SHEET MEDIA INVERTER

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ABSTRACT

Representative embodiments provide for a sheet media inverter that includes a first, a second, and a third roller. The first and second rollers are configured to define a feed nip, and the second and third rollers are configured to define an exit nip. The sheet media inverter also includes a sheet positioner. The sheet positioner is configured to selectively urge an edge of a sheet media out of engagement with the feed nip and into engagement with the exit nip, in response to a signal from a controller. The present invention further provides a method including the steps of transporting a sheet media a using a feed nip, urging an edge of the sheet media out of engagement with the feed nip and into engagement with an exit nip, and transporting the sheet media using the exit nip.
FIG. 1
(Prior Art)
FIG. 4
BEGIN

TRANSPORT SHEET OF MEDIA TOWARD SHEET POSITIONER USING FEED NIP.

URGE SHEET OF MEDIA AWAY FROM FEED NIP AND INTO EXIT NIP USING SHEET POSITIONER.

TRANSPORT SHEET OF MEDIA AWAY FROM SHEET POSITIONER USING EXIT NIP.

END

FIG. 8
Sheet Media Inverter

Background

[0001] Imaging apparatuses that are usable to selectively form images on sheet media are known in the art. Non-limiting examples of such imaging apparatuses include laser printers, ink-jet printers, photocopiers, photoprinting machines, thermal imaging devices, facsimile transceivers, ‘all-in-one’ or ‘multifunction’ imaging devices, etc. Generally, such an imaging apparatus forms images on sheet media in accordance with an electronic document file (commonly known as a print job), the optical scanning of imaging-bearing sheet media, the reception of a facsimile transmission, etc.

[0002] Some types of imaging apparatus are usable to form images on both sides of a sheet of media (such as paper) in the interest of sheet media conservation, reduced overall document size or page count, or other concerns. It is generally desirable to perform such two-sided imaging (also referred to as duplex imaging or ‘duplexing’) in as rapid yet reliable a manner as possible.

[0003] Many types of duplex-capable imaging apparatus include a single image forming device generally referred to as an imaging engine. As such, it is necessary to perform two respective exposures or ‘passes’ of a sheet media into cooperative orientation with the imaging engine in order to image both sides of the sheet of media during a duplexing operation. Typically, this is accomplished by imaging a first side of the sheet media and then returning the imaged sheet media to the imaging engine in a ‘flipped’ or ‘inverted’ state so that imaging of the second side can be performed.

[0004] Therefore, it is desirable to provide apparatuses and methods for inverting sheet media in a relatively expeditious and component-efficient manner.

Summary

[0005] One embodiment of the present invention provides for a sheet media inverter, including first, second, and third rollers. The first and second rollers are respectively configured to define a feed nip, while the second and third rollers are configured to define an exit nip. The sheet media inverter also includes a sheet positioner that is configured to selectively urge an edge of a sheet media out of engagement with the feed nip, and into engagement with the exit nip, in response to a signal from a controller.

[0006] Another embodiment of the present invention provides a sheet media inverter configured to invert a sheet media including a first edge. The sheet media inverter contains a containment guide that is configured to receive sheet media within a cavity. The sheet media inverter further includes first, second, and third rollers that are configured so that the first and second rollers define a feed nip and the second and third rollers define an exit nip. The first edge of a sheet of media received within the cavity is transported away from the feed nip and toward the exit nip by way of gravity-influenced contact with the second roller.

[0007] Still another embodiment of the present invention provides for an imaging apparatus including a controller and an imaging engine. The imaging engine is configured to selectively form images on a first side of a sheet media in response to a corresponding signal from the controller. The imaging apparatus also includes a sheet inverter. The sheet inverter is configured to selectively receive the imaged sheet media and there after to provide the imaged sheet media to the imaging engine such that a second side of the sheet media is exposed for imaging by the imaging engine. The sheet inverter performs this operation in response to a corresponding signal from the controller. The sheet inverter includes first, second, and third rollers respectively configured such that the first and second rollers define a feed nip, and the second and third rollers define an exit nip. The sheet inverter further includes a sheet positioner configured to selectively urge an edge of the imaged sheet media away from the feed nip and into engagement with the exit nip in response to a signal from the controller.

[0008] Yet another embodiment of the present invention provides for a method of inverting a sheet media, including the steps of engaging a sheet media with a feed nip, and then transporting the sheet media toward a sheet positioner using the feed nip. The method steps further include urging an edge of the sheet media away from the feed nip and into engagement with an exit nip using the sheet positioner, and transporting the sheet media away from the sheet positioner using the exit nip. The method further incorporates a first roller and a second roller that define the feed nip, as well as a third roller that cooperates with the second roller to define the exit nip.

[0009] These and other aspects and embodiments of the present invention will now be described in detail with reference to the accompanying drawings, wherein:

Description of the Drawings

[0010] FIG. 1 is a perspective view depicting a multifunction printer in accordance with the prior art.

[0011] FIG. 2 is a block diagram of an imaging apparatus in accordance with an embodiment of the present invention.

[0012] FIG. 3 is a side elevation view depicting the sheet inverter of the imaging apparatus of FIG. 2.

[0013] FIG. 4 is side elevation view depicting a sheet inverter in accordance with another embodiment of the present invention.

[0014] FIG. 5 is a plan sectional view depicting the sheet inverter of FIG. 4.

[0015] FIG. 6 is a front elevation sectional view depicting the sheet inverter of FIG. 4.

[0016] FIG. 7 is side elevation view depicting a sheet inverter in accordance with yet another embodiment of the present invention.

[0017] FIG. 8 is flowchart depicting a method in accordance with another embodiment of the present invention.

Detailed Description

[0018] In representative embodiments, the present teachings provide methods and apparatus for inverting a sheet of media within an imaging apparatus.

[0019] A sheet inverter in accordance with embodiments of the present invention can be generally summarized as follows: first, second and third rollers are cooperatively supported such that the first and second rollers define a feed nip and the second and third rollers define an exit nip. A pair
of receiving rollers is cooperatively supported such that a receiving nip is defined. A motor provides selective rotating mechanical energy to drive the pair of receiving rollers and the first, second and third rollers under the signal control of a controller. The present invention further provides sheet inverter embodiments that include a sheet positioner that is selectively actuated by signal control from the controller.

[0020] During typical operation of certain embodiments of the present invention, a sheet of media is received from an imaging device in a substantially imaged-side-up orientation by the receiving nip and is transported thereby to the feed nip. The feed nip engages the imaged sheet media and transports it toward the sheet positioner. When the imaged sheet media has substantially cleared the feed nip, a signal from the controller actuates the sheet positioner. In response, the sheet positioner urges an edge of the imaged sheet media away from the feed nip and into engagement with the exit nip. The imaged sheet media is now effectively in a ‘flipped’ or overturned state, relative to that in which it was received by the sheet inverter. The exit nip then transports the imaged sheet media in a substantially imaged-side-down orientation away from the sheet positioner and generally away from the sheet inverter. The sheet media can then be returned to the imaging device so that the non-imaged side of the sheet media can be printed with an image to produce a duplex printed sheet.

[0021] Typical operation of other embodiments of the present invention proceeds substantially as described above, except that a sheet positioner is not required. In these cases a sheet of media is transported through the feed nip into a receiving cavity. An elevationally lower edge of the sheet media is then held in contact with the second roller under the influence of gravity and is transported by the second roller toward the exit nip. Thereafter, the sheet media is engaged by the exit nip and is transported out of the sheet inverter in a substantially overturned or imaged-side-down orientation.

[0022] In any case, the sheet inverters of the present invention perform this inverting or sheet media flipping operation in a relatively rapid fashion, and without the need to bi-directionally drive any of the respective rollers. Furthermore, the sheet inverters of the present invention perform the sheet media inverting function using a generally minimized parts count.

[0023] Turning now to FIG. 1, a perspective view depicts an exemplary multifunction printer 50 in accordance with the prior art. The multifunction printer 50 includes a laser printer 52 and an optical scanner 54. The laser printer 52 is generally configured to selectively form images on sheet media (not shown) in correspondence to a print job provided by way of a suitably coupled user computer (not shown, see FIG. 2) or in accordance with the optical scanning of image-bearing sheet media (not shown) by the optical scanner 54.

[0024] Thus, the multifunction printer 50 can be selectively used, for example, to image sheet media (such as paper or transparency stock, etc.) to produce an imaged (i.e., printed) document from a electronic document file or to produce copies of existing imaged sheet media by way of the optical scanner 54.

[0025] The laser printer 52 includes a duplexing unit 56. The duplexing unit 56 is coupled in electrical, electronic, and/or mechanical communication with the balance of the laser printer 52 as required to enable the selective double-sided imaging (i.e., duplexing) of sheet media by the laser printer 52.

[0026] The laser printer 52 of the exemplary multifunction printer 50 is assumed to include a single laser-type imaging engine (not shown, see imaging device 104 of FIG. 2). It is therefore necessary to expose each side of a sheet of media (typically paper) to the imaging engine by way of a respective exposure or pass of the sheet media into cooperative (i.e., printable) orientation with the imaging engine during a duplexing operation of the multifunction printer 50. That is, a total of two such passes or exposures are required per sheet of media in order to image (i.e., print) both sides of each sheet of media when using the multifunction printer 50.

[0027] The laser printer 52 is further assumed to include a known sheet media reversing and/or inverting mechanism or mechanisms (not shown) in addition to the duplexing unit 56 as required to facilitate the normal duplexing operations of the laser printer 52 of the exemplary multifunction printer 50 and further elaboration thereof is not required for purposes herein.

[0028] Apparatus and methods in accordance with the present invention are described hereafter.

[0029] FIG. 2 is a block diagram of an imaging apparatus 100 in accordance with an embodiment of the present invention. The imaging apparatus 100 includes a controller 102. The controller 102 can be defined by any suitable control device usable to control normal operations of the imaging apparatus 100. The controller 102 can include, for example: digital, analog, and/or hybrid electronic circuitry; a microprocessor or microcontroller; a state machine; etc. One of skill in the imaging control arts can appreciate that the controller 102 can be defined by any number of suitable forms in correspondence to various embodiments of the imaging apparatus 100 and that further elaboration is not required for purposes of understanding the present invention.

[0030] The imaging apparatus 100 also include an imaging device (hereafter, imaging engine) 104. The imaging engine 104 is coupled in control signal communication with the controller 102 and is usable to selectively form images on a cooperatively exposed (i.e., oriented) side of a sheet media in response to a corresponding control signal provided by the controller 102. Non-limiting examples of such an imaging engine 104 include a laser imaging engine, an ink-jet imaging engine, a dot-matrix imaging engine, a thermal imaging engine, etc. Other suitable forms of imaging engine 104 can also be used. The particular form of imaging engine 104 can be suitably selected in correspondence to various embodiments of the imaging apparatus 100 and further elaboration thereof is not required for purposes herein.

[0031] The imaging apparatus 100 further includes a sheet diverter 106. The sheet diverter 106 is coupled in control signal communication with the controller 102 and is usable to selectively route sheet media within or away from the imaging apparatus 100 in response to a corresponding control signal provided by the controller 102. That is, the sheet diverter can divert an imaged sheet to an output tray (not shown) outside of the imaging apparatus 100, or it can redirect sheet media within the imaging apparatus 100 for
duplex printing. The sheet diverter 106 can include any suitable mechanism and/or elements as required, and further description is not necessary for an understanding of the present invention.

[0032] The imaging apparatus 100 also includes a sheet inverter 108 in accordance with the present invention. The sheet inverter 108 is coupled in control signal communication with the controller 102. The sheet inverter 108 is generally configured to selectively receive an imaged sheet of media (described hereafter) from the sheet diverter 106 in a first-side-up orientation and to provide that sheet of media in a second-side-up orientation in response to a corresponding control signal provided by the controller 102. Further detail of the sheet inverter 108 is described hereafter in regard to the typical operation of the imaging apparatus 100.

[0033] The imaging apparatus 100 also includes an input tray 110. The input tray 110 is configured to support a supply of sheet media “S” for use with the imaging apparatus 100. The sheet media S supported by the input tray 100 is assumed to be blank on both sides and can include, for example: paper; postcard stock; etc. Other types of sheet media S can also be used.

[0034] It is to be understood that any number of other devices or elements (not shown) can be provided as required or desired within corresponding embodiments of the imaging apparatus 100. Non-limiting examples of such devices and/or elements include: power supplies; operator interfaces; optical scanners; photocopying subsystems; reservoirs for ink, toner, and/or other consumables; sheet media routing and transporting mechanisms; etc. In general, various embodiments of the imaging apparatus 100 can be suitably defined by one of skill in the art that incorporate the sheet inverter 108 of the present invention or a suitable one of its alternatives or equivalents as provided herein.

[0035] FIG. 3 is a side elevation view depicting details of the sheet inverter 108 of the imaging apparatus 100 of FIG. 2. The sheet inverter 108 includes a motor 120. The motor 120 can include any suitable electric motor coupled in controlled relationship with the controller 102 (FIG. 2) and is typically defined by a direct-current type motor. Other types of motor 120 can also be used. The motor 120 is generally configured to provide rotational mechanical energy to other associated elements (described hereafter) of the sheet inverter 108 under the control signal influence of the controller 102 (FIG. 2). The motor 120 is suitably supported by the sheet inverter 108.

[0036] The sheet inverter 108 also includes a pair of receiving rollers 122. Each of the receiving rollers 122 is rotateably supported in contact with the other such that a receiving nip 124 is defined. Each of the pair of receiving rollers 122 can be formed from any material suitable for substantially non-slip contact with sheet media such as, for example: rubber; polyurethane; etc. In an alternative embodiment (not shown), a suitable non-slip material is borne on some or all of the outer surface of each of the respective receiving rollers 122.

[0037] Each of receiving rollers 122 is suitably mechanically coupled in driven relationship with the motor 120 and is further configured to rotate in a predefined direction as depicted in FIG. 3. As depicted in FIG. 3, the receiving rollers 122 are coupled to the motor 120 by respective gears 160, 161 and 162. One of skill in the mechanical arts can appreciate that such mechanical coupling of the motor 120 with the pair of receiving rollers 122 can include other suitable forms, such as belts or rollers, and that further elaboration is not needed for an understanding of the present invention.

[0038] The sheet inverter 108 also includes a first roller 126, a second roller 128, and a third roller 130. Each of the respective rollers 126, 128 and 130 is rotateably supported by the sheet inverter 108 and is mechanically coupled in driven relationship with the motor 120 by respective gears 160, 163 and 164. Other suitable mechanical coupling between the motor 120 and the first, second and third rollers 126, 128 and 130 can also be used, as for example, belts or rollers. Further, instead of being driven by motor 120, any one of the first, second and third rollers 126, 128 and 130 can be driven by a separate motor. Each of the respective rollers 126, 128 and 130 is configured to rotate in a predefined direction as depicted in FIG. 3. As such, the first roller 126 and the third roller 130 are configured to rotate in a common predefined direction, while the second roller 128 is configured to rotate in an opposite predefined direction.

[0039] Each of the first, second and third rollers 126, 128 and 130 can be formed from any material suitable for substantially non-slip contact with sheet media such as, for example, any of the materials described above in regard to the pair of receiving rollers 122. In the alternative (not shown), a suitable non-slip material is borne on some or all of the outer surface of each of the rollers 126, 128 and 130. Such non-slip material further allows the first roller 126 to drive the second roller 128, and the second roller (in turn) to drive the third roller 130.

[0040] The first roller 126 and the second roller 128 are configured in contacting relationship so as to define a feed nip 132. The second roller 128 and the third roller 130 are configured in contacting relationship such that an exit nip 134 is defined. Both the feed nip 132 and the exit nip 134 are configured to engage and transport sheet media in respective directions of travel as described in further detail hereafter.

[0041] The sheet inverter 108 further includes a sheet positioner 135. As depicted, the sheet positioner 135 includes an electric solenoid 136 coupled in controlled relationship with the controller 102 (FIG. 2) and supported in substantially fixed relationship with the sheet inverter 108. The electric solenoid 136 is typically defined by a direct-current type electric solenoid. Other suitable types of electric solenoid 136 can also be used.

[0042] The sheet positioner 135 further includes a pusher 138 that is pivotally supported by a hinge 140. The pusher 138 is also mechanically coupled to the electric solenoid 136 so as to bi-directionally pivot within a predefined angular range “R” about the hinge 140 in response to a corresponding linear force provided by the electric solenoid 136, under the selective control of the controller 102 (FIG. 2). The pusher 138 can be formed from any suitable substantially ridged material such as, for example: plastic; metal; etc. As depicted in FIG. 3, the pusher 138 is generally defined by a curved plate. Other suitable forms of pusher 138 can also be used such as, for example: a perforated plate; a pusher including one or more raised contact points; a plurality of contact fingers; a bar; etc. Generally, the pusher 138 can
include any suitable form for selectively contacting sheet media under the controlled influence of the electric solenoid 136.

[0043] In alternative embodiments (not shown), the sheet positioner 135 can include other forms of sheet moving or positioning elements such as, for example: a spring-loaded pusher; a pusher driven by a rotating orbital element or a reciprocating arm; etc. One of skill in the mechanical arts can appreciate that various suitable forms of sheet positioner 135 are anticipated herein for use in corresponding embodiments of the sheet inverter 108.

[0044] The sheet inverter 108 also includes a backstop 142 that is supported in cooperative relationship with the pusher 138 of the sheet positioner 135. The backstop 142 is further supported in substantially fixed relationship with the sheet inverter 108. As depicted in FIG. 3, the backstop 142 is generally configured such that the pusher 138 is selectively pivotable toward and away from the backstop 142 by way of controller 102 (FIG. 2) control of the electric solenoid 136. The backstop 142 can be formed from any suitable substantially ridged material such as metal, plastic, etc. As depicted in FIG. 3, the backstop 142 is generally defined by a curved plate substantially corresponding to that of the pusher 138. Other suitable forms of backstop 142 can also be used.

[0045] Hereafter, reference to FIGS. 2 and 3 shall be made as indicated.

[0046] Typical operation of the imaging apparatus 100 (FIG. 2) is as follows: to begin, it is assumed for purposes of example that the controller 102 has received an electronic document file (i.e., print job) requiring duplex printing (i.e., imaging) from a suitably coupled user computer 112. The controller 102 then causes a blank sheet of media S (i.e., paper) to be drawn from a tray 110 and routed to the imaging engine 104. As depicted in FIG. 2, the sheet media S includes a side “A” and a side “B” wherein side “A” is presently exposed in cooperative (i.e., printable) orientation with the imaging engine 104.

[0047] The controller 102 (FIG. 2) then causes the imaging engine 104 to selectively form images on side “A” of the sheet media S in accordance with the print job. The resulting formed sheet of media is depicted as “S1” in FIG. 2. The controller 102 then causes the sheet media S1 to be routed to the sheet diverter 106 and thence to the sheet inverter 108 by way of corresponding control signals. As depicted in FIG. 2, the sheet inverter 108 receives the imaged sheet media S1 with the imaged side “A” in a substantially face-up orientation. It is now assumed that the controller 102 suitably energizes (i.e., activates) the motor 120 (FIG. 3) of the sheet inverter 108 so as to provide mechanical rotation.

[0048] The sheet inverter 108 (FIG. 3) receives the imaged sheet media S1 within the receiving nip 124 by way of guide elements “G” and transports the sheet media S1 toward the feed nip 132 by way of guide elements “G2”. The first roller 126 and the second roller 128 are assumed to be under rotational drive by the motor 120 and thus engage the sheet media S1 within the feed nip 132. The sheet media S1 is then transported by way of the feed nip 132 generally toward the sheet positioner 135.

[0049] After the sheet media S1 (FIG. 3) has passed completely through the feed nip 132 the controller 102 (FIG. 2) issues a control signal to the electric solenoid 136 (FIG. 3) of the sheet positioner 135. The controller can be configured to generate the control signal at the appropriate time based on receiving an input from a sensor or the like indicating that the sheet media S1 has passed completely through the feed nip 132. For example, since sheet media length is typically known, and since the circumferences of the first and second rollers 126, 128 are known, a proximity sensor can be used to count the number of rotations of one or both of the first and second rollers 126, 128. When the number of counted rotations times the roller circumference equals the sheet length, then it can be assumed that the sheet media S1 has cleared the feed nip 132. Optical sensors of the like can also be used to determine when the sheet media S1 has entered and exited the feed nip 132. In any event, the sheet positioner 135 responds to the control signal by pivoting the pusher 138 from an initial position “P1” through the range R to a second position “P2”. This pivoting operation of the sheet positioner 135 results in an urging or generally flexing displacement of the sheet media S1 such that an edge “E” of the sheet media S1 is positioned away from the feed nip 132 and into substantial engagement with the exit nip 134. This repositioning and engagement of the edge E of the sheet media S1 with the exit nip 134 is further generally assisted by contact with the rotating second roller 128. It is to be noted that the edge E can be defined as a trailing edge of the sheet media S1 during travel through the feed nip 132 and as a leading edge of the sheet media S1 during travel through the exit nip 134. The backstop 142 prevents the sheet media S1 from being positioned beyond the usable (i.e., engageable) range of the exit nip 134.

[0050] Once the edge E (FIG. 3) of the sheet media S1 is engaged by the exit nip 134, the sheet media S1 is then transported generally from the backstop 142 and guided out of the sheet inverter 108 by guide elements “G3”. As depicted in FIG. 3, the sheet media S1 exiting the sheet inverter 108 is in a generally side “B” face-up orientation. The controller 102 (FIG. 3) then repositions the pusher 138 to the position indicated by “P1” in FIG. 3. The repositioning of the pusher 138 to position “P1” can be configured (within the controller 102, FIG. 2) to occur a predetermined time after the pusher has been moved to position “P2”, or it can be configured to occur upon receipt of a signal from a sensor, such as a sheet sensor (not shown) in guides “G3”, indicating that the sheet has been successfully engaged by the exit nip 134.

[0051] The controller 102 (FIG. 2) then causes the sheet media S1 to be suitably routed away from the sheet inverter 108 by additional powered rollers (not shown) and on toward the imaging engine 104. The sheet media S1 then arrives with side “B” cooperatively exposed to the imaging engine 104. The controller 102 thereafter causes the imaging engine 104 to selectively form images on side “B” of the sheet media S1 in accordance with the print job, thus resulting in a sheet of media bearing print and/or images on both sides (i.e., ‘duplexed’ sheet media).

[0052] The controller 102 (FIG. 2) then causes the duplexed sheet of media to be routed to the sheet diverter 106 and thereafter discharged from the imaging apparatus 100. This typical operation of the imaging apparatus 100 is repeated one sheet of media S at a time until the requirements of the print job are satisfied, resulting in a duplexed (imaged both sides) document 150.
The typical operation described above depicts one sheet of media being imaged on a first side, then inverted, and then imaged on a second side and discharged from the imaging apparatus before the imaging of another sheet of media is begun. However, it is to be understood that in another exemplary usage of the imaging apparatus, successive sheets of media can follow each other in spaced synchronization through the process of being imaged on a first side, then inverted, and then imaged on a second side and discharged under the control of the controller 102. Other suitable duplexing operations of the imaging apparatus 100 can also be performed. Further, it is in immaterial which side of the sheet media S is imaged first, since the sheet inverter 108 (FIG. 3) will always result in the non-imaged side of the sheet being presented to the image forming components of the imaging device 104 (FIG. 2).

In any case, it is to be noted that the receiving rollers 122 and the first, second and third rollers 126, 128 and 130 each rotate in a single predefined direction during operation of the sheet inverter 108 and that no bi-directional rotation of any of the rollers within the sheet inverter 108 is required. This configuration allows for quicker inversion of the sheet over prior art sheet inverting devices since those prior art devices require reversing of rollers in order for the sheet inverting process to be performed.

Furthermore, the sheet inverter 108 (FIG. 3) of the present invention makes use of a sheet positioner 135 that urges a sheet of media S1 away from the feed nip 132 and into engagement with the exit nip 134 in a relatively rapid manner and without the need to halt or reverse the rotation of any of the receiving rollers 122 or the first, second and third rollers 125, 128 and 130 (respectively). The overall result is a sheet inverter 108 of the present invention that operates in a desirably rapid fashion (that is, a relatively high sheet media throughput) while utilizing a generally minimized parts count.

FIG. 4 is a side elevation view depicting a sheet inverter 158 in accordance with another embodiment of the present invention. It is to be understood that the sheet inverter 158 is configured for use in the alternative to the sheet inverter 108 of FIG. 2 and is similarly cooperative with the imaging apparatus 100 of FIG. 2. The sheet inverter 158 includes a motor 120, pair of receiving rollers 122, first roller 126, second roller 128, third roller 130, and respective gears 160-164 substantially as described above in regard to the sheet inverter 108 of FIG. 3. The sheet inverter 158 also includes guide elements G, G2 and G3 substantially as described above in regard to the sheet inverter 108 of FIG. 3.

The sheet inverter 158 further includes a sheet positioner 165. The sheet positioner 165 includes an electric solenoid 136 substantially as described above in regard to the sheet inverter 108 of FIG. 3. The sheet positioner 165 also includes a pusher 168 pivotally supported by a hinge 140 and coupled in driven relationship with the electric solenoid 136. The pusher 168 can be formed from any suitable material such as metal, plastic, etc., and is generally defined by a flat bar or plate. Other suitable forms of pusher 168 and sheet positioner 165 can also be used, as described above with respect to pusher 138 and sheet positioner 135 of FIG. 3.

The sheet positioner 165 (FIG. 4) further includes a backstop 172. The backstop 172 is supported in substantially fixed position with respect to the sheet inverter 158 and is generally defined by a flat plate including a through slot or aperture 173. The backstop 172 can be formed from any suitable material such as plastic, metal, etc. The backstop 172 is configured to cooperate with the pusher 168 so as to limit travel of a sheet media being controllably positioned thereby.

The sheet inverter 158 further includes an exit roller 174. The exit roller 174 can be formed from any material suitable for substantially non-slip contact with sheet media such as, for example: rubber; polyurethane; etc. Other materials can also be used. In the alternative, the exit roller 174 can include a substantially non-slip material borne by some or all of the outer surface of the exit roller 174. The exit roller 174 is supported in rotationally driven relationship with the third roller 130 by way of pulleys 176 and a drive belt 178 and is thus mechanically coupled to the motor 120. The exit roller 174 is configured to transport sheet media toward the exit nip 134 of the sheet inverter 158 by way of contact with the sheet media through the aperture 173 in the backstop 172.

Reference is directed to FIGS. 5 and 6 for clarity of understanding. FIG. 5 is a plan sectional view depicting detail of the sheet inverter 158 of FIG. 4. FIG. 5 depicts the pusher 168 as it is cooperative coupled to the backstop 172 by way of the hinge 140. Further depicted in FIG. 5 is a portion of the electric solenoid 136. FIG. 6 is a front elevation view depicting details of the sheet inverter 158 of FIG. 4. As depicted in FIG. 4, the aperture 173 in the backstop 172 extends over a portion of a widthwise dimension of the backstop 172 in correspondence to an axial length of the exit roller 174. In other respective embodiments (not shown), the aperture 173 and the exit roller 174 extend over correspondingly greater or lesser portions of the width of the backstop 172. In any case, a portion of the outer surface of the exit roller 174 extends thorough the aperture 173 so as to make suitable transporting contact with the sheet media S1 at position P2 (not shown, see FIG. 4).

Reference is now returned to FIG. 4. Typical operation of the sheet inverter 158 is performed substantially as described above in regard to the sheet inverter 108 of FIG. 3 with particular detail as follows: an imaged sheet media S1 is received by the receiving rollers 122 in a substantially side "A" (i.e., printed side) face-up orientation and is transported to the input nip 132. The sheet media S1 is then transported through the input nip 132 to the sheet positioner 165. The electric solenoid 136 then pivots the pusher 168 about the hinge 140 through an angular range R in response to a corresponding control signal from the controller 102 (FIG. 2).

The pusher 168 (FIG. 4) now contacts the sheet media S1 at position P1 and urges (i.e., pivots or displaces) the sheet media S1 toward the backstop 172 and the exit roller 174. At position P2, the sheet media S1 is in actual contact with the pusher 168 and the exit roller 174. The exit roller 174 now transports the sheet media S1 generally toward the exit nip 134 until an edge E' of the sheet media S1 is engaged by the exit nip 134.

The sheet media S1 (FIG. 4) is now transported away from the sheet positioner 165 by the exit nip 134 and is guided out of the sheet inverter 158 by the guide elements G3. Thus, the sheet media S1 exits the sheet inverter 158.
with the side “B” (i.e., non-printed side) in a substantially face-up orientation and is understood to be routed in such orientation to the imaging engine 104 (FIG. 2) under the control of the controller 102.

[0064] The sheet inverter 158 of FIGS. 4-6 is substantially similar to the sheet inverter 108 of FIG. 3, but includes the exit roller 174 such that sheet media of varying lengths can be suitably inverted (i.e., flipped or overturned) by the sheet inverter 158. That is, sheet media which are of insufficient dimension to be directly engaged by the exit nip 134 are transported into engagement with the exit nip 134 by the cooperation of the exit roller 174 and the pusher 168 of the sheet inverter 158. Other configurative and cooperative aspects of the sheet inverter 158 of FIGS. 4-6 are substantially similar to those of the sheet inverter 108 of FIG. 3.

[0065] FIG. 7 is a side elevation view depicting a sheet inverter 208 in accordance with yet another embodiment of the present invention. It is to be understood that the sheet inverter 208 is configured for alternative use to the sheet inverter 108 of FIG. 3. As such, the sheet inverter 208 is substantially cooperative with the imaging apparatus 100 of FIG. 2. The sheet inverter 208 includes a motor 220, a pair of receiving rollers 222, and respective gears 260-264 that are defined, configured and cooperative substantially as described above in regard to the motor 120, pair of receiving rollers 122, and respective gears 260-264, respectively, of the sheet inverter 108 of FIG. 3. Further elaboration of these elements of the sheet inverter 208 is provided hereafter in regard to the typical operation thereof.

[0066] The sheet inverter 208 also includes a first roller 226, a second roller 228, and a third roller 230. The first, second and third rollers 226, 228 and 230 are respectively defined substantially as described above in regard to the first, second and third rollers 126, 128 and 130 of the sheet inverter 108 of FIG. 3. Furthermore, the first roller 226 and the second roller 228 are supported in contacting relationship such that a feed nip 232 is defined. Similarly, the second roller 228 and the third roller 230 are supported in contacting relationship such that an exit nip 234 is defined. Each of the first, second and third rollers 226, 228 and 230 is configured to rotate in a respective predefined direction as designated in FIG. 7 under the controlled drive of the motor 220.

[0067] As depicted in FIG. 7, the first, second and third rollers 226, 228 and 230 are further supported in a “Vee” configuration such that the second rollers 228 is generally elevationally lower than the first roller 226 and the third roller 230. Further elaboration of the first, second and third rollers 226, 228 and 230 is provided hereafter.

[0068] The sheet inverter 208 further includes a containment guide 268. The containment guide 268 can be formed from any suitable substantially ridged material such as metal, plastic, etc. The containment guide 268 is supported in generally overlying relationship with the first, second and third rollers 226, 228 and 230 and is configured to define a receiving cavity 269. The containment guide 268 is further configured to generally laterally support a sheet media within the receiving cavity 269 in cooperative proximity with the first, second and third rollers 226, 228 and 230. Further elaboration of the containment guide 268 is provided hereafter.

[0069] Typical exemplary operation of the sheet inverter 208 (FIG. 7) is as follows: the motor 220 is assumed to provide rotational energy to the pair of receiving rollers 222 and the first, second and third rollers 226, 228 and 230, respectively, by way of the respective gears 260-264. A sheet of media S1 is then received by the receiving rollers 222 in a substantially side “A” (i.e., imaged side) face-up orientation and is transported toward the feed nip 232 in a direction substantially opposite to the influence of gravity (i.e., “up hill”).

[0070] Next, the sheet media S1 (FIG. 7) is engaged by the feed nip 232 and is transported thereby into the receiving cavity 269 of the containment guide 268. The sheet media “S1” is then substantially laterally supported by the containment guide 268 and is substantially vertically supported by the second roller 228 under the influence of gravity. Thereafter, an edge E of the sheet media S1 is transported toward the exit nip 234 of the sheet inverter 208 by way of contact with the rotating second roller 228.

[0071] The sheet media S1 (FIG. 7) is then engaged by the exit nip 234 and is transported generally away from the receiving cavity 269 in a substantially downward direction and is guided out of the sheet inverter 208 by the guide elements G3. It is to be noted that the edge E can be defined as a trailing edge while the sheet media S1 is being transported into the receiving cavity 269 and as a leading edge while the sheet media S1 is being transported away form the receiving cavity 269.

[0072] Thus, the sheet media S1 (FIG. 7) exits the sheet inverter 208 in a substantially side “B” (non-imaged side) face-up orientation. For purposes of example, it is assumed that the sheet media S1 is then routed to the imaging engine 104 (FIG. 2) for selective imaging of the side “B” under the control of the controller 102 (FIG. 2).

[0073] As the sheet inverter 208 is configured for alternative use to the sheet inverter 108 of FIG. 2, the motor 220 is configured to be suitably controlled (i.e., selectively energized) by the controller 102 of the imaging apparatus 100 of FIG. 2. However, the sheet inverter 208 does not require a sheet positioner (such as the sheet positioner 135 of FIG. 3, etc.) to perform the sheet media inverting or ‘flipping’ operation. Rather, the sheet media S1, under the influence of gravity, cooperates with the rotating second roller 228 to substantially accomplish the inverting operation.

[0074] In this way, the sheet inverter 208 performs substantially the same operation as the sheet inverter 108 of FIG. 3 and the sheet inverter 158 of FIGS. 4-6 and does so with a relatively reduced parts count. Also, the sheet inverter 208 is generally configured to operate with a variety of sizes of sheet media.

[0075] FIG. 8 is a flowchart depicting a sheet inverting method 300 in accordance with the present invention. The method 300 is described in the context of the sheet inverter 108 of FIG. 3 for clarity of understanding, but it is to be understood that the method 300 is generally applicable to any embodiment of the present invention.

[0076] In step 302 (FIG. 8), the motor 120 (FIG. 3) is assumed to provide rotating mechanical energy to the receiving rollers 122 and to the first, second and third rollers 126, 128 and 130, respectively, under signal control of the controller 102 (FIG. 2). A sheet of media S1 (FIG. 3) is transported toward the sheet positioner 135 in a substantially
printed-side-up orientation by the feed nip 132 defined by
the first roller 126 and the second roller 128.

[0077] In step 304 (FIG. 8), the sheet of media S1 (FIG.
3) is urged away from the feed nip 132 and into engagement
with the exit nip 134 defined by the second roller 128 and
the third roller 130 by the sheet positioner 135, under signal
control of the controller 102 (FIG. 2).

[0078] In step 306 (FIG. 8), the sheet media S1 (FIG. 3)
is then transported away from the sheet positioner 135 and
generally out of the sheet inverter 108 in a substantially
printed-side-down orientation by the exit nip 134. The sheet
inverting method 300 (FIG. 8) is now complete for a single
sheet of media S1 (FIG. 3).

[0079] While the method 300 details particular steps and
order of execution, it is to be understood that the other steps
and orders of execution corresponding to other embodiments
of the present invention can also be used.

[0080] While the above methods and apparatus have been
described in language more or less specific as to structural
and methodical features, it is to be understood, however,
that they are not limited to the specific features shown and
described, since the means herein disclosed comprise pre-
ferrred forms of putting the invention into effect. The meth-
ods and apparatus are, therefore, claimed in any of their
forms or modifications within the proper scope of the
appended claims appropriately interpreted in accordance
with the doctrine of equivalents.

I claim:

1. A sheet media inverter configured to invert a sheet
media, the sheet media being defined by a first edge, the
sheet media inverter comprising:

first, second, and third rollers respectively configured
such that the first and second rollers define a feed nip,
and the second and third rollers define an exit nip, and
wherein as sheet media is passed completely through
the feed nip, the first edge of the sheet media is at a first
position proximate the feed nip; and

a sheet positioner configured to move the first edge of
the sheet media from the first position to a second position
proximate the exit nip.

2. The sheet media inverter of claim 1, and wherein the
feed nip is configured to transport the sheet media generally
forward the sheet positioner.

3. The sheet media inverter of claim 1, and wherein the
exit nip is configured to engage the first edge of the sheet
media at the second position and to transport the sheet media
generally away from the sheet positioner;

4. The sheet media inverter of claim 1, and further
comprising a motor configured to mechanically drive each
of the first and the second and the third rollers in a respective
predefined direction of rotation.

5. The sheet media inverter of claim 4, and wherein the
predefined direction of rotation of both the first and third
rollers is opposite to that of the second roller.

6. The sheet media inverter of claim 4, and further
comprising a pair of receiving rollers coupled in driven
relationship with the motor, and wherein the pair of receiv-
ring rollers is configured to transport the sheet media into
engagement with the feed nip.

7. The sheet media inverter of claim 4, and further
comprising an exit roller coupled in driven relationship with
the motor and configured to cooperate with the sheet posi-
tioner so as to transport the sheet media into engagement
with the exit nip.

8. The sheet media inverter of claim 1, and wherein the
first and second rollers are in contact with one another, and
the second and third rollers are in contact with one another.

9. The sheet media inverter of claim 1, and wherein the
first, second and third rollers are each defined by an outer
surface, and wherein at least a portion of the outer surface
of each roller includes a surface covering to facilitate
substantially non-slip engagement and transportation of
the sheet media by the rollers.

10. The sheet media inverter of claim 1, and wherein the
sheet positioner comprises a solenoid pusher configured to
close the sheet media proximate the first edge.

11. The sheet media inverter of claim 10, and wherein the
solenoid pusher comprises:

a pusher pivotally supported by the sheet inverter by way
of a hinge; and

an electric solenoid configured to selectively bi-direction-
ally pivot the pusher through a predefined angular
range about the hinge in response to a corresponding
signal from the controller.

12. A sheet media inverter configured to invert a sheet
media, the sheet media being defined by a first edge, the
sheet media inverter comprising:

a containment guide defining a cavity and configured to
receive sheet media within the cavity; and

first, second, and third rollers respectively configured
such that the first and second rollers define a feed nip,
and the second and third rollers define an exit nip, and
wherein the first edge of the sheet media received
within the cavity is transported away from the feed nip
and toward the exit nip by way of gravitationally
influenced contact with the second roller.

13. The sheet media inverter of claim 12, and wherein the
second roller is supported elevationally lower than the first
roller and the third roller, and wherein the second roller is in
contact with the first roller and the third roller.

14. The sheet media inverter of claim 12, wherein the feed
nip is configured to transport the sheet media into the cavity.

15. The sheet media inverter of claim 12, and wherein the
exit nip is configured to engage the first edge of the sheet
media and to transport the sheet media away from the cavity.

16. The sheet media inverter of claim 12, and wherein each
of the first, second and third rollers is defined by a
substantially non-slip outer surface.

17. The sheet media inverter of claim 12, and further
comprising a motor configured to mechanically drive each
of the first, second and third rollers in a respective pre-
defined direction.

18. The sheet media inverter of claim 17, and further
comprising a pair of receiving rollers coupled in driven
relationship with the motor and configured to transport the
sheet media into engagement with the feed nip.

19. The sheet media inverter of claim 12, and wherein the
containment guide is supported in a substantially overlying
position relative to the first, second and third rollers.
20. An imaging apparatus, comprising:

a controller;

an imaging engine configured to selectively form images on a cooperatively exposed first side of a sheet media in response to a corresponding signal from the controller; and

a sheet inverter configured to selectively receive the imaged sheet media and to provide the imaged sheet media to the imaging engine such that a second side of the sheet media is cooperatively exposed to the imaging engine in response to a corresponding signal from the controller, the sheet inverter including:

first, second, and third rollers respectively configured such that the first and second rollers define a feed nip and the second and third rollers define an exit nip; and

a sheet positioner configured to selectively urge an edge of an imaged sheet media away from the feed nip and into engagement with the exit nip in response to a corresponding signal from the controller.

21. The imaging apparatus of claim 20, and further comprising a sheet diverter configured to receive an imaged sheet media from the imaging engine and to selectively route the imaged sheet media to one of an output location or the sheet inverter in response to a corresponding signal from the controller.

22. The imaging apparatus of claim 20, and wherein the sheet positioner includes a solenoid pusher comprising:

a pusher pivotally supported by the sheet inverter by way of a hinge; and

an electric solenoid configured to selectively bi-directionally pivot the pusher through a predefined angular range about the hinge in response to a corresponding signal from the controller.

23. The imaging apparatus of claim 20, and further comprising a motor configured to selectively mechanically drive each of the first and second and the third rollers in a respective predefined direction of rotation in response to a corresponding signal from the controller, and wherein the predefined direction of rotation of the first and third rollers is opposite to that of the second roller.

24. The imaging apparatus of claim 23, and wherein the sheet inverter further comprises a pair of receiving rollers coupled in driven relationship with the motor and configured to selectively transport the received imaged sheet media toward the feed nip in response a corresponding signal from the controller.

25. The imaging apparatus of claim 20, and wherein each of the first, second and third rollers is defined by a substantially non-slip outer surface.

26. A method of inverting a sheet media, comprising:

providing a first roller, a second roller, and a third roller, wherein the first and second rollers define a feed nip, and the second and third rollers define an exit nip;

engaging a sheet media with the feed nip;

transporting the sheet media toward a sheet positioner using the feed nip;

urging an edge of the sheet media out of engagement with the feed nip and into engagement with the exit nip using the sheet positioner; and

transporting the sheet media away from the sheet positioner using the exit nip.

27. The method of claim 26, and further comprising transporting the sheet media toward the feed nip using a pair of receiving rollers.

28. The method of claim 26, and further comprising rotating both of the first and third rollers in a predefined direction and rotating the second roller in an opposite predefined direction.

29. A method of imaging both sides of a sheet media, comprising:

providing a first roller, a second roller, and a third roller, wherein the first and second rollers define a feed nip, and the second and third rollers define an exit nip;

selectively forming images on a first side of a sheet media;

engaging the imaged sheet media with the feed nip;

transporting the imaged sheet media toward a sheet positioner using the feed nip;

urging an edge of the imaged sheet media away from the feed nip and towards the exit nip;

transporting the imaged sheet media away from the sheet positioner using the exit nip; and

selectively forming images on a second side of the imaged sheet media.

30. The method of claim 29, and further comprising transporting the imaged sheet media toward the feed nip using a pair of receiving rollers.

31. The method of claim 29, and further comprising rotating both of the first and third rollers in a predefined direction and rotating the second roller in an opposite predefined direction.

32. A sheet media inverter, comprising:

first, second and third roller means for transporting a sheet media;

motor means for rotating the first and second and third roller means; and

sheet positioner means for urging a sheet media away from the first and second roller means and into engagement with the second and third roller means.

33. The sheet media inverter of claim 32, and further comprising roller pair means coupled to the motor means for transporting the sheet media into engagement with the first and second roller means.

34. The sheet media inverter of claim 32, and wherein the sheet positioning means further comprises an exit roller means configured to urge the sheet media into engagement with the second and third roller means.

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