 has a front face 40 which faces and is closely spaced from the printed side of the web 14 being carried by the transfer roll 16. The upper lip 36 has a front face 42 which faces and is closely spaced from the printed side of the web 14 being carried by the transfer roll 16.

As illustrated in Figures 1 and 4, the transfer roll 16 moves the web 14 progressively past the lower lip 38, the slot 34 and the upper lip 36 as it moves the web 14 past the slot coating die 12. The slot 34 is configured to enable hot melt varnish, in a molten state, to be extruded therethrough at a predetermined flow rate and pressure. The front faces 42, 40 of the upper and lower lips are specially configured, in accordance with the principles of this invention, to (i) at least partially redirect (or guide) the varnish to flow in the direction of movement of the web 14, and (ii) shape the hot melt varnish into a substantially smooth, streakless coating on the web 14, and (iii) enable small particles in the varnish to be released from the slot coating die 12, as the web moves past the slot coating die 12.

The hot melt varnish which is extruded through the slot coating die 12 is preferably a hot melt varnish material made by Swift Adhesives, 3100 Woodcreek Drive, P. O. Box 1546, Downers Grove, Illinois 60515 and having the product designation 2H195. The hot melt varnish (i) is substantially solid at ambient temperature, (ii) has a softening point of about 230 ° F, (iii) can be melted to a substantially liquid state and extruded through the slot coating die 12 and onto the web 14 at about 350 ° F. Moreover, the hot melt varnish will partially solidify to a predetermined state after being applied to the web 14 and transferred a predetermined distance on the web 14 in a substantially ambient atmosphere by the transfer roll 16, in accordance with the principles of U.S. application serial No. 07/005,237.

The web 14 is wrapped around a substantial portion of the transfer roll 16, (e.g. from about 220 ° to about 270 ° about the transfer roll 16) with the unprinted side of the web 14 in contact with the transfer roll 16. The slot coating die 12 is tilted in a slightly downward direction (e.g., at a tilt angle ϕ relative to a horizontal line extending through the axis of rotation of the transfer roll 16) so that molten varnish is extruded through the slot die 12 in a direction which is oriented slightly downward relative to the direction of movement of the web 14 being carried by the transfer roll 16. The transfer roll 16 is positively rotated at a selected speed by known drive means (not shown), to move the web 14 past the slot coating die 12 at a predetermined constant speed. The speed of rotation of the transfer roll 16 can be selectively changed, to change the speed at which the web 14 is moved past the slot coating die 12.

The slot coating die 12 is coupled to bracketry of known construction, e.g., Nordson model "NT" bracketry (not shown), which allows the slot coating die 12 to be supported and maintained at a predetermined distance from the web 14, and at a predetermined tilt angle ϕ relative to the web 14. Specifically, the lower die member 32 is coupled to the "NT" bracketry, by coupling means which are well known to those in the slot coating art. The upper die member 30 is aligned with, and coupled to, the lower die member 32 by means of (i) dowels (not shown) which are conventional and fit into respective dowel holes in the die members (see e.g., dowel holes 50 in Figure 5) and align the die members, and (ii) fasteners (not shown) which are conventional and extend through bores in the die members (in Figures 3 and 5 see e.g., bores 52 in the upper die member 30) and couple the die members together. Moreover, it is contemplated that shims (not shown but of known construction), would be used to define the spacing between the die members, in order to define the width of the slot 34. Still further, the upper die member 32 has threaded bores 54 (Figures 2 and 5) which receive set screws, of known construction, to clamp the die members together.

According to the present invention, the front face 42 of the upper lip 36 is configured to form the hot melt varnish into to a smooth, streakless coating on the web 14, while allowing small particles in the varnish to be released from the coating die 12 without causing streaking of the coating. Specifically, the front face 42 of the upper lip 36 is configured to define (i) a wiping surface 60, (ii) a release surface 62 which curves

away from the wiping surface 60 and away from the web 14, and (iii) a relief surface 64 extending from the slot 34 to the beginning of the wiping surface 60. Preferably, the relief surface 64 is substantially straight and extends generally along a tangent to the transfer roll 16. The wiping and release surfaces comprise successive regions of a curved surface which begins at the end of the relief surface 64, and has a predetermined radius of curvature R_1 . The region of the curved surface which forms the wiping surface 60 begins at the end of the relief surface and is closely spaced from the web 14. The remainder of the curved surface, which forms the release surface 62, curves away from the wiping surface 60 and away from the web 14.

In the preferred embodiment, the lower edge 70 of the relief surface 64 is adjacent the slot 34. The upper edge 72 of the lower lip 38 is also adjacent the slot 34. The lower edge 70 of the relief surface 64 is offset (or undercut) relative to the upper edge 72 of the lower lip 38. The relief surface 64 extends from the lower edge 70 toward the wiping surface 60 at a relief angle θ of up to about 2° . Thus, the relief surface 64 cooperates with the moving web 14 to define a channel 66 which converges toward the wiping surface 60. That channel at least partially redirects (or guides) the hot melt varnish extruded through the slot 34 in the direction of movement of the web 14 and toward the wiping surface 60 during the coating process.

The front face 40 of the lower lip 38 extends downward away from the upper edge 72. The upper edge 72 is not in contact with the web 14, but is located close enough to the web 14 to block flow of hot melt varnish past the lower die member 32. The remainder of the front face 40 is offset (or undercut) to extend away from the transfer roll 16, to provide an inlet through which the web 14 is guided into proximity with the coating die 12.

As illustrated in Figure 4, during operation of the slot coating die 12, hot melt varnish is extruded through the slot 34 and is formed by the coating die 12 into a smooth, streakless coating on the moving web 14. Specifically, the coating die 12 is tilted slightly downward at a small angle $\emptyset$ (toward the direction of movement of the web 14). The lower lip 38 is located so that its upper edge 72 does not contact the web 14, but is close enough to the web 14 to block flow of hot melt varnish past the lower lip 38. The configuration of the upper lip 36 at least partially redirects (or guides) the hot melt varnish in the direction of the moving web 14 and toward the wiping surface 60. The wiping surface 60 lightly contacts the hot melt varnish, and gently wipes the varnish to a substantially smooth, streakless state. The release surface 62 gently curves away from the wiping surface 60 and away from the web 14, so that small particles in the varnish pass through the die, and can be released from the slot coating die 12. Thus, the particles pass through the die and become relatively harmless specks on the coating, but they do not accumulate in the slot coating die, and require interruption of the coating process to clean the slot coating die, or cause streaking of the varnish coating.

As discussed above, a slot coating die constructed according to the principles of the present invention is particularly useful in a system for coating a web of printed label stock with a layer of hot melt varnish. An example of such a system would have the following configuration:

5	Transfer Roll	A Steel Roll with Silicon Cover
	Transfer Roll Diameter	6.0"
	Hot Melt Varnish	Swift Adhesives' Type 2H195-01E
	Web Wrap (about Transfer Roll)	220 ° F.
	Die Angle $\varnothing$	tilted downward at an angle of approximately 3.0 °
	Shim Thickness	0.010"
10	Upper Die Lip Offset (or undercut)	approximately 0.005"
	Radius of Rounded Portion of Upper Lip	0.236"
	Linear distance L_1 from slot to end of rounded portion	0.315"
15	Linear distance L_2 from slot to beginning of wiping surface	0.139"
	Coating Thickness	0.001" - 0.0015"
	Web	Printed Foil Label Stock or Printed Paper Label Stock
	Extrusion Temp of Varnish	350 ° F
20	Web Speed	25-300 FPM
	Flow Rate of Varnish	approximately 5-80 lbs/hr.
	Relief Angle θ	2.0 °

25 The foregoing example illustrates a slot coating die configuration which is particularly useful in connection with the preferred hot melt varnish, and a web being carried by a transfer roll having a 6.0" radius. Certain features of the slot die configuration such as (i) the radius of the rounded portion, (ii) the linear distance L_1 from the slot to the end of the rounded portion, (iii) the linear distance L_2 from the slot to the beginning of the wiping surface, (iv) the slot coating die tilt angle, (v) the relief angle θ , and (vi) the extent of the upper die lip offset (or undercut) are related to each other, to allow for proper release of small particles from the slot coating die as the coating is being wiped to a substantially smooth finish. The specific relationship of those components may change with respect to each other, with changes in the size of the transfer roll, the type of hot melt varnish, etc.

30 Of course, while the foregoing example of a slot coating die system is useful in coating printed label stock, modifications are contemplated. For example, the transfer roll could be formed of chrome. Moreover, the substrate, the printed label stock or other types of products could be formed of a material such as polyethylene. Additionally, while the slot coating die is located at about a nine o'clock position and in a generally horizontal orientation to the transfer roll (which is a common location and orientation), the die can be located at different positions about the periphery of the transfer roll. Still further, the relief surface 64 of the upper lip could be slightly curved, rather than straight. Additionally, other hot melt materials such as an EVA (ethylene vinyl acetate) or a polyethylene type could be used. Still other modifications of the principles of the present invention, for applying hot melt coatings to various substrates, will be further apparent to those in the slot coating arts.

45 Claims

1. Apparatus comprising a slot coating die and a means for moving a substrate past the slot coating die; said slot coating die being adapted to apply a coating of a hot melt material to the substrate as the substrate is moved past the slot coating die and comprising an upper lip, a lower lip, and a slot disposed between said upper and lower lips; said substrate being moved progressively past said lower lip, said slot, and said upper lip of said slot coating die as said substrate is moved past said slot coating die, and said upper lip of said slot coating die being configured to wipe the coating to a substantially smooth finish while allowing small particles in the coating material to be released from the coating die as the coating is being wiped to the substantially smooth finish.
2. Apparatus as set forth in claim 1, wherein said upper lip is configured to define a wiping surface which wipes the coating to a substantially smooth finish, and a release surface which extends beyond said wiping surface and away from said web, said release surface being configured to enable small particles

in the coating material to be released from the slot coating die as the coating is being wiped to the substantially smooth finish.

- 5 3. Apparatus as set forth in claim 2, wherein said upper lip is configured to define a relief surface which extends between said slot and said wiping surface, said slot being configured to extrude hot melt material toward said substrate, and said relief surface being configured to at least partially guide hot melt material extruded through said slot toward said wiping surface.
- 10 4. Apparatus as set forth in claim 3, wherein said lower lip has an upper edge which is adjacent the slot and which is configured to block flow of hot melt material past the lower lip during coating of the substrate, and wherein said relief surface has a lower edge adjacent said slot, said lower edge of said relief surface having a predetermined offset relative to the upper edge of said lower lip.
- 15 5. Apparatus as set forth in claim 4, wherein said relief surface converges from said lower edge of said upper lip toward said wiping surface at a predetermined relief angle.
6. Apparatus as set forth in claim 5, wherein said release surface curves away from said wiping surface and said web at a predetermined radius of curvature.
- 20 7. Apparatus as set forth in claim 6, wherein the radius of curvature of said release surface is related to (i) the linear distance L_1 from the slot to the end of the release surface, (ii) the linear distance L_2 from the slot to the beginning of the wiping surface, (iii) said predetermined offset between the lower edge of said relief surface and said upper edge of said lower lip, and (iv) said predetermined relief angle, to allow small particles in the coating material to be released from the coating die as the coating is being
25 wiped to the substantially smooth finish.
8. Apparatus as set forth in claim 7, wherein said wiping surface and said release surface comprise successive regions of a curved surface having a single radius of curvature.
- 30 9. Apparatus as set forth in any of claims 1-8, wherein said hot melt material comprises a hot melt varnish.
10. Apparatus as set forth in claim 4 wherein said relief surface converges from said lower edge of said upper lip toward said wiping surface at a relief angle of about 2° .

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FIG. 1

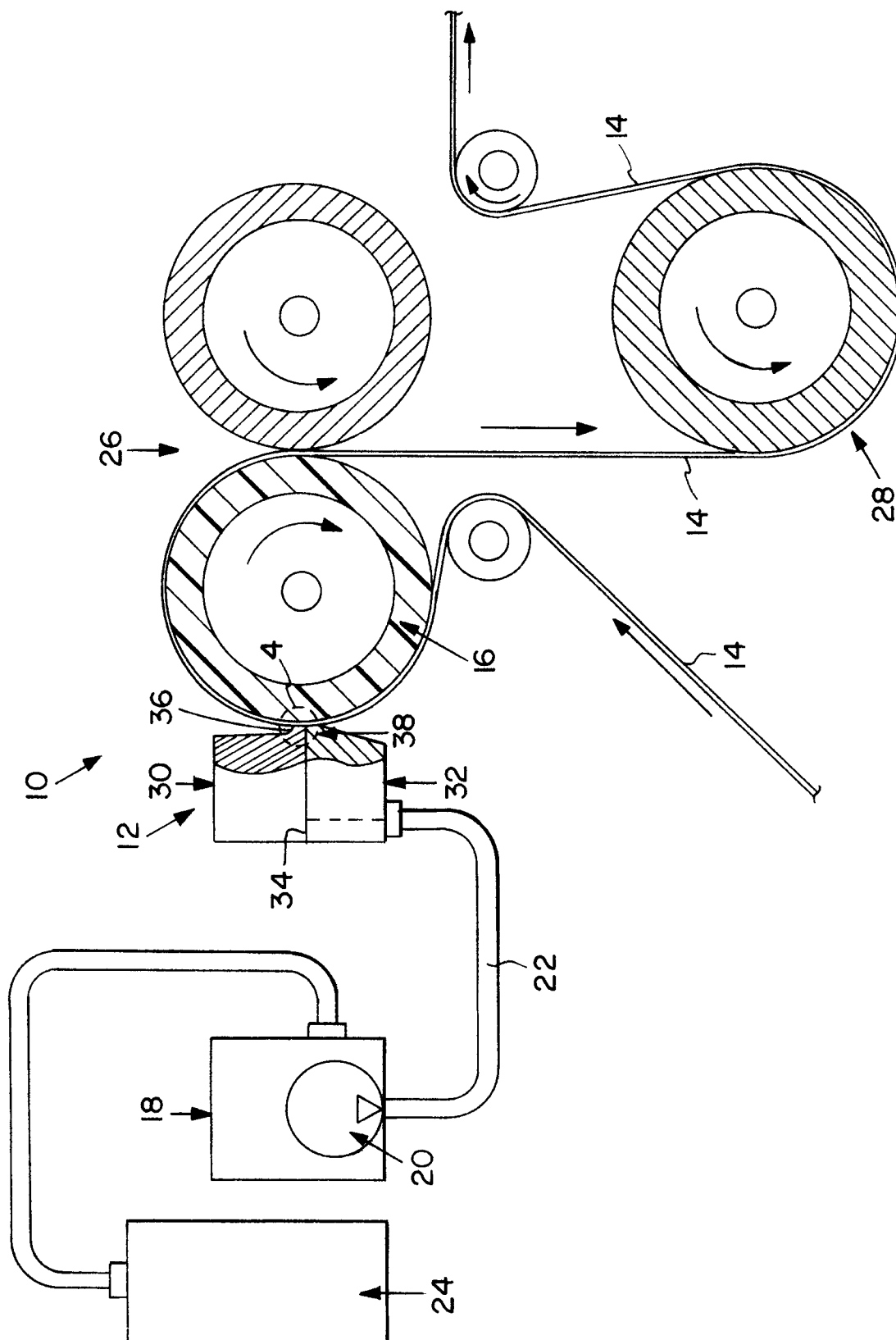


FIG. 2

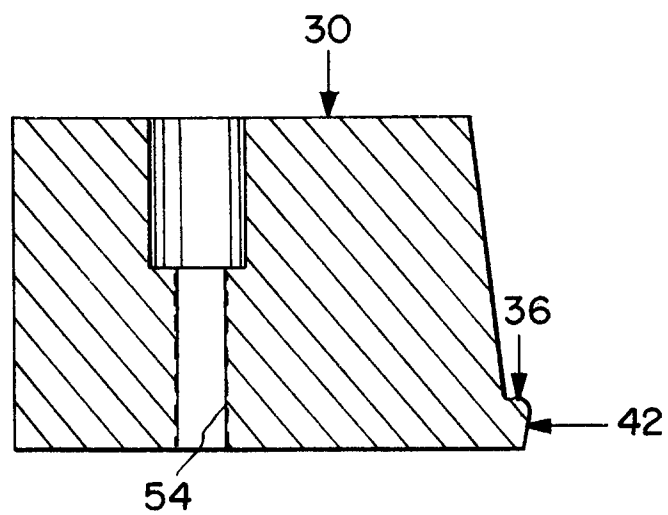
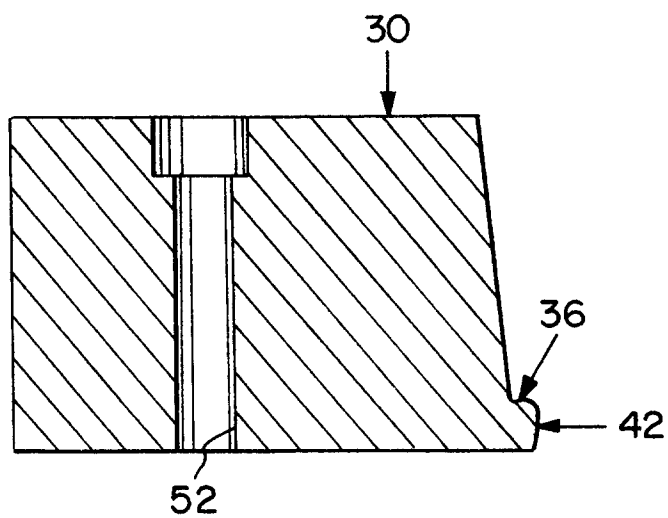
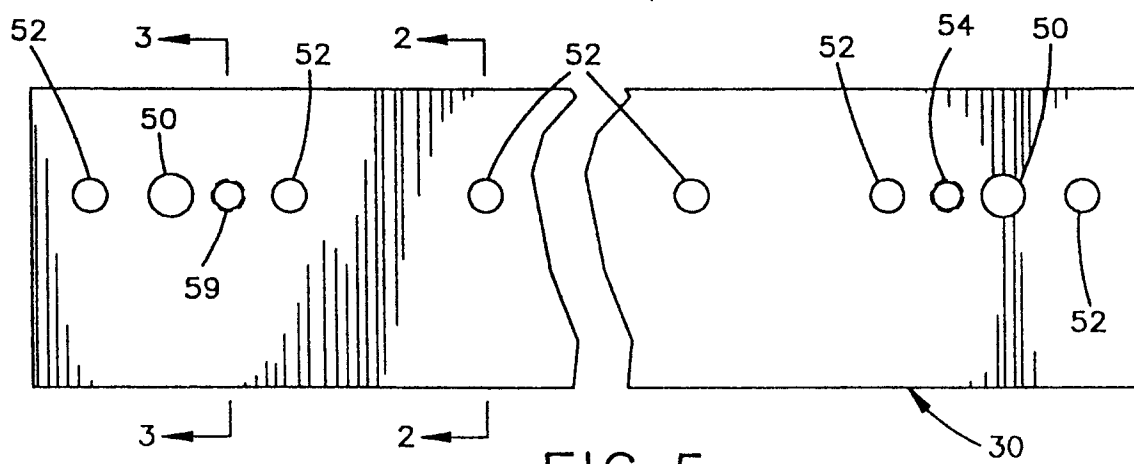
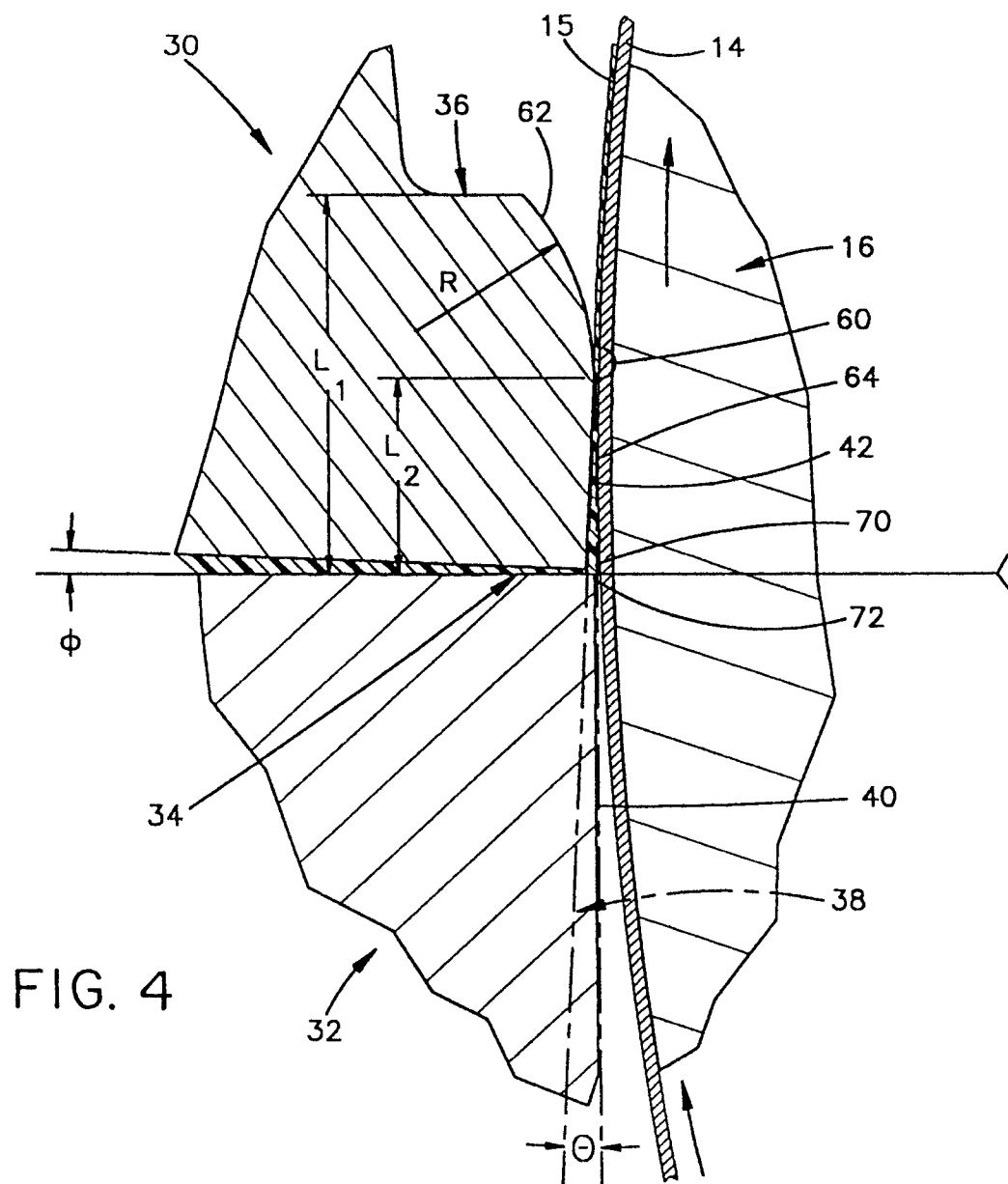


FIG. 3







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Application Number
EP 94 11 5809

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A A	US-A-4 299 186 (PIPKIN ET AL.) * column 3, line 19 - line 66; figure 1 * --- EP-A-0 025 007 (ACUMETER LABORATORIES) * the whole document * -----	1-7 8-10 1	B05C5/02
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B05C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 6 February 1995	Examiner Guastavino, L
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