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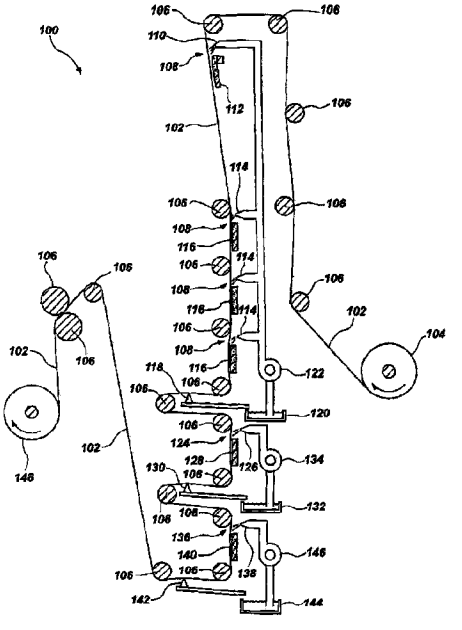
(54) **Titre : PROCEDE ET SYSTEME POUR ENLEVER L'ENCRE DE FILMS**
(54) **Title: METHOD AND SYSTEM FOR REMOVING INK FROM FILMS**



(57) **Abrégé/Abstract:**
A method of removing ink from a film includes unrolling the film from a first roll, exposing the film to a cleaning composition, and scraping the cleaning composition from the film. The film and the cleaning composition pass adjacent a first nonabrasive cloth to spread the cleaning composition over a width of the film, and adjacent at least one additional nonabrasive cloth to remove the ink from the film. The film may be polymeric, metallic, or a metalized polymer. A system includes a means for unrolling a film, at least one nozzle configured to expose the film to a cleaning composition, and a blade configured to scrape the cleaning composition from the film. The system also includes a first nonabrasive cloth configured to spread the cleaning composition over a width of the film, and at least one additional nonabrasive cloth configured to scrub the ink from the film.

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(54) Title: METHOD AND SYSTEM FOR REMOVING INK FROM FILMS

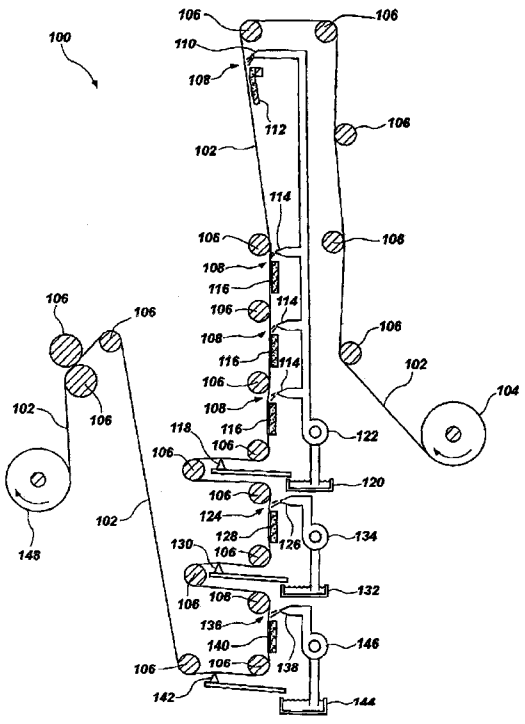

FIG. 1

(57) Abstract: A method of removing ink from a film includes unrolling the film from a first roll, exposing the film to a cleaning composition, and scraping the cleaning composition from the film. The film and the cleaning composition pass adjacent a first nonabrasive cloth to spread the cleaning composition over a width of the film, and adjacent at least one additional nonabrasive cloth to remove the ink from the film. The film may be polymeric, metallic, or a metalized polymer. A system includes a means for unrolling a film, at least one nozzle configured to expose the film to a cleaning composition, and a blade configured to scrape the cleaning composition from the film. The system also includes a first nonabrasive cloth configured to spread the cleaning composition over a width of the film, and at least one additional nonabrasive cloth configured to scrub the ink from the film.

WO 2014/096926 A1

WO 2014/096926 A1

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METHOD AND SYSTEM FOR REMOVING INK FROM FILMS

PRIORITY CLAIM

This application claims the benefit of the filing date of United States Patent Application Serial No. 13/725,817, filed December 21, 2012, for "Method and System for Removing Ink From Films".

FIELD

Embodiments of the disclosure relate to chemical processing, such as the processing of flexible films (*e.g.*, polyethylene, polypropylene, polyvinyl chloride, aluminum, and other films) used for packaging or labeling.

BACKGROUND

Polymeric, metallic, and metalized polymeric films have various properties that make them useful as packaging or labeling materials. For example, such films may be lightweight, strong, impervious to liquids and gases, transparent, printable, flexible, foldable, fusible, and/or heat-shrinkable. Films are commonly formed into sheets and rolled for processing, transport, and storage.

Films may be printed with various inks to provide information, decoration, *etc.* For example, rolls of polymeric films may be printed by unrolling the film, subjecting the unrolled film to a corona treatment (surface modification by exposure to a low-temperature plasma), applying an ink to the treated film, and rolling the film to another roller. Printing typically occurs in high-speed printing machinery, which may be capable of processing 100 linear feet (30.4 meters) per minute of plastic film or more.

Errors in printing (*e.g.*, typographical errors in labels, overruns, alignment errors, incorrect colors, *etc.*) can be costly because large quantities of film may be processed before an error is identified and printing is interrupted. Higher-speed printing equipment is desirable in the industry because it allows for higher outputs; but higher-speed printing may correspond to larger quantities of misprinted films when errors are made. Misprinted films are typically sold as scrap for a small fraction of the price of virgin film. Such films may be melted and recycled, but this process may be

costly and environmentally problematic. Thus, printing errors can be costly and disruptive, particularly when they occur with high-speed printing equipment.

Various attempts have been made to develop methods of effectively removing ink from films. For example, European Patent Specification EP 1 414 829 A1, published May 19, 2004, and titled "Procédé de recyclage de support d'impression imprimé de type film plastique et installation pour la mise en oeuvre dudit procédé," describes a de-inking process in which a plastic film is simultaneously or sequentially immersed in a detergent composition and scrubbed with brushes. International Patent Application Publication WO 95/09256, published April 6, 1995, and titled "Treatment of Surfaces by Corona Discharge," describes a surface-cleaning process that may be used for metallic sheets or foils. An electric discharge is used to remove grease or oils from such metallic films. International Patent Application Publication WO 2006/028263 A1, published March 16, 2006, and titled "Erasable Ink, Method of Erasing Image Including the Same, and Method of Recycling Recording Medium Using the Erasing Method," describes an erasable ink that may be printed onto a recording medium. The ink may be removed from the recording medium by exposure to an oxidizing gas, such as that generated by a corona discharge. U.S. Patent 5,621,939, issued April 22, 1997, and titled "Apparatus for Regenerating Recording Medium," describes methods for removing toner from sheets of overhead projector film by immersing the sheet in a cleaning liquid to swell the toner, then removing the swollen toner with a brush or cloth belt. The sheets are then dried, heated, and calendered.

DISCLOSURE

Described is a method of removing ink from a flexible film. The method includes removing the film from a first roll and feeding the film a processing system, exposing the film to a cleaning composition, and scraping the cleaning composition from the film. The method includes passing the film and the cleaning composition adjacent a first nonabrasive cloth to spread the cleaning composition over a width of the film, and passing the film and the cleaning composition adjacent at least one additional nonabrasive cloth to scrub the ink from the film before scraping the cleaning composition from the film. The method may be operated continuously to clean an entire roll of flexible film.

A system for removing ink from a flexible film includes a means for removing the film from a first roll and feeding the film into the system, at least one nozzle configured to expose a first side of the film to a cleaning composition, and a blade configured to scrape the cleaning composition from the first side of the film. Such a system includes a first nonabrasive cloth configured to spread the cleaning composition over a width of the first side of the film, and at least one additional nonabrasive cloth configured to scrub the ink from the first side of the film before scraping the cleaning composition from the film. Such a system further typically includes means for continuously rolling the film back into a roll after ink removal, but may alternatively include a means for reprinting the film after ink removal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified schematic illustrating a system and process for removing ink from a film;

FIG. 2 is an enlarged detail view of a portion of FIG. 1; and

FIG. 3 shows a detail of a nonabrasive cloth of the system shown in FIG. 1.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

Processes and machines for removing ink from flexible films, as disclosed herein, include unrolling the film from a first roll, exposing the film to a cleaning composition, scraping the cleaning composition from the film, and rolling the film onto a second roll. The process includes passing the film and the cleaning composition adjacent a first nonabrasive cloth and passing the film and the cleaning composition adjacent at least one additional nonabrasive cloth before scraping the cleaning composition from the film. The nonabrasive cloths spread the cleaning composition and/or scrub the ink and cleaning composition from the film.

As used herein, the term "film" means and includes a polymeric, metallic, or metalized polymeric material having a thickness of less than about 1 mm and a width of at least about 10 cm. Polymeric films that may be used in the processes disclosed herein include, for example, polyester (*e.g.*, bi-axially oriented polyethylene terephthalate (BOPET)), polyethylene (*e.g.*, high density polyethylene (HDPE), low density polyethylene (LDPE), or ethylene vinyl alcohol polyethylene resin (EVOH

PE)), polypropylene (*e.g.*, oriented polypropylene (OPP), bi-axially oriented polypropylene (BOPP) or cast polypropylene (CPP)), polyvinyl chloride (PVC), *etc.* Metallic films that may be used in the processes disclosed herein include, for example, aluminum, copper, or tin. Metalized polymer films that may be used in the processes disclosed herein include, for example, polymer films coated with a thin layer of metal (*e.g.*, aluminum).

As used herein, the term "flexible" means and includes capable of being bent or flexed repeatedly without structural damage. For example, a continuous flexible material may be routed along rollers in a continuous process, and the rollers may bend the flexible material, such that different portions of the flexible material are each travelling in different directions simultaneously.

As used herein, the term "ink" means and includes an opaque or translucent material formulated to bond to a film. Inks include, for example, solvent-based inks, water-based inks, electron-beam-curing inks, ultraviolet-curing inks, and two-part inks.

A simplified (side view) schematic of a system 100 for removing ink from a flexible film 102 is shown in FIG. 1, and the system 100 also illustrates a method of removing ink. In the system 100, the film 102 is unrolled from a first roll 104. The film 102 passes over, under, or between rollers 106, which are configured to allow the film 102 to continuously pass through the system 100 during the ink-removal process. The rollers 106 are also configured to direct the film 102 through the system 100 and to maintain tension on the film 102 while the film 102 is processed. The rollers 106 direct the film 102 upward, and a pair of rollers 106 bend the film such that the film is traveling downward during the ink removal.

As shown in FIG. 2, which is an enlarged detail view of a portion of FIG. 1, a cleaning composition 108 is applied to the film 102 through a first set of nozzles 110, typically after the film 102 has passed over, under, or between two or more rollers 106 to bring the film 102 to a location near the nozzles 110. The first set of nozzles 110 may include one or more rows of nozzles evenly spaced across a width of the film 102, but may alternatively be a single channel opening adjacent to the film 102. The nozzles 110 may be formed of a material selected to avoid corrosion upon exposure to the cleaning composition 108, or may be coated with a material selected to avoid corrosion. For example, the nozzles 110 may be coated with polyurethane or may be

formed of a ceramic. In some embodiments, the nozzles 110 may include an array of nozzles, each typically having a diameter of less than about 1 mm, less than about 500 μm, or even less than about 200 μm.

The cleaning composition 108 is spread across the width of the film 102 by a first nonabrasive cloth 112 or other soft material. The first nonabrasive cloth 112 may be disposed adjacent the nozzles 110, such that the cleaning composition 108 is spread across the film 102 almost immediately after application of the cleaning composition 108 to the film 102. For example, the first nonabrasive cloth 112 may be disposed within ten (10) cm of the nozzle(s) 110, within five (5) cm of the nozzle(s) 110, or even within one (1) cm of the nozzle(s) 110. The first nonabrasive cloth 112 may be secured to a support or brace 113 such that a V-shaped space or air gap is formed between an upper portion of the first nonabrasive cloth 112 and the film 102, but a lower portion of the first nonabrasive cloth 112 rests against the film 102 with a thin layer of cleaning composition 108 therebetween. After the film 102 passes the first nonabrasive cloth 112, the cleaning composition 108 may be spread approximately uniformly across a width of the film 102. The width across which the cleaning composition 108 is spread may be the entire width of the film 102, or may be only a portion of the width of the film 102. For example, there may be portions at each edge of the film 102 over which the cleaning composition 108 is not spread, such as portions of the film 102 that do not have ink or portions of the film 102 on which the ink is to be retained. In some embodiments, a portion of the film 102 may remain uncoated with the cleaning composition 108 to limit or prevent contact of the cleaning composition 108 with the rollers 106.

The cleaning composition 108 may be a commercial or industrial cleaning composition having one or more of a surfactant, a terpene, water, a solvent, and an emulsifier. As used herein, the term "surfactant" means and includes a compound having both a hydrophobic group and a hydrophilic group. The surfactant may be an anionic, nonionic, cationic, amphoteric, or zwitterionic surfactant, or a combination thereof. Examples of surfactants include, but are not limited to, soaps, sulfonates, sulfates, carboxylates, phosphonates, phosphates, laurates, quaternary ammonium detergents, *etc.* In some embodiments, cleaning compositions including D-limonene may be used, such as those described in Great Britain Patent Specification 1 603 047,

published November 18, 1981, and titled "Cleansers Containing D-Limonene." The cleaning composition 108 may be selected to be free of abrasive material, which may limit or prevent scratching or tearing of the film 102 during the ink-removal process.

The first nonabrasive cloth 112 is typically a woven or nonwoven microfiber cloth. The first nonabrasive cloth 112 may be selected to limit or prevent scratching or tearing of the film 102 during the ink-removal process. For example, the first nonabrasive cloth 112 may be a cloth as described in European Patent Specification 1314808, granted January 4, 2006, and titled "Superfine microfiber nonwoven web." FIG. 3 shows a detail of the first nonabrasive cloth 112. The first nonabrasive cloth 112 may have loops or threads of material arranged in rows 300 with spaces or voids 302 between the rows 300. The first nonabrasive cloth 112 may be oriented in the system 100 (FIG. 1) such that the rows 300 and the spaces or voids 302 form parallel channels oriented parallel to the direction of travel of the film 102. Thus, as the film 102 passes the first nonabrasive cloth 112, a portion of the cleaning composition 108 may travel adjacent the first nonabrasive cloth 112 through the spaces or voids 302. In such an orientation, the rows 300 of material and the spaces or voids 302 of the first nonabrasive cloth 112 tend to spread the cleaning composition 108 into a relatively uniform coating on the film 102. If the cleaning composition 108 is applied to the film 102 across the entire width of the first nonabrasive cloth 112, the cleaning composition 108 tends to cover the entire portion of the film 102 passing over the first nonabrasive cloth 112.

Returning to FIG. 1, the cleaning composition 108 may be applied to the film 102 at a location at which the film 102 is traveling downward. In such an arrangement, the cleaning composition 108 flows down the film 102, driven both by the downward motion of the film 102 and by the force of gravity. The speed of the film 102, the distance between the first nonabrasive cloth 112 and subsequent processing features, and the viscosity of the cleaning composition 108 may be selected such that the film 102 is exposed to the cleaning composition 108 for a selected period of time. For example, the film 102 may be exposed to the cleaning composition 108 for a time period from about 0.1 s (second) to about sixty (60) s, such as from about one (1) s to about ten (10) s. The ability of the cleaning composition 108 to remove ink may depend on the time of exposure of the film 102 to the cleaning composition 108.

After the initial exposure of the film 102 to the cleaning composition 108, additional cleaning composition 108 may be applied to the film 102 through an additional set of nozzles 114 while the film 102 travels downward. The film 102 then passes adjacent to an additional nonabrasive cloth 116. The additional nonabrasive cloth 116 may be similar to the first nonabrasive cloth 112, described above, but may be disposed substantially parallel to the direction of travel of the film 102. For example, the additional nonabrasive cloth 116 may be wrapped partially around a block, and the film 102 may pass along a surface of the block. The additional nonabrasive cloth 116 scrubs ink from the film 102 as the film 102 passes the additional nonabrasive cloth 116.

Another portion of cleaning composition 108 (*e.g.*, a third portion of cleaning composition 108) may be applied to the film 102 through another set of nozzles 114 (*e.g.*, a third set of nozzles), which may be followed by another nonabrasive cloth 116. The sequence of cleaning composition 108 followed by a nonabrasive cloth 116 may be repeated as many times as necessary to sufficiently remove ink from the film 102. The film 102 may continue to travel in a generally downward direction during the application of the cleaning composition 108. For example, and as shown in FIG. 1, the system may include four sets of nozzles 110, 114, and four nonabrasive cloths 112, 116. The first nonabrasive cloth 112 may be configured primarily to spread the cleaning composition 108, and the additional nonabrasive cloths 116 may be configured primarily to remove (*e.g.*, scrub, rub, scrape, *etc.*) ink from the film 102.

After scrubbing ink from the film 102, a roller 106 bends the film 102 to a horizontal direction, and a stationary blade 118 scrapes the cleaning composition 108 and dislodged ink material from the film 102 into a collection vessel 120. With the film 102 in a horizontal orientation, the cleaning composition 108 and dislodged ink material may fall down the blade 118 and flow down an incline to the collection vessel 120. A pump 122 recycles the cleaning composition 108 back through the nozzles 110, 114. The collection vessel 120 or the pump 122 may include a means for separating ink material from the cleaning composition 108. For example, the collection vessel 120 may be large enough that ink material can settle from the cleaning composition 108 based on density. In some embodiments, the pump 122 may include a filter to remove ink material from the cleaning composition 108.

After scrubbing the film 102 with cleaning composition 108, the film 102 may be scrubbed again with another cleaning composition 124. One or more rollers 106 may bend the film 102 to a vertical direction traveling downward. The cleaning composition 124 is applied to the film 102 through a set of nozzles 126, followed by another nonabrasive cloth 128. The sequence of cleaning composition 124 followed by a nonabrasive cloth 128 may be repeated as many times as necessary to sufficiently remove ink from the film 102, and may be performed while the film travels substantially downward. For example, and as shown in FIG. 1, the system may include one set of nozzles 126, and one nonabrasive cloth 128.

A roller 106 bends the film 102 back to a horizontal direction, and another stationary blade 130 scrapes the cleaning composition 124 and dislodged ink material from the film 102 into a collection vessel 132. With the film 102 in a horizontal orientation, the cleaning composition 124 and dislodged ink material may fall down the blade 130 and flow down an incline to the collection vessel 132. A pump 134 recycles the cleaning composition 124 back through the nozzles 126. The collection vessel 132 or the pump 134 may include means for separating ink material from the cleaning composition 124. For example, the collection vessel 132 may be large enough that ink material can settle from the cleaning composition 124 based on density. In some embodiments, the pump 134 may include a filter to remove ink material from the cleaning composition 124.

The cleaning composition 124 may be similar to the cleaning composition 108, as described above. However, the cleaning composition 124 may be kept separate from the cleaning composition 108, such that as the film 102 passes through the system 100, the film 102 is contacted with progressively cleaner liquid. Because the film 102 has already been scrubbed to remove some of the ink before cleaning composition 124 is applied, the cleaning composition 124 may be kept cleaner than the cleaning composition 108 used for initial cleaning. After the system 100 has operated for a period of time, the cleaning composition 124 may used to replace all or a portion of the cleaning composition 108, and new cleaning composition (*e.g.*, virgin cleaning composition or a cleaning composition that has been purified) may be used to replace the cleaning composition 124.

After scrubbing the film 102 with cleaning composition 124, the film 102 may be rinsed with a solvent 136, such as an alcohol, an ether, a chlorinated solvent, water, or any combination thereof. For example, the solvent 136 is typically a liquid and may include isopropyl alcohol, methanol, ethanol, water, and/or deionized water. One or more rollers 106 may bend the film 102 again to a vertical direction traveling downward. The solvent 136 is applied to the film 102 through a set of nozzles 138, followed by another nonabrasive cloth 140. The sequence of solvent 136 followed by a nonabrasive cloth 140 may be repeated as many times as necessary to sufficiently remove ink and cleaning composition from the film 102, and may be performed while the film travels substantially downward. For example, and as shown in FIG. 1, the system may include one set of nozzles 138, and one nonabrasive cloth 140.

A roller 106 bends the film 102 back to a horizontal direction, and another stationary blade 142 scrapes the film 102 to remove the solvent 136, cleaning composition, and ink, which are collected in a collection vessel 144. With the film 102 in a horizontal orientation, the solvent 136, cleaning composition, and dislodged ink material may fall down the blade 142 and flow down an incline to the collection vessel 144. A solvent pump 146 recycles the solvent 136 back through the nozzles 138. The collection vessel 144 or the solvent pump 146 may include a means for separating ink material and cleaning composition from the solvent 136. For example, the collection vessel 144 may be large enough that ink material and cleaning composition can settle from the solvent 136 based on density. In some embodiments, the solvent pump 146 may include a filter to remove ink material or cleaning composition from the solvent 136.

The solvent 136 may be selected to have a low boiling point, such that any solvent 136 remaining on the film 102 after the film 102 passes the blade 142 evaporates quickly at ambient temperatures. Thus, the film 102 may be dry or nearly dry (*i.e.*, free of solvent) after passing over the blade 142.

The film 102 may travel downward during exposure to the cleaning compositions 108, 124, and solvent 136 and before contacting the nonabrasive cloths 112, 114, 128, 140. In some embodiments, the total downward travel of the film 102 may be between 2 m and 20 m, such as between about 3 m and 10 m. For example, the film 102 may travel downward a total of about 5 m in the system 100 from the point

the first cleaning composition 108 is applied to the blade 142 configured to remove the solvent 136 from the film 102.

After passing over the blade 142, the film 102 may be continuously transferred to a second (motorized) roll 148 for reuse in a printing process. After rolling the film 102 onto the second roll 148 (*e.g.*, after the cleaning process has been completed for that particular film 102), the second roll 148 may be transported to a storage location to a printing system, to a cutting system, *etc.* The second roll 148 may provide a driving force to pull the film 102 along its path through the system 100.

The blades 118, 130, 142 exert a force uniformly across the width of the film 102, such that the ink, cleaning compositions 108, 124, and solvent 136 are removed from the film 102. The blades 118, 130, 142 may be formed of a polymeric or metal material, and may be formed by casting, pressing, molding, stamping, *etc.* The design of the blades 118, 130, 142 may be selected to achieve any selected stiffness to promote removal of the ink, cleaning compositions 108, 124, and solvent 136 from the film 102. The blades 118, 130, 142 may be selected to have a width approximately equal to the width of the film 102 to be cleaned, approximately equal to the width of a portion of a film 102 if not all of the width is to be cleaned, or greater than the width of the film 102 or portion to be cleaned. In some embodiments, the blades 118, 130, 142 may be formed of a molded polyurethane.

In some embodiments, the edges of the film 102 may retain ink material. For example, to avoid contamination of the rollers 106 or other processing equipment, the cleaning compositions 108, 124 may not be spread to the edges of the film 102 during the cleaning process. In such embodiments, a portion of one or both edges of the film 102 may be sliced after the cleaning process, such as by conventional slicing techniques known in the art. For example, approximately one (1) mm, two (2) mm, five (5) mm, ten (10) mm, or even twenty (20) mm of material may be sliced from one edge or each edge of the film 102.

In some embodiments, the system 100 may be coupled with a printing system, as known in the art and not described in detail herein, such that the system 100 provides a continuous supply of cleaned flexible film 102 to the printing system. In such embodiments, the second roll 148 may optionally be omitted if the supply of film 102 to be passed through the system 100 is expected to consistently provide the needs

of the printing system. In such embodiments, the printing system may provide the driving force to pull the film 102 through the system 100.

The system 100 includes sufficient rollers 106 to maintain tension on the film 102. The tension on the film 102 allows the nonabrasive cloths 112, 116, 128, 140 and the blades 118, 130, 142 to exert forces on the film 102. The rollers 106 also maintain the direction of travel of the film 102. The placement of the rollers 106, the nonabrasive cloths 112, 116, 128, 140 and/or the blades 118, 130, 142 may be varied to vary the amount of force (*e.g.*, tension) on the film 102. For example, tension may be increased to clean heavily printed films or films with relatively stronger-bonded ink, or may be decreased to clean relatively thin or weak films without breaking or tearing.

The system 100 also includes various controls, which are known in the art and not described in detail herein. For example, the system 100 may include motors, valves, springs, sensors, computer controls, *etc.* In some embodiments, portions of the system 100 may be enclosed, such as to collect a portion of vapor of the solvent 136 or to protect workers from moving parts or from hazardous materials.

The system 100 may be operable to continuously process flexible films to remove ink therefrom. For example, the system 100 may be operable to process at least 50 linear meters of film per minute (50 m/min), 100 m/min, 200 m/min, or even 500 m/min.

The system 100 as shown and described is configured to remove ink from a single side of a film 102. That is, the cleaning compositions 108, 124, the solvent 136, the nonabrasive cloths 112, 114, 128, 140, and blades 118, 130, 142 may all contact the same side of the film 102. To clean ink from both sides of a film 102, the film 102 may be passed through the system 100 twice or through two systems 100 in series. Alternatively, a cleaning system may include additional nozzles, nonabrasive cloths, blades, rollers, *etc.* configured in the same manner as shown and described to remove ink from the opposite side before or after rolling the film 102 onto the second roll 148. The two sides of the film 102 may be cleaned sequentially (*e.g.*, one side is substantially cleaned before the cleaning composition is applied to the other side) or simultaneously (*e.g.*, the cleaning composition is applied to both sides concurrently).

EXAMPLE

A roll of clear, flexible, bi-axially oriented polypropylene (BOPP) film having a width of about 1.0 m has a design printed on one surface, such that about 75% of that surface has ink affixed thereto. The BOPP film is processed in a system such as the system 100 shown in FIG. 1. A cleaning solution including D-limonene and water is applied to the BOPP film, and is spread over substantially the entire width of the printed surface of the BOPP film by a microfiber cloth. The film travels downward approximately 1.5 m at about 100 m/min before additional cleaning solution is applied to the printed surface of the BOPP film. Continuing its downward path, the printed surface of the BOPP film passes a second microfiber cloth, which scrubs some of the ink from the BOPP film. Additional cleaning solution is applied to the printed surface of the BOPP film, and a third microfiber cloth scrubs more of the ink. Additional cleaning solution is applied to the printed surface of the BOPP film, and a fourth microfiber cloth scrubs still more of the ink from the BOPP film. The BOPP film travels horizontally after passing a roller, and the cleaning solution and dislodged ink are then removed from the BOPP film by a first polyurethane blade. The cleaning solution is separated from the ink and recycled within the system.

The BOPP film travels vertically downward again, where another cleaning solution is applied to the BOPP film. A fifth microfiber cloth scrubs ink from the BOPP film. The BOPP film travels horizontally after passing a roller, and the cleaning solution and dislodged ink are then removed from the BOPP film by a second polyurethane blade. The cleaning solution is separated from the ink and recycled within the system.

The BOPP film travels vertically downward again, where a solution of 70% isopropyl alcohol and 30% water is applied to the BOPP film. A sixth microfiber cloth scrubs the BOPP film. The BOPP film travels horizontally after passing a roller, and the solution of alcohol and water, remaining cleaning solution, and dislodged ink are removed from the BOPP film by a third polyurethane blade. The solution of alcohol and water is separated from the ink and recycled within the system. The total downward travel of the BOPP film during the cleaning process is about 5 m.

The BOPP film is rerolled for subsequent re-printing and reuse. The process removes substantially all the ink from the printed surface of the BOPP film, leaving a

slight tint at the edges of the BOPP film, which is optionally removed by slicing. The BOPP film is substantially free of residue of the ink or the cleaning solution. By removing the ink from the BOPP film, the BOPP film may be suitable for reuse in packaging products, instead of recycled by melting the BOPP film. For example, the BOPP film may be clean enough for packaging food products.

Once being apprised of the instant disclosure, one of ordinary skill in the art will be able to make the system with readily commercially available components (*e.g.*, motors, rolls, pumps, and nozzles).

CLAIMS

What is claimed is:

1. A method of removing ink from a flexible film, the method comprising:
removing the film from a first roll of film;
feeding the film into a system for removing ink from the flexible film;
exposing the first side of the film fed into the system to a cleaning composition;
passing the first side of the film and the cleaning composition adjacent a first member comprising a microfiber cloth having a plurality of parallel channels between adjacent rows of fibers to spread the cleaning composition over a width of the first side of the film;
passing the first side of the film and the cleaning composition adjacent at least one additional member comprising cloth to remove the ink from the first side of the film; and
scraping the cleaning composition from the first side of the film.

2. The method of claim 1, wherein each channel of the parallel channels extends in a direction parallel to a direction of travel of the film.

3. The method of claim 1 or claim 2, further comprising translating the cleaning composition approximately vertically downward on the first side of the film from the first member comprising cloth to the at least one additional member comprising cloth.

4. The method of claim 1 or claim 2, further comprising exposing the first side of the film to additional cleaning composition before passing the first side of the film and the cleaning composition adjacent at least one additional member comprising cloth.

5. The method of claim 1 or claim 2, wherein the film and the cleaning composition are passed adjacent at least three additional members, each of the at least three additional members comprising cloth.

6. The method of claim 1 or claim 2, further comprising exposing the first side of the film to a solvent after passing the first side of the film and the cleaning composition adjacent the at least one additional member comprising cloth, the solvent comprising at least one of an alcohol, an ether, a chlorinated solvent, and water.

7. The method of claim 6, further comprising passing the first side of the film and the solvent adjacent a further member comprising cloth.

8. The method of claim 6, wherein exposing the first side of the film to a solvent after passing the first side of the film and the cleaning composition adjacent the at least one additional member comprising cloth comprises exposing the first side of the film to isopropyl alcohol.

9. The method of claim 1 or claim 2, wherein the method comprises removing ink from a polymeric film.

10. The method of claim 1 or claim 2, wherein the method comprises removing ink from a film comprising a metal.

11. A system for removing ink from a film, the system comprising:

means for removing the film from a first roll of film and feeding the film into the system traveling in a first direction;

at least one roller configured to bend the film and cause the film to travel in a second direction opposite the first direction;

at least one nozzle configured to expose a first side of the film removed from the roll and fed into the system to a cleaning composition;

a first member comprising a microfiber cloth having a plurality of parallel channels between adjacent rows of fibers configured to distribute the cleaning composition over a width of the first side of the film; and

at least one additional member comprising cloth configured to remove the ink from the first side of the film after the film and the cleaning composition travel in the second direction; and

a stationary blade configured to scrape the cleaning composition from the first side of the film.

12. The system of claim 11, wherein each channel of the plurality of parallel channels extends in a direction parallel to the second direction.

13. The system of claim 11 or claim 12, wherein the system is configured such that the first side of the film carries the cleaning composition approximately vertically downward from the first member comprising cloth to the at least one additional member comprising cloth.

14. The system of claim 11 or claim 12, further comprising at least one additional nozzle configured to expose the first side of the film to additional cleaning composition before the film passes the at least one additional member comprising cloth.

15. The system of claim 11 or claim 12, wherein the at least one additional member comprising cloth comprises at least three additional members, each of the at least three additional members comprising cloth.

16 The system of claim 11 or claim 12, further comprising at least one additional nozzle configured to expose the first side of the film to a solvent after the film passes the at least one additional member comprising cloth.

17. The system of claim 16, further comprising another member comprising cloth configured to contact the first side of the film after the film passes the at least one additional nozzle configured to expose the first side of the film to a solvent.

18. The system of claim 11 or claim 12, wherein the at least one nozzle comprises at least one nozzle coated with polyurethane.

19. The system of claim 11 or claim 12, wherein the first member further comprises a brace configured to maintain the cloth in a constant position adjacent the film.

20. The system of claim 19, wherein the brace is configured to maintain the cloth in a position such that the cloth and the film define a V-shaped volume into which the cleaning composition passes.

21. The system of claim 11 or claim 12, wherein the at least one additional member has a surface adjacent to and oriented in a direction parallel to the second direction.

22. A system for removing ink from a film, the system comprising:

a plurality of rollers configured to direct the film from a first roll of film, wherein the film is selected from the group consisting of polyethylene, polypropylene, polyvinyl chloride, and aluminum;

at least one nozzle configured to expose a first side of the film removed from the first roll to a cleaning composition;

a first cloth comprising a microfiber cloth having a plurality of parallel channels between adjacent rows of fibers configured to spread the cleaning composition over a width of the first side of the film;

at least one additional cloth configured to dissociate the ink from the first side of the film; and

a stationary blade configured to scrape the cleaning composition and ink from the first side of the film.

23. A system for removing ink from a film, the system comprising:

means for removing the film from a first roll of film;

at least one nozzle configured to expose a first side of film removed from the first roll to a cleaning composition; and

a blade configured to scrape the cleaning composition from the first side of the film;

further comprising:

means for distributing the cleaning composition over a width of the first side of the film after the first side of the film is exposed to the cleaning composition through the at least one nozzle, said means for distributing comprising a microfiber cloth having a plurality of parallel channels between adjacent rows of fibers; and

means for dissociating distributed cleaning composition and ink from the first side of the film before scraping the cleaning composition and the ink from the first side of the film, the means for removing comprising cloth and separate from the means for distributing.

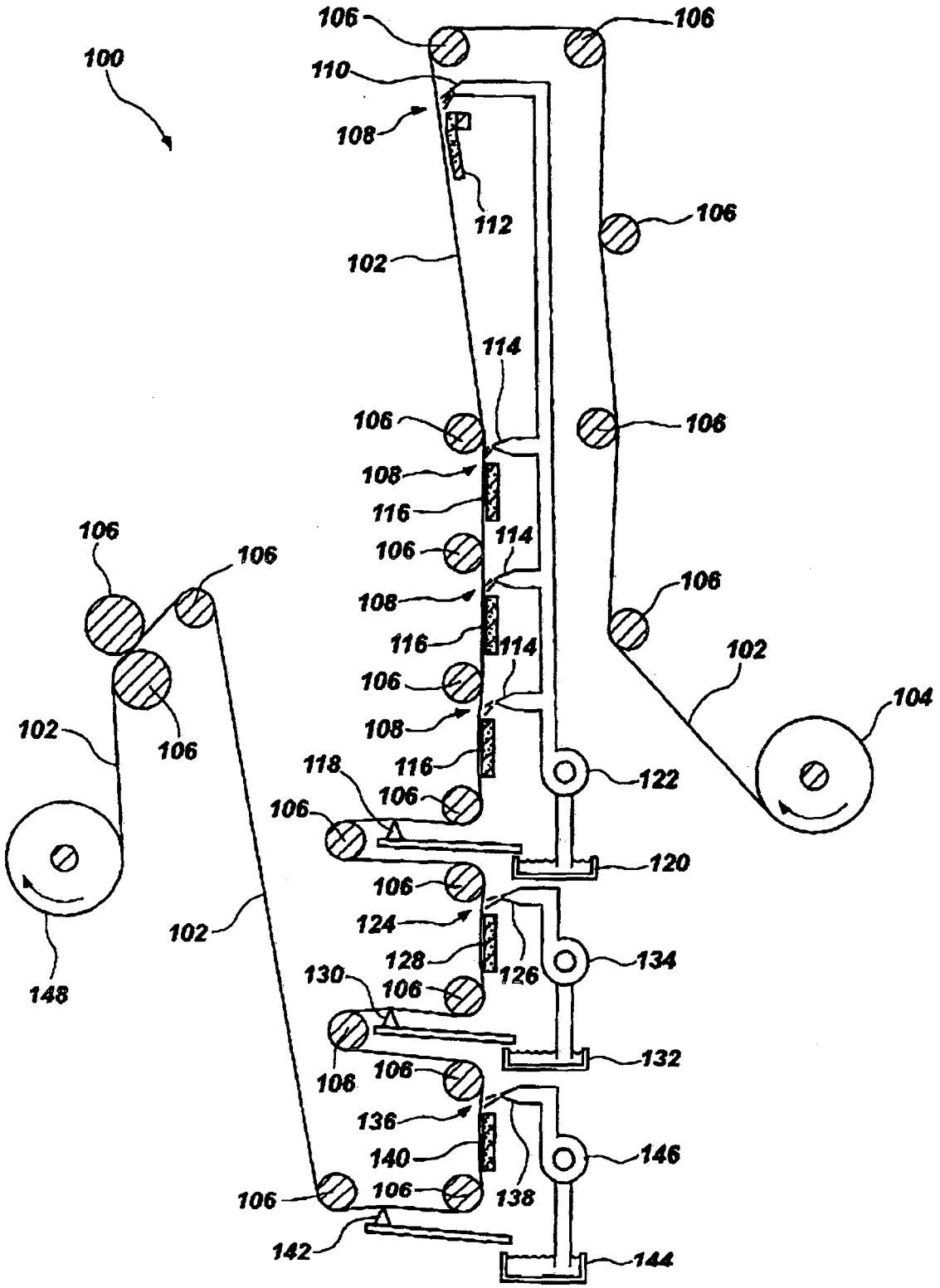
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FIG. 1

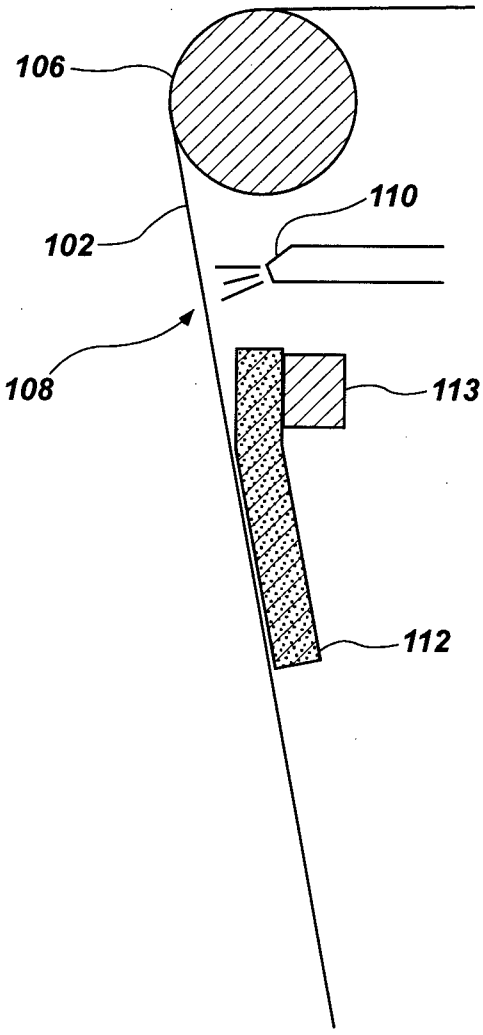


FIG. 2

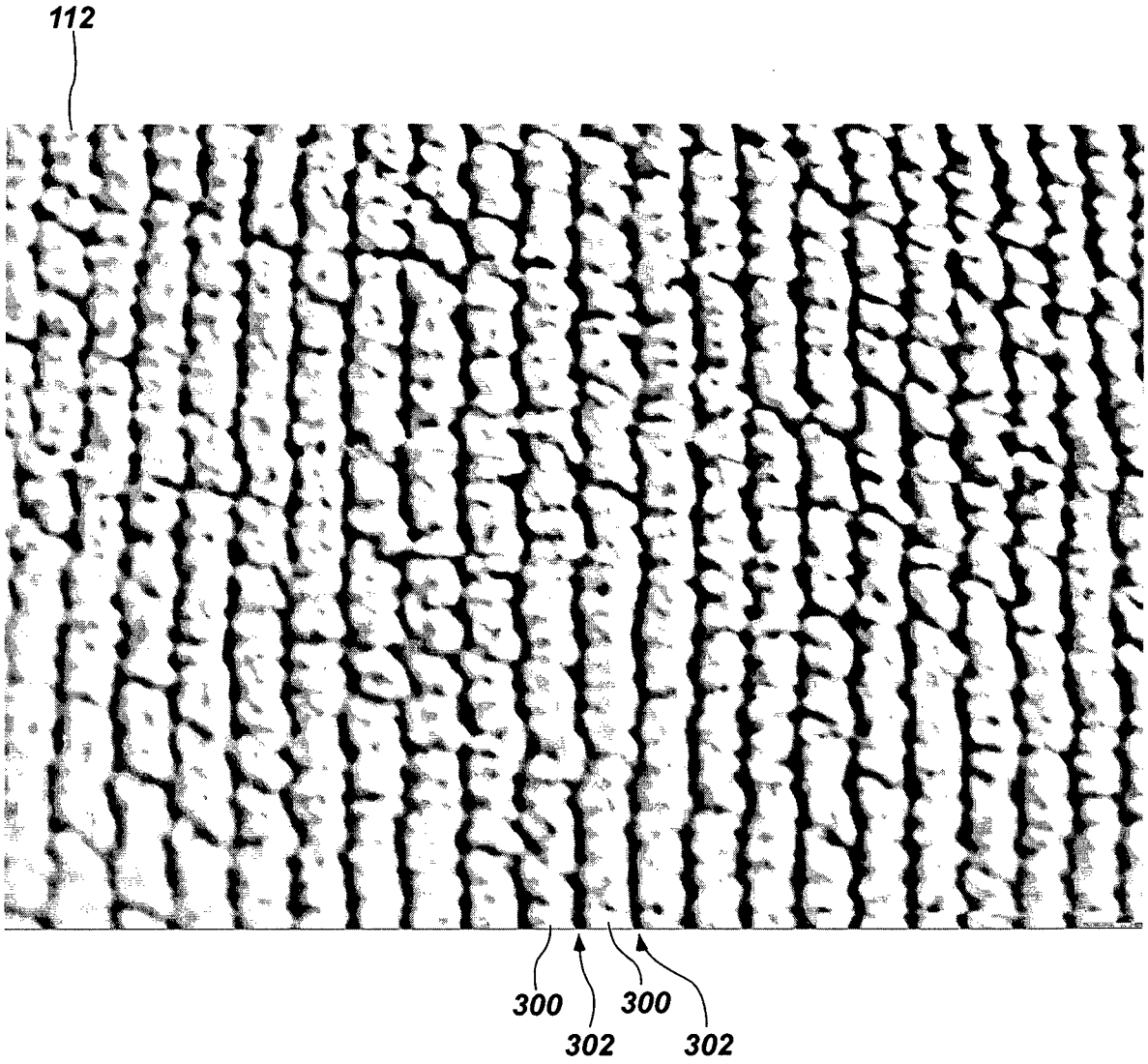
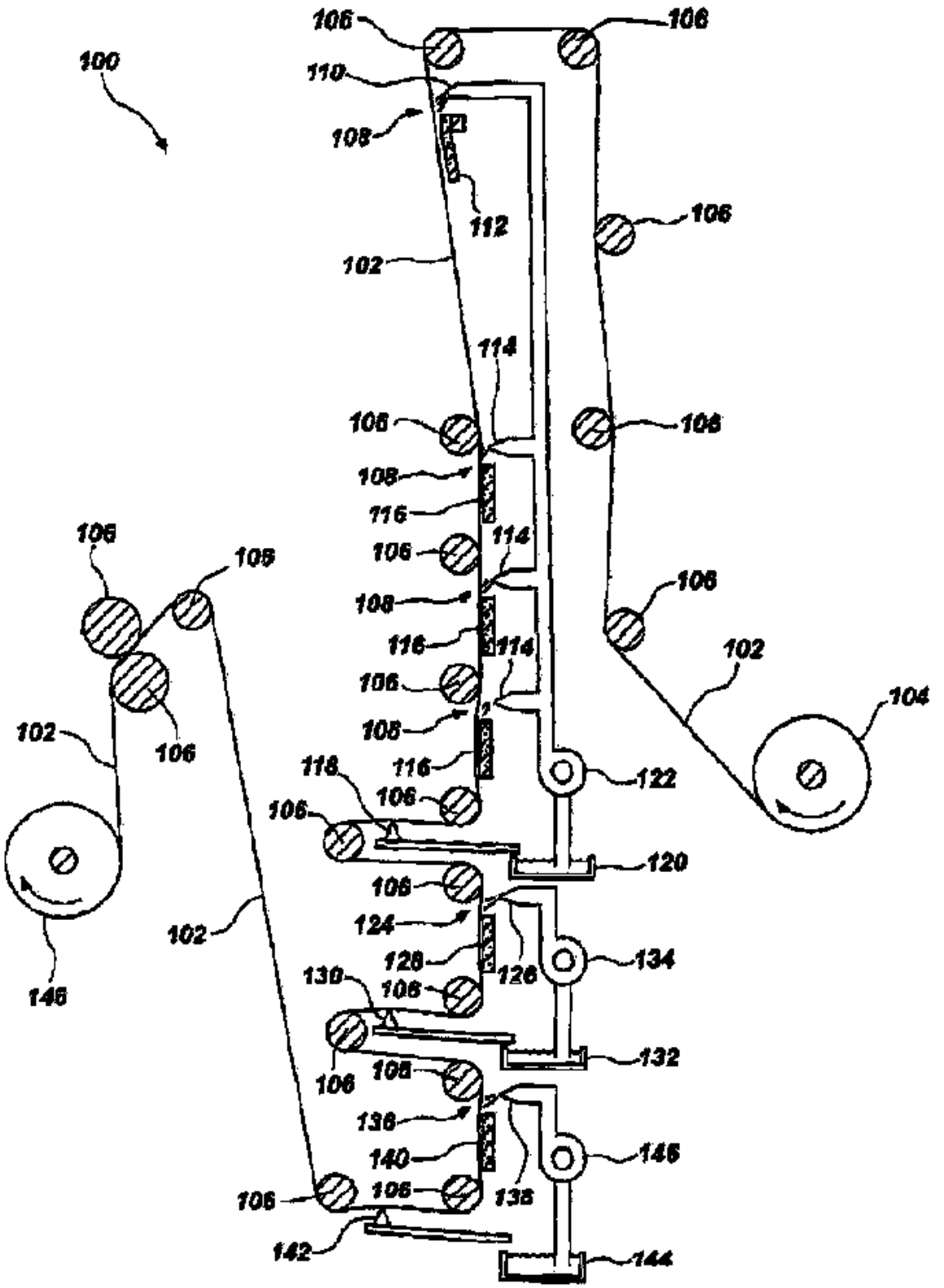


FIG. 3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