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(54) **TAPE COATING APPARATUS AND PRINTING APPARATUS**

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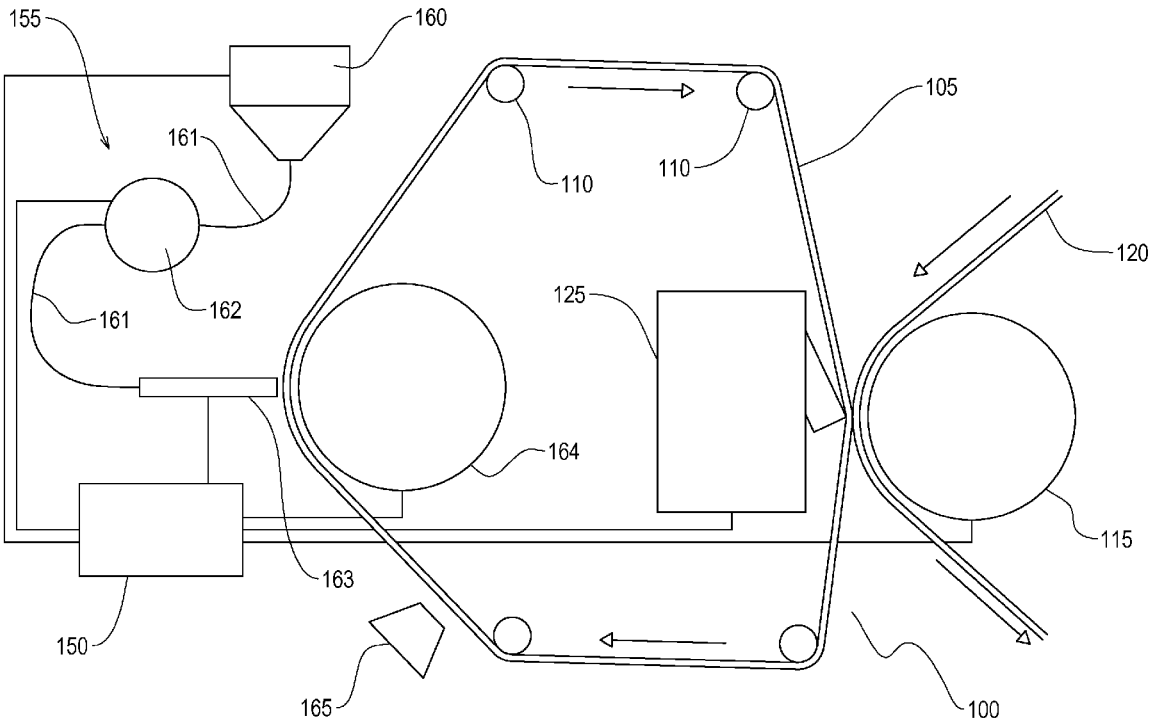
(57) **ABSTRACT**

A tape coating apparatus (**155**) including a slot die (**163**) to apply ink to a printer tape (**105**), a printing apparatus (**100**) including such a tape coating apparatus (**155**) and a method of applying ink to a tape (**105**) using a slot die (**163**).



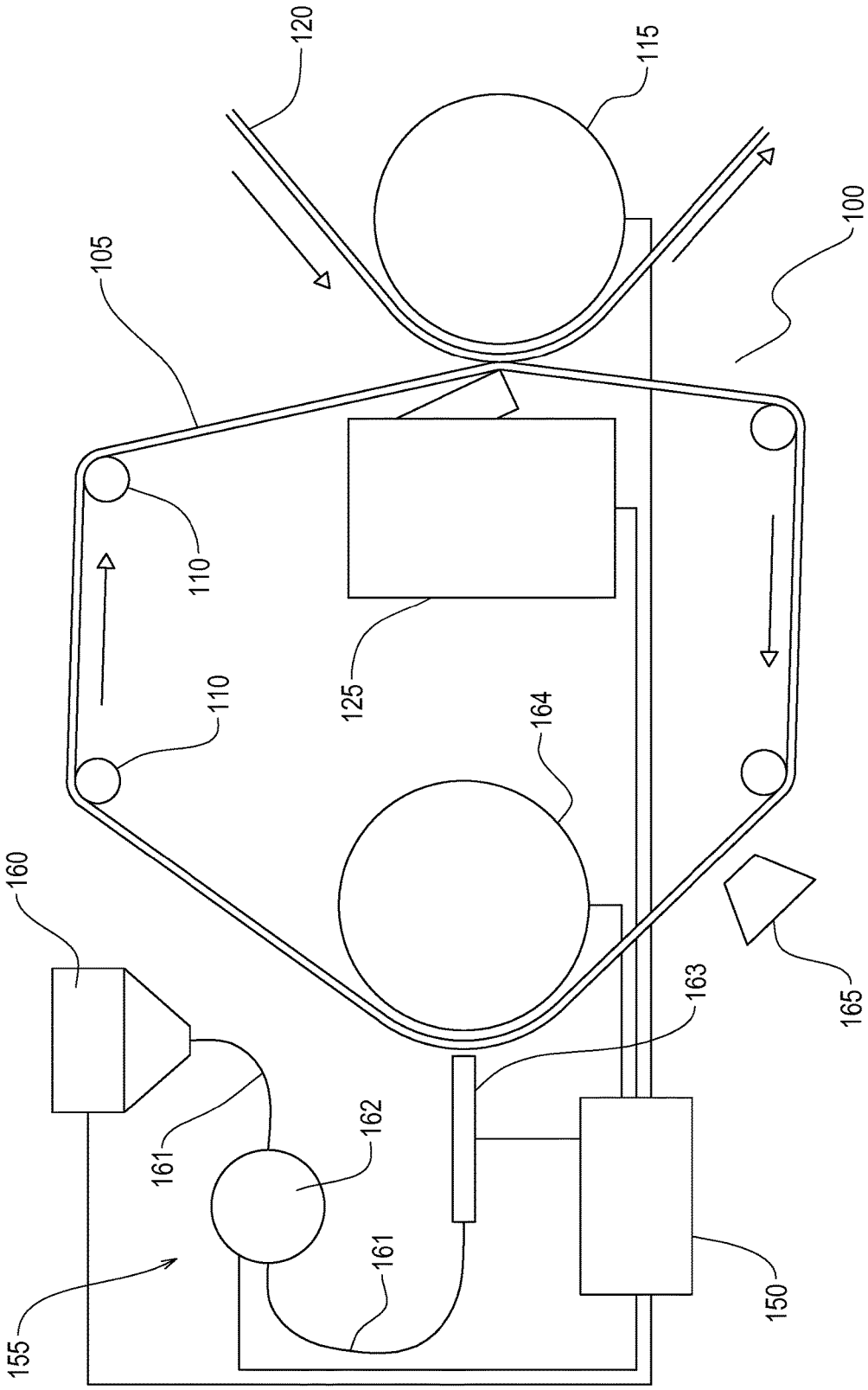


Figure 1

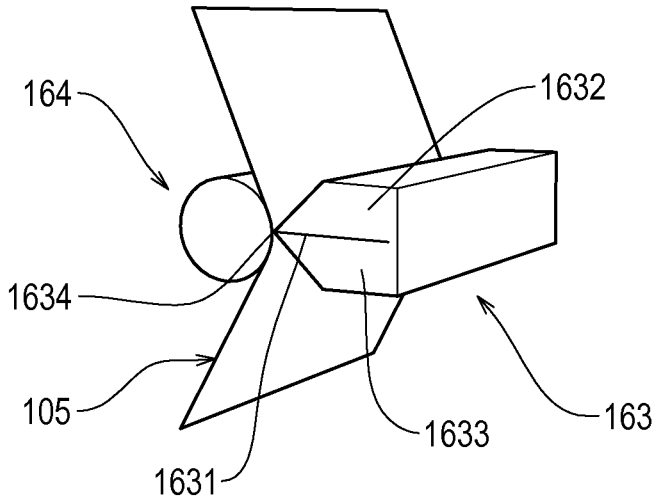


Figure 2

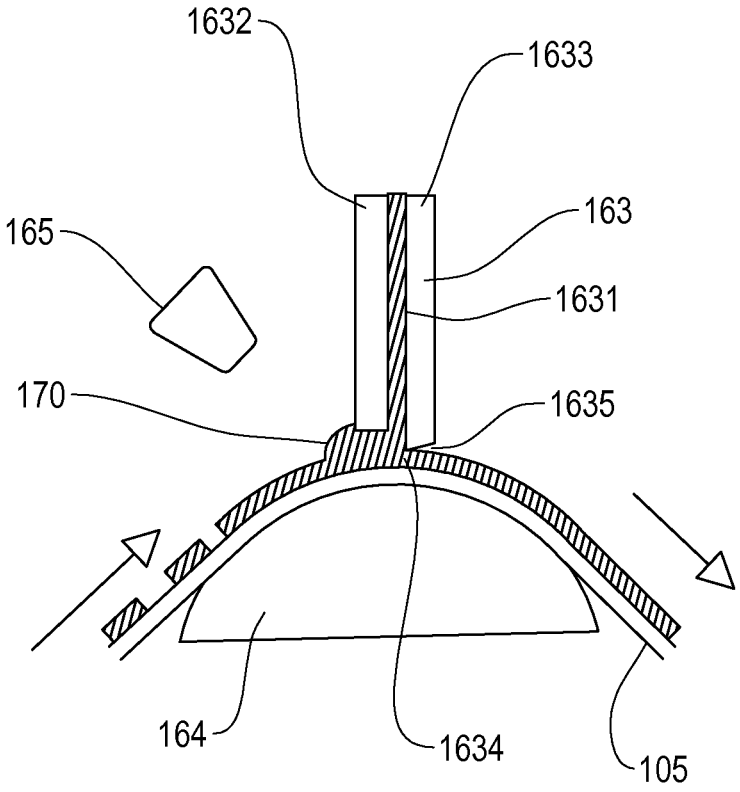


Figure 3

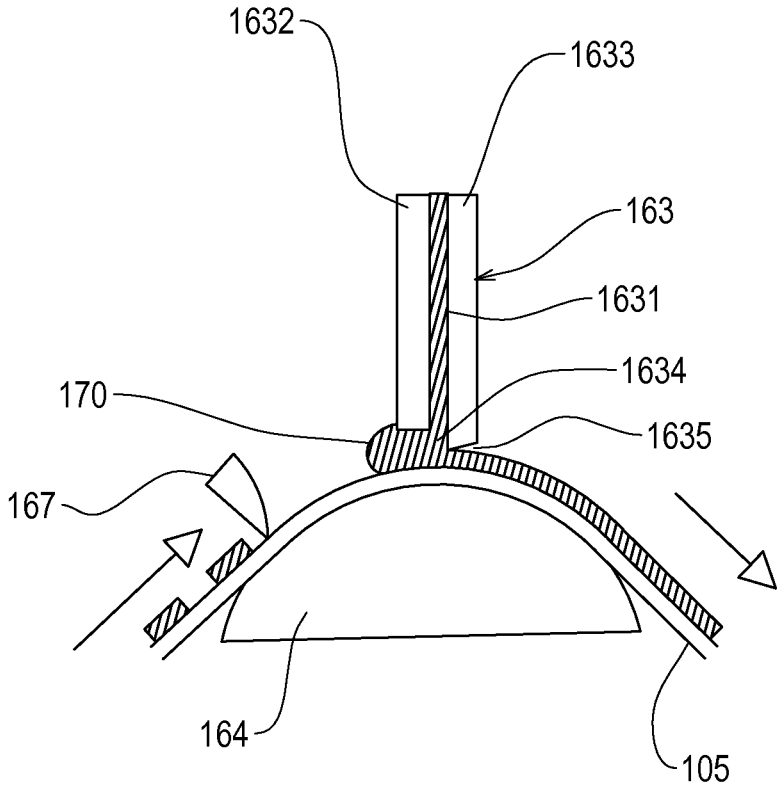


Figure 4

TAPE COATING APPARATUS AND PRINTING APPARATUS

DESCRIPTION OF INVENTION

[0001] The present invention relates to a coating apparatus for applying ink to a printer tape, a printing apparatus including such a coating apparatus and a method of applying ink to a printer tape.

[0002] The invention is particularly useful in relation to a printing apparatus which utilises a printing tape or "ribbon" which includes a web carrying marking medium, e.g. ink, and a printhead which, in use, removes marking medium from selected areas of the web to transfer the marking medium to a substrate to form an image, such as a picture or text.

[0003] More particularly, the invention relates to a so called thermal transfer overprinting apparatus in which the printhead includes a plurality of thermal heating elements which are selectively energisable by a controller during printing to warm and soften pixels of ink from the tape and to transfer such pixels to the substrate. The printhead presses the tape against the substrate such that the pixels of ink contact the substrate before the web of the tape is peeled away, thus transferring the pixels of ink from the tape to the substrate.

[0004] A thermal transfer overprinter may be used to print on to a product's primary packaging and typically mounts within a packaging machine. The image to be printed is often a date code or other product information which needs to be applied to the product's packaging as close as possible to the time at which the product was packaged. A tape drive is used to move and position the thermal transfer tape.

[0005] It is known to provide thermal transfer printing apparatus in two different configurations. In the first, so called "intermittent" configuration, the substrate to be printed and the tape are held stationary during a printing operation, whilst the printhead is moved across the area of the substrate to be printed. Once the printing operation is complete, the printhead is lifted away from the tape, and the tape is advanced to present a fresh region of tape to the printhead for the next printing operation.

[0006] In the second, so called "continuous" configuration, the substrate to be printed moves substantially continuously and the tape is accelerated to match the speed of the tape before the printhead is brought into thermal contact with the tape and the printing operation is carried out. In this configuration, the printhead is maintained generally stationary during each printing operation.

[0007] In the case of a printing apparatus in continuous configuration, it is also necessary to accurately control the speed of the tape, to ensure that it matches the speed of the substrate. A typical thermal transfer printer operates with substrate that advances at linear speeds between approximately 0.01 metres per second and approximately 2 metres per second. Typical substrate accelerations are up to approximately 12 metres per second per second.

[0008] Printing apparatus of the kind described above includes drive apparatus for moving the tape relative to the printhead, to present fresh tape, from which pixels of ink are yet to be removed, to the printhead, such that successive printing operations can be carried out. It has long been known to provide tape drives which include two spool supports, one of which supports a supply spool on which unused tape is initially wound, and the other of which supports a take-up spool, onto which the tape is wound after it has been used. Tape extends between the spools in a tape path. Each of the spool supports, and hence each of the spools of tape, is drivable by a respective motor.

[0009] It is also known, for example from U.S. Pat. No. 8,922,611, to provide a printing apparatus which includes a substantially continuous band or loop of tape or ribbon, upon which is provided hot-melt ink. A thermal transfer printhead is positioned adjacent the band, so that during a printing operation, the printhead is operable to transfer 'pixels' of ink on to a substrate, e.g. packaging or a label. The band is moveable in a path such that following the removal of ink from a portion of the tape, the portion of tape from which the ink has been removed is positioned adjacent a heating device, to cause the ink which remains on the band to be melted, to flow and to be redistributed on the band, to replace at least some of the ink which has been removed. It will be appreciated that the movement of the band may be 'intermittent' or 'continuous' as outlined above. The heating device of this printer also includes an ink roller for applying additional ink to the band, which is used to substantially uniformly coat the band with ink.

[0010] The inks required for a thermal transfer print process have very high viscosity (typically greater than approximately 20 Pa s when molten). Melting of the ink typically occurs at temperatures above approximately 90° C. Using a roller mechanism to reapply ink to the band is very difficult to achieve with such high viscosity inks. Controlling the coating process using a roller is very difficult.

[0011] An aim of the present invention is to provide an improved apparatus and method of applying ink to a printer tape.

[0012] In accordance with a first aspect of the present invention, there is provided a tape coating apparatus including a slot die to apply ink to a printer tape.

[0013] The tape coating apparatus may be to apply ink to a thermal transfer printer tape.

[0014] The tape coating apparatus may be operable to apply ink to a substantially continuous band of printer tape.

[0015] The tape coating apparatus may be operable to apply ink to a printer tape which already bears a quantity of ink.

[0016] A controller may be included to control the operation of the slot die, which may include controlling the flow of ink to and/or from the slot die.

[0017] The tape coating apparatus may include a pump or reversible pump which may be controlled by the controller.

[0018] The controller may be operable to determine the amount of ink which is required to restore an amount of ink on the tape to a desired, substantially uniform thickness across a portion of the tape.

[0019] One or more sensors may provide a signal to the controller.

[0020] At least one of the one or more sensors may provide a signal to the controller which is indicative of the amount of ink remaining on the tape following a printing operation and/or the amount of ink which is absent from the tape following a printing operation.

[0021] At least one of the one or more sensors may be operable to provide a signal to a controller which is indicative of a size of a meniscus of ink which is adjacent an opening of the slot die.

[0022] The tape coating apparatus may include an ink removal device which may remove at least a portion of ink which remains on a portion of the tape after a printing operation, from the band.

[0023] The ink removal device may be operable to remove substantially all of the ink which remains on a portion of the tape after a printing operation.

[0024] The slot die may include a slot defined by first and second side parts, whereby the first side part may be longer than the second side part so as to form an extended lip.

[0025] In according with a second aspect of the invention, there is provided a printing apparatus which includes a tape coating apparatus in accordance with the first aspect of the invention.

[0026] The printing apparatus may include a printhead which may be operable to transfer ink from a substantially continuous band of inked tape to a substrate, and may include a support apparatus for supporting a band of inked tape which may be adjacent the printhead and the tape coating apparatus.

[0027] A drive mechanism may be included for transporting the tape in a loop, such that successive portions of tape may be alternately positioned adjacent the printhead and the tape coating apparatus.

[0028] The printing apparatus may be a thermal transfer printer.

[0029] In accordance with a third aspect of the present invention, there is provided a method of coating a tape for use in a printing apparatus with ink, the method including applying a portion of ink to the tape using a slot die.

[0030] The method of coating a tape may include applying ink to a portion of the tape which already bears a quantity of ink.

[0031] The method of coating a tape may include transporting the tape in a loop such that successive portions of tape may be alternately positioned adjacent a printhead of the printing apparatus and the slot die.

[0032] The successive portions of tape may be transported in a substantially continuous loop so as to repeatedly be presented alternately to the printhead and the slot die.

[0033] The method may include controlling the operation of the slot die by controlling the flow of ink to and/or from the slot die.

[0034] The method may include controlling a pump rate of a pump or reversible pump which pumps ink to and/or from the slot die.

[0035] The method may include determining the amount of ink which is required to replace ink which has been removed from a portion of the tape in a printing operation, to restore a coating of ink on the tape to a desired, substantially uniform thickness.

[0036] The method may include providing a signal to a controller, the signal being indicative of the amount of ink remaining on the portion of the tape following a printing operation and/or indicative of the amount of ink which is absent from the portion of the tape following a printing operation.

[0037] The method may include using the signal indicative of the amount of ink remaining on the portion of tape and/or the signal indicative of the amount of ink which is absent from the portion of the tape to control the flow of ink to and/or from the slot die.

[0038] The method may include providing a signal to a controller which is indicative of a size of a meniscus of ink which is adjacent an opening of the slot die.

[0039] The method may include using the signal which is indicative of the size of the meniscus to control the flow of ink to and/or from the slot die.

[0040] The method may include removing at least a portion of ink remaining on a portion of the tape following a printing operation, and before re-coating that portion of the tape with ink.

[0041] The method may include removing substantially all of the ink remaining on a portion of the tape following a printing operation and before re-coating that portion of the tape with ink.

[0042] The invention will now be described, by way of example only, with reference to the accompanying drawings, of which:

[0043] FIG. **1** is an illustrative view of a printing apparatus including a tape coating apparatus;

[0044] FIG. **2** is a perspective view of a part of the tape coating apparatus;

[0045] FIG. **3** is a cross sectional view of the coating apparatus applying ink to a band of tape; and

[0046] FIG. **4** is a cross sectional view of the tape coating apparatus including an ink removal device.

[0047] Referring to FIG. **1**, there is shown a printing apparatus **100**. The printing apparatus is a thermal transfer printing apparatus. The printing apparatus **100** includes a band of tape **105**, which is supported in the printing apparatus **100** by a support apparatus. In the present example, the support apparatus includes a plurality of rollers **110**, but it will be appreciated that the support apparatus may include additional or alternative components, for example pins, plates or rods. A part of the support apparatus, for example one or more of the rollers **110** may be biased, for example spring loaded, to control tension in the band **105**. The support apparatus also includes a roller **164**, which will be described in more detail below. The roller **164** could have a form other than a substantially cylindrical body, for example a platen.

[0048] The band **105** may be manufactured from various materials, for example polyimide film, engineering plastics, or metal. Selection of an appropriate thickness for a given type of band material can result in good heat transfer characteristics through the band **105**, allowing high quality prints at high speeds, whilst also maintaining the durability of the band **105**. One example of a suitable material for the band is a polyimide film with a thickness of approximately 7.5 microns. In some implementations, the polyimide film is a Kapton® material from E. I. du Pont du Nemours and Co. In some implementations, the band **105** may be engineering plastic which has a heat transfer rate of greater than 0.120 Watts/metre-Kelvin and a thickness less than 25 microns, for example 4.5 microns. In some implementations, the band can be a metal, such as stainless steel ribbon with a thickness of 10 microns or less, for example 5 microns. The band **105** is substantially continuous, as in U.S. Pat. No. 8,922,611.

[0049] A substrate support **115** is provided to support a substrate **120**, for example paper, plastics film, or labels, adjacent the band **105**, and a printhead **125**. The substrate support **115** is shown as a roller, but could be of any appropriate form, for example a platen. The printhead **125** is a thermal transfer printhead, which includes an array of selectively energisable printing elements for transferring ink

from the band **105** to the substrate **120**. The printhead **125** includes a mechanism which is operable to press the band **105** against the substrate **120**, so that a portion of ink on the band **105**, which has been heated by the or each energised printing element of the printhead **125** is transferrable to the substrate **120**.

[0050] The printing apparatus **100** also includes a tape coating apparatus **155**. The tape coating apparatus **155** includes a reservoir or tank **160** for holding hot melt ink. The tape coating apparatus **155** also includes a slot die **163**. The tape coating apparatus **155** also includes a pump **162** for transferring ink between the tank **160** and the slot die **163**. Different arrangements of the components of the tape coating apparatus **155** are possible to optimise the mechanism for the space available. The tank **160** and pump **162** may be incorporated into the slot die **163** itself, removing the need for the interconnecting pipes **161**, for example.

[0051] The tank **160** is preferably heatable to a temperature which is suitable to maintain the hot melt ink in liquid or at least semi-liquid form. The tank **160** is fluidly communicable with the slot die **163**. The tank **160** is fluidly communicable with the pump **162** via a pipe or pipes **161**. The pump **162** is fluidly communicable with the slot die **163** via a pipe or pipes **161**. The pump **162** is operable to transfer ink from the tank **160** to the slot die **163**. The pump **162** is a reversible pump, to enable the pump **162** to transfer ink back to the tank **160**, but may be of an alternative type, as necessary or appropriate. For instance, in some embodiments, there may be more than one, e.g. two, pumps whereby a first pump is configured to transfer ink to the slot die **163** and a second pump is configured to transfer ink away from the slot die **163**.

[0052] The or each pipe **161** is preferably heatable, to maintain ink in liquid form as it is transferred from the tank **160** to the slot die **163**. The slot die **163** and the roller **164** are also preferably heatable. The optimum temperature of ink for a successful coating operation is dependent upon the type of ink and the material of the band **105**, and is determined by empirical testing. The temperatures of the tank **160**, the or each pipe **161**, the slot die **163** and/or the roller **164** are controlled by a controller **150**, which is operable to monitor the temperature of each component of the coating apparatus **155**, and may also monitor the ambient temperature, to select and/or adjust the temperature of one or more of the components of the tape coating apparatus **155**. A temperature of one or more of the components of the coating apparatus **155** may additionally be selectable and/or adjustable by an operator.

[0053] FIGS. **2** and **3** show the slot die **163** in more detail. The slot die **163** includes a slot **1631** defined by two side parts **1632**, **1633**. The slot **1631** terminates in an opening **1634** which is positioned near to and facing the roller **164**. In some embodiments, the slot die **163** may include an extended lip **1635**, which is formed by the side part **1633** being slightly longer than the side part **1632**. One purpose of the extended lip **1635** may be, for example, to assist in controlling the thickness of the coating of ink applied to the band **105**.

[0054] The controller **150** is part of a control system which controls the process of coating the band **105** with ink. In the present example, the controller **150** also controls the speed and direction of travel of the band **105**, by controlling the operation of a band drive mechanism. However, it will be appreciated that, additionally or alternatively, the controller **150** may receive a signal from a sensor or the like, which indicates the speed and/or direction of travel of the band **105**. The controller **150** is able to stop movement of the band **105**. The speed and direction of the substrate **120** is typically controlled by a packaging machine with which the printing apparatus **100** is associated. The controller **150** is operable to control the printhead **125**, for example to energise printing elements of the printhead **125** to create an image, and to move the printhead **125** into and out of engagement with the band **105**. It is important that the speed and direction of the band **105** matches that of the substrate **120** whenever the printhead **125** is engaged with the substrate **120**.

[0055] The control system may include a sensor **165** which is, for example, an optical sensor or an ultrasonic sensor. In some embodiments, the sensor **165** may be operable to 'scan' the band **105** in a location near to the coating apparatus **155** to determine the amount of ink on the band **105**. In some embodiments, the sensor **165** may be operable to determine the size of a meniscus of ink adjacent the opening **1634** of the slot die **163**.

[0056] In use, the controller **150** controls the printing apparatus **100** to carry out printing operations. Each printing operation may include a printing phase during which ink is transferred from the band **105** to the substrate **120** and a non-printing phase during which ink is not transferred from the band **105** to the substrate **120**. The movement of the band **105** and the substrate **120** during each printing operation are controlled by the controller **150**. The speed and direction of the band **105** and/or the substrate **120** may alter during the course of each printing operation. A series of printing operations may be carried out sequentially, and substantially continuously.

[0057] The controller **150** operates the printhead **125** to move the printhead **125** directly adjacent the band **105**, and selectively energise one or more of the printing elements of the printhead **125**, such that the or each energised printing element is able to melt a portion of ink on the band, and transfer the melted ink to the substrate **120**. Once the printing operation is complete, the controller **150** de-activates the or each printing element and/or retracts the printhead **125** from the band **105**.

[0058] The band **105** travels in a substantially continuous loop such that after each successive portion of the band **105** has been used in a printing operation, that portion of the band **105** moves towards the slot die coater **163**, to replace the ink which has been removed in the printing operation.

[0059] The band **105** is, in part, supported by the roller **164**, which is substantially adjacent the slot die **163**. The controller **150** controls the temperature of the roller **164** so as to melt or at least soften the remaining ink on the band **105** before it reaches the slot die **163**. As mentioned above, the appropriate optimum temperature will depend upon the material of the band **105** and the type of ink.

[0060] The slot die **163** is then used to apply ink to the band **105**, to provide a substantially uniform coating of ink of a desired thickness on the band **105**. The desired thickness of the ink 'film' which is applied to the band is between approximately 4 μm and approximately 20 μm.

[0061] The controller **150** is operable to control the speed of the pump **162**, which in turn affects the volume of the ink leaving the slot die **163** and hence the thickness of the coating of ink applied to the band **105**. The controller **150** is able to use a number of variables to determine the speed of the pump **162**, which variables may include the speed of the

band **105** and/or the amount of ink remaining on the band after a printing operation and before a coating operation. When the band **105** is moving, it is advantageous for the speed of the pump **162** to be directly proportional to the speed of travel of the band **105**.

[0062] It is advantageous for the speed of the pump to be inversely proportional to the amount of ink remaining on the band **105**. The amount of ink remaining on the band **105** may be determined in two ways, in order to control the slot die **163** in an appropriate manner. The two methods may be used alone or in conjunction with one another.

[0063] In the first method, each successive portion of the band **105** is scanned by the sensor **165** as it returns towards the coating apparatus **155**. For example, an optical or ultrasound scan of the band **105** may be carried out to ascertain the amount of ink remaining on each portion of the band **105** after a printing operation. Other sensing/scanning methods may be desirable and appropriate.

[0064] The sensor scans a narrow strip across the band **105**, the strip being oriented in a direction which is substantially perpendicular to the direction of travel of the band **105** relative to the printhead and/or the slot die **163**.

[0065] The controller **150** may assume that the coating of ink is either at the initial, coated thickness, or has been completely removed.

[0066] The sensor **165** provides a signal to the controller **150**, which is indicative of the amount of ink which has been removed from the band **105** or the amount of ink remaining on the band **105**, and hence the amount of ink which is required to be provided by the slot die **163** to restore a required thickness of ink across the full width of the band **105**, in a substantially uniform coating. The controller **150** uses this indication, together with knowledge of the movement of the band **105**, e.g. speed of movement of the band **105**, to control the pump **162**, so that the flow of ink from the slot die **163** matches a volume calculated to restore the ink to the scanned strip of the band **105** to its desired, substantially uniform thickness, when the strip arrives at a position adjacent the slot die **163**. The controller **150** has knowledge of the linear distance between the band **105** and the opening **1634** of the slot die **163**.

[0067] In a second method of operation, the controller **150** controls the speed of the pump **162**, which controls the flow of ink in to the slot die **163**. A meniscus **170** is formed at the opening **1634** of the slot die **163** (i.e. at the end closest to the band **105**). The size of the meniscus **170** is dependent on a number of variables, for example, the speed of the pump **162**, the amount of ink being 'taken' by the band **105** as it travels past the slot die **163**, the viscosity of the ink being used, etc. The controller **150** monitors the size of the meniscus **170** using the sensor **165**. The controller **150** controls the pump **162** to maintain the meniscus **170** at or substantially at an optimum size. For example, if the controller **150** detects that the size of the meniscus **170** is decreasing, this may mean that more ink is being used to restore ink on the band **105** than is being pumped into the slot die **163**. Thus, the controller **150** may increase the speed of the pump **162** to restore the meniscus **170** to a predetermined/optimum size. Likewise, if the controller **150** detects an increase in the size of the meniscus **170**, this may indicate that less ink is being used to coat the band **105** than is being pumped in to the slot die **163**. In other words, the band **105** may be close to saturation. Thus, the controller **150** may reduce the speed of the pump **162** (or stop the pump **162** altogether) to restore the meniscus **170** to the predetermined size.

[0068] In other words, the amount of ink left on the band **105** after a printing operation will affect how much ink is laid down by the slot die **163** (from the meniscus **170**). If a lot of ink has been removed during the printing operation comparatively more ink will be taken from the meniscus to "fill in the gaps" on the band **105**, and vice versa, if less ink has been removed from the band **105** then less ink will be needed from the meniscus **170** to restore the coating on the band **105**.

[0069] The signal sent to the controller **150** which is indicative of the size of the meniscus **170** is used to control the speed of the pump **162**. Therefore, monitoring the size of the meniscus **170** ensures that a uniform thickness of ink is restored to the band **105**.

[0070] In some embodiments, the sensor **165** may send signals to the controller **150** substantially continuously during operation of the printing apparatus **100** or at predetermined time intervals. Therefore, any of the methods of operation described above may result in an iterative process. In some embodiments, the controller **150** may continuously update one or more control parameters (for example, the speed of the pump **162**) of the slot die **163** based on signals received from the sensor **165**.

[0071] In some embodiments, the resilience of the roller **164** may be set based upon the properties of the ink (including viscosity) and the thickness of the coating of ink which is required. Standard coating applications are available to calculate the required resilience.

[0072] In some embodiments (which may be in combination with the above described methods or alone), the extended lip **1635** may control the thickness of the coating of ink on the band **105**, as the band is coated by the slot die **163**. The ink on a portion of the band **105** has been 'fragmented' by a printing process, and the portion of the band **105** is returned to the slot die **163** to be coated with ink. The remaining ink on the band **105** is melted or at least softened by the roller **164** as the portion of the band **105** nears the slot die **163**. The melted remaining ink is combined with replacement ink which is provided by the slot die **163**. The thickness of the ink layer leaving the slot die **163** is controlled by a combination of the position of the extended lip **1635** relative to the roller **164**, the thickness of the band **105**, and the resilience of the roller **164**.

[0073] The controller **150** may use information relating to images printed by the printing apparatus **100** to determine the amount of ink required to replace the ink which has been removed from the tape in a printing operation. The controller **150** has knowledge of how many printing elements of the printhead **125** are/have been activated during a printing operation, or during a series of printing operations, and their position relative to the band **105**. The controller **150** can assume that activation of each printing element leads to transfer of ink to the substrate **120**. Since the controller **150** also controls the movement of the band **105**, the controller **150** can determine when a depleted area of ink has arrived or is due to arrive at the slot die **163**. This information can be used alone, or to validate the information received from the sensor **165**, to determine the amount of ink which remains on the band **105**, and how much ink should be applied by the slot die **163**. The controller **150** is able to operate the coating apparatus **155** accordingly, to apply the

correct amount of ink to achieve a uniform, optimum thickness coating on the band **105**.

[0074] Once each portion of the band **105** has been coated, it then returns towards to printhead **125** to be used in a subsequent printing operation. As each portion of the band **105** moves away from the slot die **163**, and leaves the vicinity of the roller **164**, the coating of ink on the band is able to cool and solidify, before it reaches the printhead **125**.

[0075] This printing and recoating process repeats substantially continuously, although it will be appreciated that the band **105** need not, and in practice is unlikely to, move at a constant speed. In other words, whilst the printing and recoating process is substantially continuous, there may be pauses, and the band **105** may even reverse direction, to take into account requirements of each printing operation or a particular printing operation.

[0076] In the event that the controller **150** detects that the speed of the substrate **120** has reduced so much that it is not possible for a printing operation to be successfully carried out, for example the speed of the substrate **120** has reduced to approximately 50 mm/s or less, the printing activity may be aborted. When printing operations are to cease, the controller **150** controls the printhead **125** to cease printing, by de-energising any currently energised printing elements and not energising any further printing elements of the printhead **125** and/or retracting the printhead **125**, or at least a part thereof, away from the band **105**. The controller **150** also reduces the speed of the band **105** to its minimum speed, which may be stationary. As the band **105** slows to a stop, the controller **150** controls the pump **162** to reverse the flow of ink, back towards the tank **160**, to prevent a build-up of ink between the slot die **163** and the band **105**, which can solidify and form lumps on the band **105** and/or on or in the opening of the slot die **163**.

[0077] In an embodiment of the invention, as shown in FIG. **4**, the printing apparatus includes an ink removal device **167**. The ink removal device **167** is positioned near to the slot die **163**, and is operable to remove as much ink as possible, preferably all of the ink, which remains on a portion of the band after a printing operation has been carried out. The ink removal device **167** may be a rigid or resilient blade, which is operable to scrape ink from the surface of the band **105**, as the band travels between the printhead **125** and the slot die **163**. The slot die **167** then replaces a uniform coating of ink on the band **105** before a further printing operation is carried out. This is a substantially continuous process, such that as ink is being removed from one portion of the tape in a printing operation, the remaining ink is being removed from a further portion of the band **105**, and replacement ink is being applied to yet another portion of the band **105** by the slot die **163**. An advantage of this embodiment of the printing apparatus **100** is that it is not strictly necessary to determine the amount of ink left on each portion of the band **105** before it reaches the slot die **163**, since substantially all of the ink has been removed from the band **105**. Therefore the slot die is operable in accordance with the speed of the band to apply a desired thickness of ink to each successive portion of the band **105**. It will be understood that the methods of determining the amount of ink remaining on each successive portion of the band **105** may still be used, to check that the portion of the band which is about to be coated with ink by the slot die **163** is, in fact, free or substantially free from ink. This avoids inadvertently providing a portion of the band **105** with too thick a coating of ink or a 'lumpy' coating of ink.

[0078] An advantage of using a slot die as part of the tape coating apparatus **155** is that the thickness of the coating of ink on the band **105** can be controlled by the operation of the pump **162**, which can be calibrated to deliver the desired ink thickness on the 'clean', i.e. ink free or 'ink-light' areas of the band **105**. Previously, slot dies have not been used to deliver high viscosity inks. Furthermore, in conventional slot die applications, the carrier material (in this example, the band **105**) to which a substance (in this example, ink) is applied, is completely clean, i.e. it does not carry any of the substance prior to the slot die application process. The present invention overcomes the difficulty of providing the band with a substantially uniform coating thickness even when applying high viscosity ink to a band which already bears some ink.

[0079] The invention has been described in relation to hot melt inks, but it will be appreciated that other types of ink may be applied to a tape using the apparatus and method described herein.

[0080] When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

[0081] The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

1. A tape coating apparatus including a slot die to apply ink to a printer tape.

2. A tape coating apparatus according to claim **1** to apply ink to a thermal transfer printer tape.

3. A tape coating apparatus according to claim **1** or claim **2** which is operable to apply ink to a substantially continuous band of printer tape.

4. A tape coating apparatus according to any of the preceding claims which is operable to apply ink to a printer tape which already bears a quantity of ink.

5. A tape coating apparatus according to any of the preceding claims which includes a controller to control the operation of the slot die, including by controlling the flow of ink to and/or from the slot die.

6. A tape coating apparatus according to claim **5** which further includes a pump or reversible pump which is controlled by the controller.

7. A tape coating apparatus according to claim **5** or **6** wherein the controller is operable to determine the amount of ink which is required to restore an amount of ink on the tape to a desired, substantially uniform thickness across a portion of the tape.

8. A tape coating apparatus according to claim **5** or **6** or **7** including one or more sensors to provide a signal to the controller.

9. A tape coating apparatus according to claims **8** wherein at least one of the one or more sensors provides a signal to the controller which is indicative of the amount of ink

remaining on the tape following a printing operation and/or the amount of ink which is absent from the tape following a printing operation.

10. A tape coating apparatus according to any of claim **8** or **9** wherein at least one of the one or more sensors is operable to provide a signal to a controller which is indicative of a size of a meniscus of ink which is adjacent an opening of the slot die.

11. A tape coating apparatus according to any of the preceding claims, including an ink removal device to remove at least a portion of ink which remains on a portion of the tape after a printing operation, from the band.

12. A tape coating apparatus according to claim **11** wherein the ink removal device is operable to remove substantially all of the ink which remains on a portion of the tape after a printing operation.

13. A tape coating apparatus according to any of the preceding claims wherein the slot die includes a slot defined by first and second side parts, whereby the first side part is longer than the second side part so as to form an extended lip.

14. A tape coating apparatus substantially as described herein and/or as shown in the accompanying drawings.

15. A printing apparatus including a tape coating apparatus according to any of claims **1** to **14**.

16. A printing apparatus according to claim **15**, the printing apparatus including a printhead which is operable to transfer ink from a substantially continuous band of inked tape to a substrate, and a support apparatus for supporting a band of inked tape adjacent the printhead and the tape coating apparatus.

17. A printing apparatus according to claim **16**, including a drive mechanism for transporting the tape in a loop, such that successive portions of tape are alternately positioned adjacent the printhead and the tape coating apparatus.

18. A printing apparatus according to claim any of claims **15** to **17** wherein the printing apparatus is a thermal transfer printer.

19. A printing apparatus substantially as described herein and/or as shown in the accompanying drawings.

20. A method of coating a tape for use in a printing apparatus with ink, the method including applying a portion of ink to the tape using a slot die.

21. A method of coating a tape according to claim **20** including applying ink to a portion of the tape which already bears a quantity of ink.

22. A method of coating a tape according to claim **20** or claim **21** including transporting the tape in a loop such that successive portions of tape are alternately positioned adjacent a printhead of the printing apparatus and the slot die.

23. A method of coating a tape according to claim **22**, wherein the successive portions of tape are transported in a substantially continuous loop so as to repeatedly be presented alternately to the printhead and the slot die.

24. A method of coating a tape according to any of claims **20** to **23** which includes controlling the operation of the slot die by controlling the flow of ink to and/or from the slot die.

25. A method of coating a tape according to claim **24** including controlling a pump rate of a pump or reversible pump which pumps ink to and/or from the slot die.

26. A method of coating a tape according to claim **24** or **25** including determining the amount of ink which is required to replace ink which has been removed from a portion of the tape in a printing operation, to restore a coating of ink on the tape to a desired, substantially uniform thickness.

27. A method of coating a tape according any of claims **24** to **26** including providing a signal to a controller, the signal being indicative of the amount of ink remaining on the portion of the tape following a printing operation and/or indicative of the amount of ink which is absent from the portion of the tape following a printing operation.

28. A method of coating a tape according to claim **27** including using the signal indicative of the amount of ink remaining on the portion of tape and/or the signal indicative of the amount of ink which is absent from the portion of the tape to control the flow of ink to and/or from the slot die.

29. A method of coating a tape according to claim **24** to claim **28** including providing a signal to a controller which is indicative of a size of a meniscus of ink which is adjacent an opening of the slot die.

30. A method of coating a tape according to claim **29** including using the signal which is indicative of the size of the meniscus to control the flow of ink to and/or from the slot die.

31. A method according to any one of claims **20** to **30** including removing at least a portion of ink remaining on a portion of the tape following a printing operation, and before re-coating that portion of the tape with ink.

32. A method according to claim **31** including removing substantially all of the ink remaining on a portion of the tape following a printing operation and before re-coating that portion of the tape with ink.

33. A method of coating a tape for use in a printing apparatus with ink substantially as described herein and/or as shown in the accompanying drawings.

34. Any novel feature or novel combination of features substantially as described herein and/or as shown in the accompanying drawings.

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