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Patent Public Search | Text View

United States Patent Application Publication

20250262852

Kind Code

A1

Publication Date

August 21, 2025

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MAGNETIC ENCODER POSITION SENSOR FOR REMOTELY ADJUSTING REGISTRATION OR PRINT PRESSURE OF A CAN DECORATOR

Abstract

A remote registration and print pressure adjustment system includes a can decorator including a plurality of plate cylinders and a plurality of inking stations, each plate cylinder being associated with an individual inking station; a magnetic encoder position sensor disposed in proximity to a rotatory component of the can decorator and structured to detect rotational position parameters of the rotatory component; and a remote registration and print pressure control system structured to receive a position signal including the rotational position parameters from the magnetic encoder position sensor, determine the linear distance based on the position signal and instant position of one of the registration mechanism and the print pressure adjustment mechanism based on the determined linear distance, and cause a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of one of the registration mechanism and the print pressure adjustment mechanism.

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Appl. No.: 18/897464

Filed: September 26, 2024

Related U.S. Application Data

us-provisional-application US 63554330 20240216

Publication Classification

Int. Cl.: **B41F33/00** (20060101); **B41F17/22** (20060101); **B41M1/40** (20060101); **G01B7/30** (20060101); **G01D5/14** (20060101); **G01D5/16** (20060101)

U.S. Cl.:

CPC **B41F33/0009** (20130101); **B41F17/22** (20130101); **B41M1/40** (20130101); **G01B7/30** (20130101); **G01D5/145** (20130101); **G01D5/16** (20130101);

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application claims priority to U.S. Provisional Patent Application Ser. No. 63/554,330, filed Feb. 16, 2024, entitled, **MAGNETIC ENCODER POSITION SENSOR FOR REMOTELY ADJUSTING REGISTRATION OR PRINT PRESSURE OF A CAN DECORATOR**, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The disclosed concept relates generally to a system and method for decorating cans using a can decorator and, more particularly, to a magnetic encoder position sensor for remotely adjusting registration or print pressure of a can decorator.

BACKGROUND OF THE INVENTION

[0003] High speed continuous motion machines for decorating cans, commonly referred to as “can decorator machines” or simply “can decorators,” are generally well known. FIG. 1 shows a can decorator 2. As shown in FIG. 1, a can decorator 2 includes an infeed conveyor 15, which receives cans 16 from a can supply (not shown) and directs them to arcuate cradles or pockets 17 along the periphery of spaced parallel rings secured to a pocket wheel 12. The pocket wheel 12 is fixedly secured to a continuously rotating mandrel carrier wheel 18, which in turn is keyed to a continuously rotating horizontal drive shaft 19. Horizontal spindles or mandrels (not shown), each being pivotable about its own axis, are mounted to the mandrel carrier wheel 18 adjacent its periphery. Downstream from the infeed conveyor 15, each spindle or mandrel is in closely spaced axial alignment with an individual pocket 17, and undecorated cans 16 are transferred from the pockets 17 to the mandrels. Suction applied through an axial passage of the mandrel draws the can 16 to a final seated position on the mandrel.

[0004] While mounted on a mandrel, each can 16 is decorated by being brought into engagement with a blanket (e.g., without limitation, a replaceable adhesive-backed piece of rubber) disposed on a blanket wheel of the multicolor printing unit indicated generally by reference numeral 22. Thereafter, and while still mounted on the mandrels, the outside of each decorated can 16 is coated with a protective film of varnish applied by engagement with the periphery of a varnish applicator roll (not shown) rotating on a shaft 23 in the overvarnish unit indicated generally by reference numeral 24. Cans 16 with decorations and protective coatings thereon are then transferred from the mandrels to suction cups (not shown) mounted adjacent the periphery of a transfer wheel (not shown) rotating on a shaft 28 of a transfer unit 27. From the transfer unit 27 the cans 16 are deposited on generally horizontal pins 29 carried by a chain-type output conveyor 30, which carries the cans 16 through a curing oven (not shown).

[0005] While moving toward engagement with an undecorated can 16, the blanket wheel engages a plurality of plate cylinders 31, each of which is associated with an individual inking station 32 (exemplary eight inking stations 32 are shown in FIG. 1). An inking station 32 may be also referred to herein as an inking station assembly 32. The plurality of plate cylinders 31 and the inking

stations **32** place a label on a can **16** based on a specification from a vendor. Typically, each inking station **32** provides a different color ink and each plate cylinder **31** applies a different ink image segment to the blanket. All of the “ink image” segments combine to produce a “main image” (i.e., a label) that is structured to be applied to the can body. The “main image” is then transferred to undecorated cans **16** and becomes, as used herein, the “can body applied image.”

[0006] Each inking station **32** includes a plurality of rollers, or as used herein, “rolls,” that are structured to transfer a quantity of ink from a reservoir, or as used herein an “ink fountain,” to the blanket. The path that the ink travels is, as used herein, identified as the “ink train.” That is, the rolls over which the ink travels define the “ink train.” Further, as used herein, the “ink train” has a direction with the ink fountain **33** being at the “upstream” end of the ink train and a plate cylinder **31** at the “downstream” end of the ink train.

[0007] The ink train extends over a number of rolls each of which has a purpose. The ink train starts at the ink fountain and is initially applied as a film to a fountain roll. The fountain roll is intermittently engaged by a ductor roll. When the ductor roll engages the fountain roll, a quantity of ink is transferred to the ductor roll. The ductor roll also intermittently engages a downstream roll and transfers ink thereto. The ductor roll has a “duty cycle” which, as used herein, means the ratio of the duration of the ductor roller being in contact with the fountain roller divided by the duration of a complete cycle (ductor roller in contact with the fountain roller, move to the first downstream roller, contact with first steel roller, move back to fountain roller).

[0008] The other rolls include, but are not limited to, distribution roll(s), oscillator roll(s), and transfer roll(s). Generally, these rolls are structured to distribute the ink so that a proper amount of ink is generally evenly applied to the plate cylinder **31**. For example, the oscillator rolls are structured to reciprocate longitudinally about their axis of rotation so as to spread the ink as it is applied to the next downstream roll. The final roll is the plate cylinder **31** which applies the ink to the blanket. It is understood that each inking station **32** applies an “ink image” of a single selected color to the blanket and that each inking station **32** must apply the ink image in a proper position relative to the other ink images so that the main image does not have offset ink images.

[0009] Thus, as used herein, an “ink image” means the image of a single ink color which is part of a “main image.” As used herein, a “main image” means an image created from a number of ink images and which is the image that is applied to a can body as the “can body applied image.” It is understood that a “main image” includes a number, and typically a plurality, of ink images. For example, if the main image was the French flag (which is a tricolor flag featuring three vertical bands colored blue (hoist side), white, and red), an inking station **32** with blue ink would provide an ink image that is a blue rectangle, an inking station **32** with white ink would provide an ink image that is a white rectangle and an inking station **32** with red ink would provide an ink image that is a red rectangle. Further, presuming that the main image was of a French flag with the hoist side on the left, the inking station **32** with blue ink would provide the blue rectangle ink image on the left side of the blanket, the inking station **32** with white ink would provide the white rectangle ink image on the center of the blanket immediately adjacent the blue rectangle ink image, and the inking station **32** with red ink would provide the red rectangle ink image on the right side of the blanket immediately adjacent the white rectangle ink image. Once all the ink images are applied to the blanket, the main image is formed and then applied to a can body.

[0010] Each ink station assembly **32** is structured so that the final rolls before the printing cylinder **31** apply a proper amount of ink to the printing cylinder **31**. Those of skill in the art know the amount of ink required so as to produce an image with an intended clarity, resolution and hue. Thus, as would be understood by those of skill in the art, and as used herein, the “proper” amount of ink is an amount that is neither too little (which typically results in a faint image) nor too much (which typically results in a blurred image), i.e., a “proper” amount of ink is an amount of ink that results in the image being produced with the intended clarity, resolution and hue. Further, the “proper” amount of ink applied to a printing cylinder **31** is also a film with a substantially

consistent thickness. It is understood that those of skill in the art know the amount of ink to be applied to a substrate such as, but not limited to a can body, that is required to produce an image with the intended clarity, resolution and hue. The amount of ink applied may be controlled by adjusting print pressure between a printing plate and the blanket wheel.

[0011] Each plate cylinder **31** must be positioned so as to ensure the ink images are in proper registration. As would be understood by those of skill in the art, and as used herein, the “registration” of an “ink image” means that each ink image is substantially in the proper location. The “proper location” of the ink image means that the ink image is applied to the blanket in the position intended relative to the other ink images applied by other ink station assemblies **32** and that all ink images form a main image wherein the individual ink images do not overlap in an unintended manner. Further, the “proper location” of the ink images means that the ink images, and therefore the main image, has the intended sidelay registration and the intended circumferential registration relative to the other ink images so that the plurality of ink images form the main image. “Circumferential” registration means registration of the ink image in an axial direction around the can **16** as shown by the arrow **1600** and “sidelay” registration means registration in an up/down direction associated with the can **16** as shown by the arrow **1610** in FIG. **1A**. As used herein, the “intended” sidelay/circumferential registration means that the sidelay/circumferential registration is such that the can body applied image is the intended image. As used herein, the “intended image” means the image as created by the creator of the image, as would be understood by those of skill in the art. As used herein, the “can body applied image” means the image as applied to a can body; i.e., the image that is on the can body after a printing operation is complete.

[0012] Registration and/or print pressure may be controlled manually on site at location of the can decorators by a technician who monitors the can decorator output and manually adjusts various elements of the ink station assemblies and/or the blanket wheel so that the ink is applied in a proper amount and in a proper position. Alternatively, it can be controlled by a remote registration adjustment mechanism coupled to the can decorator. For remote registration and/or print pressure adjustment, linear positioning sensors are typically used to detect instant position of the rotatory parts. For example, linear inductive sensors have been used to measure linear distance in plate cylinder motion such that registration and/or print pressure adjustment may be controlled remotely based the measured linear distance. That is, the position of a registration mechanism may be detected by measuring linear distance of a plate cylinder by a linear inductive sensor disposed in proximity to a rotatory component such as a plate cylinder gear. The linear inductive sensors may be inductive analog sensors and monitor registration and print pressure position feedback and measures the linear distance of the plate cylinder moved by the rotations of the plate cylinder gear based on the feedback. However, the linear inductive sensors have limited resolution and repeatability. Their performance is also affected by extreme temperatures, cutting fluids or chemical affects to which the can decorators in general are exposed. Accordingly, the accuracy of the linear inductive sensors has been limited, resulting in errors in detecting positions of rotatory machine parts (e.g., without limitation, the plate cylinder gear) associated with registration and/or print pressure position.

[0013] Any error in registration and/or print pressure position may cause the position of an image to be skewed or misprinted, or result in inefficient levels of ink for a specified optimal temperature required to apply an image on a container. In some instances, there is overlay of print layers which results in ink contamination and undesired colors being printed on the can. In this circumstance, hundreds or thousands of cans need to be discarded and the decorator needs to be shut down, leading to the can line as a whole being shut down and typically production loss between 400 and 6000 cans per minute. This stoppage results in higher operating costs and large amounts of spoilage.

[0014] There is room for improvement in the can manufacturing process.

[0015] There is room for improvement in detecting positions of registration and print pressure

mechanisms moved by rotatory components of can decorators.

SUMMARY OF THE INVENTION

[0016] These needs, and others, are met by a remote registration and print pressure adjustment system including a can decorator including a plurality of plate cylinders and a plurality of inking stations, each plate cylinder being associated with an individual inking station; a magnetic encoder position sensor disposed in proximity to a rotatory component of the can decorator and structured to detect rotational position parameters of the rotatory component, the rotatory component being structured to move one of a registration mechanism and a print pressure adjustment mechanism by a linear distance based on rotations of the rotatory component; and a remote registration and print pressure control system communicatively coupled to the can decorator and the magnetic encoder position sensor, the remote registration and print pressure control system being structured to receive a position signal including the rotational position parameters from the magnetic encoder position sensor, determine the linear distance based on the position signal and instant position of one of the registration mechanism and the print pressure adjustment mechanism based on the determined linear distance, and cause a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of one of the registration mechanism and the print pressure adjustment mechanism.

[0017] Another example embodiment of the disclosed concept provides a method of remotely adjusting registration for a can decorator. The method includes: providing a remote registration adjustment system that comprises: (i) a can decorator including a plurality of plate cylinders and a plurality of inking stations, each plate cylinder being associated with an individual inking station; (ii) a magnetic encoder position sensor disposed in proximity to a rotatory component of the can decorator and structured to detect rotational position parameters of the rotatory component, the rotatory component being structured to move a registration mechanism by a linear distance based on rotations of the rotatory component; and (iii) a remote registration and print pressure control system communicatively coupled to the can decorator and the magnetic encoder position sensor, the remote registration and print pressure control system being structured to receive a position signal including the rotational position parameters from the magnetic encoder position sensor, determine the linear distance based on the position signal and instant position of the registration mechanism based on the determined linear distance, and cause a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the registration mechanism; detecting, by the magnetic encoder position sensor, the rotational position parameters of the rotatory component; receiving, by the remote registration control system, the position signal from the magnetic encoder position sensor; determining, by the remote registration control system, the linear distance based on the position signal and instant position of the registration mechanism based on the determined linear distance; and causing, by the remote registration control system, a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the registration mechanism.

[0018] Yet another example embodiment provides a method of remotely adjusting print pressure of a can decorator. The method comprises: providing a remote print pressure adjustment system that comprises: (i) a can decorator including a plurality of plate cylinders and a plurality of inking stations, each plate cylinder being associated with an individual inking station; (ii) a magnetic encoder position sensor disposed in proximity to a rotatory component of the can decorator and structured to detect rotational position parameters of the rotatory component, the rotatory component being structured to move a print pressure adjustment mechanism by a linear distance based on rotations of the rotatory component; and (iii) a remote registration and print pressure control system communicatively coupled to the can decorator and the magnetic encoder position sensor, the remote registration and print pressure control system being structured to receive a position signal including the rotational position parameters from the magnetic encoder position sensor, determine the linear distance based on the position signal and instant position of the print

pressure adjustment mechanism based on the determined linear distance, and cause a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the print pressure adjustment mechanism; detecting, by the magnetic encoder position sensor, the rotational position parameters of the rotatory component; receiving, by the remote registration control system, the position signal from the magnetic encoder position sensor; determining, by the remote registration control system, the linear distance based on the position signal and instant position of the print pressure adjustment mechanism based on the determined linear distance; and causing, by the remote registration control system, a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the print pressure adjustment mechanism.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] A full understanding of the invention can be gained from the following description of the preferred embodiments when read in conjunction with the accompanying drawings in which:

[0020] FIG. 1 is a side elevation view of an exemplary can decorator;

[0021] FIG. 1A illustrates circumferential and sidelay registration during can decorating;

[0022] FIG. 2 is an isometric view of a portion of a can decorator machine and ink station assembly therefor, in accordance with a non-limiting, example embodiment of the disclosed concept;

[0023] FIG. 3 is a partially schematic isometric view of one of the ink station assemblies of FIG. 2 in accordance with a non-limiting, example embodiment of the disclosed concept;

[0024] FIG. 4 is an isometric view of a printing plate cylinder pressure adjustment assembly operatively coupled to a printing cylinder assembly; and

[0025] FIG. 5 is a flow chart for a method of remote registration adjustment in accordance with a non-limiting, example embodiment of the disclosed concept.

DETAILED DESCRIPTION OF THE INVENTION

[0026] It will be appreciated that the specific elements illustrated in the figures herein and described in the following specification are simply exemplary embodiments of the disclosed concept, which are provided as non-limiting examples solely for the purpose of illustration.

Therefore, specific dimensions, orientations, assembly, number of components used, embodiment configurations and other physical characteristics related to the embodiments disclosed herein are not to be considered limiting on the scope of the disclosed concept.

[0027] Directional phrases used herein, such as, for example, clockwise, counterclockwise, left, right, top, bottom, upwards, downwards and derivatives thereof, relate to the orientation of the elements shown in the drawings and are not limiting upon the claims unless expressly recited therein.

[0028] As used herein, the singular form of “a,” “an,” and “the” include plural references unless the context clearly dictates otherwise.

[0029] As used herein, “structured to [verb]” means that the identified element or assembly has a structure that is shaped, sized, disposed, coupled and/or configured to perform the identified verb. For example, a member that is “structured to move” is movably coupled to another element and includes elements that cause the member to move or the member is otherwise configured to move in response to other elements or assemblies. As such, as used herein, “structured to [verb]” recites structure and not function. Further, as used herein, “structured to [verb]” means that the identified element or assembly is intended to, and is designed to, perform the identified verb. Thus, an element that is merely capable of performing the identified verb but which is not intended to, and is not designed to, perform the identified verb is not “structured to [verb].”

[0030] As used herein, “associated” means that the elements are part of the same assembly and/or

operate together or act upon/with each other in some manner. For example, an automobile has four tires and four hub caps. While all the elements are coupled as part of the automobile, it is understood that each hubcap is “associated” with a specific tire.

[0031] As used herein, the statement that two or more parts or components are “coupled” shall mean that the parts are joined or operate together either directly or indirectly, i.e., through one or more intermediate parts or components, so long as a link occurs. As used herein, “directly coupled” means that two elements are directly in contact with each other. As used herein, “fixedly coupled” or “fixed” means that two components are coupled so as to move as one while maintaining a constant orientation relative to each other. As used herein, “adjustably fixed” means that two components are coupled so as to move as one while maintaining a constant general orientation or position relative to each other while being able to move in a limited range or about a single axis. For example, a doorknob is “adjustably fixed” to a door in that the doorknob is rotatable, but generally the doorknob remains in a single position relative to the door. Further, a cartridge (nib and ink reservoir) in a retractable pen is “adjustably fixed” relative to the housing in that the cartridge moves between a retracted and extended position, but generally maintains its orientation relative to the housing. Accordingly, when two elements are coupled, all portions of those elements are coupled. A description, however, of a specific portion of a first element being coupled to a second element, e.g., an axle first end being coupled to a first wheel, means that the specific portion of the first element is disposed closer to the second element than the other portions thereof. Further, an object resting on another object held in place only by gravity is not “coupled” to the lower object unless the upper object is otherwise maintained substantially in place. That is, for example, a book on a table is not coupled thereto, but a book glued to a table is coupled thereto.

[0032] As used herein, the statement that two or more parts or components “engage” one another means that the elements exert a force or bias against one another either directly or through one or more intermediate elements or components. Further, as used herein with regard to moving parts, a moving part may “engage” another element during the motion from one position to another and/or may “engage” another element once in the described position. Thus, it is understood that the statements, “when element A moves to element A first position, element A engages element B,” and “when element A is in element A first position, element A engages element B” are equivalent statements and mean that element A either engages element B while moving to element A first position and/or element A either engages element B while in element A first position.

[0033] As used herein, “correspond” indicates that two structural components are sized and shaped to be similar to each other and may be coupled with a minimum amount of friction. Thus, an opening which “corresponds” to a member is sized slightly larger than the member so that the member may pass through the opening with a minimum amount of friction. This definition is modified if the two components are to fit “snugly” together. In that situation, the difference between the size of the components is even smaller whereby the amount of friction increases. If the element defining the opening and/or the component inserted into the opening are made from a deformable or compressible material, the opening may even be slightly smaller than the component being inserted into the opening. With regard to surfaces, shapes, and lines, two, or more, “corresponding” surfaces, shapes, or lines have generally the same size, shape, and contours.

[0034] As used herein, the term “number” shall mean one or an integer greater than one (i.e., a plurality). That is, for example, the phrase “a number of elements” means one element or a plurality of elements. It is specifically noted that the term “a ‘number’ of [X]” includes a single [X].

[0035] As used herein, “about” in a phrase such as “disposed about [an element, point or axis]” or “extend about [an element, point or axis]” or “[X] degrees about an [an element, point or axis],” means encircle, extend around, or measured around. When used in reference to a measurement or in a similar manner, “about” means “approximately,” i.e., in an approximate range relevant to the measurement as would be understood by one of ordinary skill in the art.

[0036] As used herein, an “elongated” element inherently includes a longitudinal axis and/or longitudinal line extending in the direction of the elongation.

[0037] As used herein, “generally” means “in a general manner” relevant to the term being modified as would be understood by one of ordinary skill in the art.

[0038] As used herein, “substantially” means “for the most part” relevant to the term being modified as would be understood by one of ordinary skill in the art.

[0039] As used herein, “at” means on and/or near relevant to the term being modified as would be understood by one of ordinary skill in the art.

[0040] FIG. 2 illustrates a remote registration and print pressure adjustment system **1000** in accordance with a non-limiting, example embodiment of the disclosed concept. The remote registration and print pressure adjustment system **1000** includes a can decorator machine (alternately as used herein a “can decorator”) **100** and a registration and print pressure adjustment control system **600**. The can decorator machine **100** includes a can transport assembly **102** (shown schematically) and an ink application system **104**. The can transport assembly **102** is structured to move a number of undecorated can bodies **300** into contact with the ink application system **104** and, as shown, a blanket wheel **112** and/or an image transfer segment **114**. The ink application system **104** is structured to apply ink in a selected pattern to the exterior of each can body **300**, and includes a plurality of ink station assemblies **200** (eight are shown) and a blanket wheel **112**. It will be appreciated that, while the can decorator **100** in the example shown and described herein includes eight ink station assemblies **200**, that it could alternatively contain any known or suitable alternative number and/or configuration of ink station assemblies (not shown), without departing from the scope of the disclosed concept. It will further be appreciated that, for economy of disclosure and simplicity of illustration, only one of the ink station assemblies **200** will be shown and described in detail herein.

[0041] As shown in detail in FIG. 3, the ink station assembly **200** includes an ink fountain **202** and a printing plate cylinder assembly **221**. The ink fountain **202** is structured to provide a supply of ink **400** (shown in phantom line drawing in simplified form in FIG. 3). Each printing plate cylinder assembly **221** includes a printing plate cylinder **222** having a printing plate (generally indicated by reference number **224**) as well as a printing plate cylinder axial adjustment assembly **226** and a circumferential adjustment assembly **228**, shown schematically in FIG. 3. The printing plate cylinder **222** cooperates with a number of form rolls **230** to apply the ink **400** to the printing plate **224**. The printing plate cylinder **222** engages the blanket wheel **112** and/or the image transfer segment **114**. The blanket wheel **112** and/or the image transfer segment **114** (FIG. 2) engages a can body **300** thereby transferring the ink to the can body **300**. Thus, generally, each ink station assembly **200** defines an ink train, whereby ink **400** is transferred from the fountain roll **204** to the form roll **230**. It is understood that each ink station assembly **200** applies a single color ink image to the blanket wheel **112** and/or an image transfer segment **114**.

[0042] The axial adjustment assembly **226** is structured to move the printing plate cylinder **222** in an axial direction relative to the printing plate cylinder **222** axis of rotation. That is, the axial adjustment assembly **226** is structured to, and does, alter the sidelay registration of the main image. That is, as the axial position of each ink image is moved axially (while being brought into proper sidelay registration with the other ink images), the position of the main image is moved axially relative to the can body upon which the main image is applied. In an exemplary non-limiting embodiment, the axial adjustment assembly **226** includes a mounting **227** and an actuator **229**, both shown in simplified form in FIG. 3. The axial adjustment assembly mounting **227** is structured to, and does, rotatably support the printing plate cylinder **222** (and/or the axle (not numbered) of the printing plate cylinder **222**). The axial adjustment assembly mounting **227** is movable coupled to the printing unit frame assembly **22**. The axial adjustment assembly actuator **229** is structured to move the axial adjustment assembly mounting **227** relative to the printing unit frame assembly **22** so that the printing plate cylinder **222** moves in an axial direction. It is understood that as the

printing plate cylinder **222** moves in an axial direction, the location of the ink image (and/or the main image) changes position on the blanket wheel **112** and/or an image transfer segment **114**. The change in position of the ink image (and/or the main image) on the blanket wheel **112** and/or an image transfer segment **114** changes the position of the can body applied image on the can body **300**. That is, the position of the can body applied image on the can body **300** is moved in an axial direction on the can body **300**.

[0043] The circumferential adjustment assembly **228** is structured to alter the circumferential registration of the can body applied image. The circumferential adjustment assembly **228** includes bearings on the printing cylinder shaft which are driven by a helical gear **1110** (schematically shown in FIGS. **2** and **3**) mounted to the shaft (not shown). A plate cylinder helical gear **1110** is driven by a larger helical gear **1110** (schematically shown in FIGS. **2** and **3**) mounted on the blanket wheel **112**. The plate cylinder helical gear **1110** is rotationally keyed to the shaft, but it is allowed to move axially on the shaft. A linear screw mechanism (not shown) is used to move the helical gear **1110** axially on the shaft while the machine **100** is running. The axial movement of the plate cylinder gear **1110** causes the shaft to rotatably advance or retard its timing proportional to the helix angle of the gear **1110**. This advances or retards the location of the ink image on the blanket for that particular color. These elements are collectively and schematically represented by box **228** on FIG. **3**. The circumferential adjustment assembly **228** further includes an actuator **233** (shown schematically) that is structured to, and does, actuate the linear screw mechanism.

[0044] The registration and print pressure adjustment control system **600** (shown schematically in FIG. **2**) is structured to determine a linear distance by which a registration mechanism or a print pressure adjustment mechanism is moved as a result of rotations of an associated rotatory component **1100** of the can decorator **100**, determine instant position of the registration mechanism or the print pressure adjustment mechanism based on the linear distance, and remotely (and automatically) adjust instant print parameters of an ink image based at least in part on the linear distance.

[0045] The registration and print pressure adjustment control system **600** includes an electronic can decorator control assembly **602**, a mechanical can decorator control assembly **604** and a magnetic encoder position sensor **1**. In some examples, the registration and print pressure adjustment control system **600** may also include a number of image sensors **606** (e.g., without limitation, cameras) structured to capture ink images/the main images printed on the cans **300**. The electronic can decorator control assembly **602** is communicatively coupled to the mechanical can decorator control assembly **604** and the magnetic encoder position sensor **1** in a wired or wireless connection. The electronic can decorator control assembly **602** is structured to determine if the ink image applied to can body has the proper amount of ink and that the ink images/the main image are/is in the proper location. A proper amount of ink and a proper position of ink image are set forth by a label specification provided by a customer. As mentioned previously, the ink image is applied at a proper position, e.g., if the main image does not have offset ink images. The electronic can decorator control assembly **602** includes a programmable logic circuit (PLC) **610** and a number of modules, e.g., without limitation, a database module **620** and a comparison module **622**. The registration and print pressure adjustment control system **600** may be part of or in communication with an external control system. However, it will be appreciated that in some exemplary embodiments, the registration and print pressure adjustment control system **600** may be omitted.

[0046] In an exemplary embodiment, the database module **620** includes at least predefined print parameters in accordance with the label specification and a comparison module **622**. The predefined print parameters include at least predefined registration parameters including predefined sidelay registration parameters and predefined circumferential registration parameters, predefined ink thickness, predefined print pressure based on the predefined ink thickness, predefined ink colors or predefined hews. The comparison module **622** is further structured to compare a position signal received from the magnetic encoder position sensor **1** to the predefined print parameters. The

position signal may include rotational position parameters of the rotatory component **1100** (FIG. 2). The rotational position parameters include changes in the magnetic field and an angular information (e.g., degree of rotation of a sensor target) converted from the changes in the magnetic field. The PLC **610** receives the position signal and determines a linear distance of the registration mechanism or the print pressure adjustment mechanism, the linear distance having been caused by the rotations of associated rotatory components (e.g., a plate cylinder gear **1110** as schematically shown in FIG. 2) of the can decorator **100** by converting the angular information into the linear distance. Based on the determined linear distance, the PLC **610** may determine the instant position of the registration mechanism or the print pressure adjustment mechanism. The PLC **610** may then determine instant print parameters based on the instant position of the registration mechanism or the print pressure adjustment mechanism. The comparison module **622** may then compare the instant print parameters to the predefined print parameters stored in the database module **610**. If the comparison module **622** determines that the instant print parameters do not fall within the acceptable registration or print pressure parameters (e.g., predefined registration or print pressure thresholds), the registration and print pressure adjustment control system **600** causes a corresponding actuator **650** (e.g., without limitation, a printing plate cylinder assembly circumferential adjustment assembly actuators **658** in FIG. 3) to adjust the position of the registration mechanism or the print pressure adjustment mechanism such that the instant print parameters are adjusted to be within the predefined print parameters. As used herein, “acceptable” means that the can body applied image/ink images/main image is substantially the intended image, as would be understood by those of skill in the art. For example and without limitation, an acceptable registration in accordance with an embodiment of the disclosed concept is preferably within about 0.001 inch of the intended image position and, more preferably, within about 0.0005 inch of the intended image position. It is understood that those of skill in the art are capable of creating, and do create, can image data that is an electronic construct representing the intended image.

[0047] The mechanical can decorator control assembly **604** includes an actuator **650** (as used herein, the reference number **650** represents a generic actuator or any actuator of the mechanical can decorator control assembly **604**) structured to actuate the associated construct, and thus structured to be operatively coupled to the associated construct. In exemplary embodiments, the mechanical can decorator control assembly **604** includes at least one, or, a number of, ink application adjustment assembly actuator(s) **652** (FIG. 3, shown schematically), a number of ductor roll assembly duty cycle adjustment actuators **654** (FIG. 3, shown schematically), a number of printing plate cylinder assembly axial adjustment assembly actuators **656** (FIG. 3, shown schematically), a number of printing plate cylinder assembly circumferential adjustment assembly actuators **658** (FIG. 3, shown schematically), and/or a number of printing plate cylinder pressure adjustment assembly actuators.

[0048] Each ink application adjustment assembly actuator **652** is coupled to an ink application adjustment assembly adjustment device (not shown) and structured to actuate the ink application adjustment assembly **500**. Each ductor roll assembly duty cycle adjustment actuator **654** is structured to actuate the ductor roll assembly duty cycle adjustment assembly **209** so as to adjust the amount of ink applied to the printing plate cylinder assembly. Each printing plate cylinder assembly axial adjustment assembly actuator **656** is operatively coupled to the axial adjustment assembly **226**. In another exemplary non-limiting embodiment, each printing plate cylinder assembly axial adjustment assembly actuator **656** is an axial adjustment assembly mounting actuator **229**. Each printing plate cylinder assembly circumferential adjustment assembly actuator **658** is operatively coupled to the circumferential adjustment assembly **228** including bearings on the printing cylinder shaft that are driven by the plate cylinder helical gear **1110** mounted to the shaft (not shown). A printing plate cylinder pressure adjustment assembly actuator is structured to actuate a printing plate cylinder pressure adjustment assembly **700** (FIG. 4).

[0049] FIG. 4 is an isometric view of the printing plate cylinder pressure adjustment assembly 700. The printing plate cylinder pressure adjustment assembly 700 is structured to adjust printing plate cylinder pressure and operatively coupled to a printing plate cylinder assembly 221. The printing plate cylinder assembly 221 includes a printing plate cylinder drive shaft 240. Rotation of the printing plate cylinder drive shaft 240 causes rotation of the printing plate 224 (FIG. 3). The printing plate cylinder drive shaft 240 is driven via a printing plate cylinder drive gear 241 (FIG. 4). A printing plate cylinder pressure adjustment assembly actuator may include an air motor 701 operatively coupled to a worm gear 1120 such that operation of the air motor 701 causes turning of the worm gear 1120. That is, the operation of the air motor 701 causes a worm gear drive shaft (not shown) to move linearly, and as the drive shaft moves linearly, the teeth of a worm drive gear (not shown) interact with the teeth of the worm gear 1120 to cause the worm gear 1120 to rotate. The worm gear 1120 is operatively coupled to an elongated member such as, for example and without limitation, a turnbuckle assembly 703 such that turning of the worm gear 1120 causes movement of the turnbuckle assembly 703 via an eccentric pivot. The turnbuckle assembly 703 is in turn operatively coupled to an eccentric bushing 1130 via an eccentric bushing bracket 243 such that movement of the turnbuckle assembly 703 causes corresponding movement of the eccentric bushing 1130. The eccentric bushing 1130 is disposed around the printing plate cylinder drive shaft 240 of the printing plate cylinder assembly 221 and has an eccentric shape such that rotation of the eccentric bushing 1130 will cause the printing plate cylinder drive shaft 240, and thus the printing plate 224 (FIG. 3) to move closer or further from the blanket wheel 112.

[0050] The magnetic encoder position sensor 1 is communicatively coupled to the electronic can decorator control assembly 602. It may be a standard magnetic encoder position sensor, and include a permanent magnet attached to a rotatory component (i.e., a sensor target 1100 (FIG. 2)) and a magnetic sensor disposed in proximity to the sensor target 1100. The magnetic encoder position sensor 1 may be a magneto-resistive sensor or a Hall effect sensor. The magnetic encoder position sensor 1 is structured to detect rotational position parameters of the sensor target 1100, the rotational position parameters including changes of the magnetic field generated by the permanent magnet and transmit a position signal including the rotational position parameters to a control circuit (e.g., without limitation, the PLC 610). That is, the direction of the magnetic field detected by the magnetic sensor changes as the permanent magnet attached to the sensor target 1100 rotates. The change of the magnetic field is converted into an angular information (i.e., degree of the revolution of the sensor target 1100) of the rotations of the sensor target 1100. Upon receiving the position signal including the rotational position parameters, the PLC 610 is structured to determine a linear distance of the registration mechanism moved by the rotations of the sensor target 1100 by converting the angular information into the linear distance. The PLC 610 is further structured to determine a position of associated registration mechanism or print pressure adjustment mechanism based on the linear distance. The comparison module 622 may determine instant print parameters based on the position of the associated registration mechanism and compare the instant print parameters to the predefined registration parameters stored in the database module 620. The instant print parameters include instant registration parameters, instant print pressure parameters, and other parameters associated with registration and/or print pressure. Based on the comparison, the comparison module 622 may determine that the instant print parameters are to be adjusted in accordance with the predefined print parameters. For example, if the comparison module 622 determines that instant registration parameters do not fall within the acceptable registration (e.g., predefined registration thresholds), the registration and print pressure adjustment control system 600 causes a corresponding actuator 650 to adjust the registration mechanism such that the ink image is printed within the acceptable registration. In another example, if the comparison module 622 determines that instant print pressure does not fall within the acceptable print pressure parameters (e.g., predefined print pressure thresholds), the registration and print pressure adjustment control system 600 causes a corresponding actuator 650 to adjust the print pressure

adjustment mechanism such that the print pressure falls within the predefined print pressure thresholds.

[0051] The sensor target **1100** may include any rotatory components associated with registration and/or print pressure adjustment, e.g., without limitation, the plate cylinder helical gear **1110** (schematically shown in FIG. 2), the worm gear **1120** (FIG. 4), the eccentric bushing **1130** (FIG. 4), or other components whose changes in rotational position correspond to registration and/or print pressure changes. For example, the magnetic encoder position sensor **1** may be disposed in proximity to a plate cylinder helical gear **1110** (schematically shown in FIG. 2) of the circumferential adjustment assembly **228**. The magnetic encoder position sensor **1** is structured to detect rotational position parameters of the plate cylinder helical gear **1100** based on changes of the magnetic field, and transmit a position signal including the rotational position parameters to the PLC **610** of the registration and print pressure adjustment control system **600**. The magnetic encoder position sensor **1** converts the changes of the magnetic field into an angular information of the rotation (i.e., degree of revolution) of the plate cylinder helical gear **1100**. Upon receiving the position signal, the PLC **610** is structured to convert the angular information into linear distance of a corresponding registration mechanism (e.g., without limitation, a printing cylinder shaft (not shown)) moved by the rotations of the plate cylinder helical gear **1110**. The PLC **610** then determines the position of the printing cylinder shaft based on the linear distance and instant print pressure based on the position of the printing cylinder shaft. The comparison module **622** then compares the instant print pressure to the predefined print pressure threshold stored in the database module **610**. If the comparison module **622** determines that the instant registration parameters fall outside of the acceptable registration (e.g., the predefined registration threshold), the remote registration and print pressure adjustment system **600** is structured to cause the can decorator **100** (e.g., without limitation, the actuator **658** or actuator **233**) to adjust the instant registration parameters to fall within the predefined registration threshold.

[0052] In another example, the magnetic encoder position sensor **1** may be disposed in proximity to a worm gear **1120** operatively coupled to an air motor **701** of the printing plate cylinder adjustment assembly **700**. The magnetic encoder position sensor **1** is structured to detect rotational position parameters of the worm gear **1120** based on changes of the magnetic field, and transmit a position signal including the rotational position parameters to the PLC **610** of the registration and print pressure adjustment control system **600**. The magnetic encoder position sensor **1** converts the changes of the magnetic field into angular information of the rotation of the worm gear **1120**. Upon receiving the position signal, the PLC **610** is structured to convert the angular information into a linear distance between the eccentric bushing **1130** and the blanket wheel **112** as a result of the rotations of the worm gear **1120**. The PLC **610** further converts the linear distance into an instant print pressure of the printing plate **224** against the blanket wheel **112**. The comparison module **622** then compares the instant print pressure to the predefined print pressure stored in the database module **620**. If the comparison module **622** determines that the print pressure of the printing plate **224** against the blanket wheel **112** falls outside of the acceptable print pressure (e.g., the predefined print pressure threshold), the PLC **610** is structured to cause the can decorator **100** (e.g., without limitation, the air motor **701**) to adjust the position of the printing plate such that the instant print pressure parameters fall within the predefined print pressure threshold. That is, the PLC **610** causes the air motor **701** to increase or decrease its speed such that the position of the printing plate **224** is adjusted and the print pressure parameters are adjusted to fall within the predefined print pressure threshold.

[0053] In some examples, the magnetic encoder position sensor **1** may be disposed in proximity to the eccentric bushing **1130** and detect the rotational position parameters of the eccentric bushing **1130** based on changes of the magnetic field, and transmit a position signal including the rotational position parameters to the PLC **610** of the registration control system **600**. The magnetic encoder position sensor **1** converts the changes of the magnetic field into angular information of the rotation

of the eccentric bushing **1130**. Upon receiving the position signal, the PLC **610** is structured to convert the angular information into linear distance between the eccentric bushing **1130** and the blanket wheel **112**. The PLC **610** further converts the linear distance into instant print pressure of the printing plate **224** against the blanket wheel **112**. The comparison module **622** then compares the instant print pressure to the predefined print pressure stored in the database module **620**. If the comparison module **622** determines that the print pressure of the printing plate **224** against the blanket wheel **112** falls outside of the acceptable print pressure (e.g., a predefined print pressure threshold), the registration and print pressure adjustment control system **600** is structured to cause the can decorator **100** (e.g., without limitation, the air motor **701**) to adjust instant print pressure parameters. That is, the PLC **610** causes the air motor **701** to increase or decrease its speed such that the position of the printing plate is adjusted, and thus the instant print pressure is also adjusted to be within the predefined print pressure threshold. It will be understood that these examples are for illustrated purposes only, and thus a sensor target **1100**, associated registration mechanism, and associated actuator **650** may include any other rotatory machines, registration mechanism, and actuators **650** as appropriate for remotely adjusting registration and/or print pressure without departing from the scope of the disclosed concept.

[0054] Accordingly, the magnetic encoder position sensor **1** of the disclosed concept improves accuracy of the position detection significantly as compared to that of linear position sensors. For example, the linear inductive sensors measure linear distance in order to detect position of the registration mechanism. As such, when measuring small amounts of linear movement of the sensor target **1100**, the accuracy of such measurement is limited by resolution of the sensors. The linear inductive sensors, however, are subject to a minimum resolution and repeatability. By measuring angular information of the rotations of the sensor target **1100** and converting the angular information into linear distance moved by the sensor target **1100**, the magnetic encoder position sensor **1** avoids the resolution and repeatability of the linear inductive sensors, thereby significantly increasing the accuracy of the position detection of sensor target **1100**.

[0055] FIG. **5** is a flow chart for a method **5000** of remote registration adjustment for a can decorator using a magnetic encoder position sensor according to a non-limiting, example embodiment of the disclosed concept. The can decorator is similar to the can decorator **100** as described with reference to FIGS. **2-4**. The method **5000** may be performed by the can decorator **100** or any components thereof.

[0056] At **5010**, a remote registration adjustment system for a can decorator is provided. The remote registration adjustment system includes: (i) a can decorator including a plurality of plate cylinders and a plurality of inking stations, each plate cylinder being associated with an individual inking station; (ii) a magnetic encoder position sensor disposed in proximity to a rotatory component of the can decorator and structured to detect rotational position parameters of the rotatory component, the rotatory component being structured to move a registration mechanism by a linear distance based on rotations of the rotatory component; and (iii) a remote registration and print pressure control system communicatively coupled to the can decorator and the magnetic encoder position sensor, the remote registration and print pressure control system being structured to receive a position signal including the rotational position parameters from the magnetic encoder position sensor, determine the linear distance based on the position signal and instant position of the registration mechanism based on the determined linear distance, and cause a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the registration mechanism.

[0057] At **5020**, the magnetic encoder position sensor detects rotational position parameters of the rotatory component.

[0058] At **5030**, the remote registration control system receives the position signal from the magnetic encoder position sensor.

[0059] At **5040**, the remote registration control system determines the linear distance based on the

position signal and instant position of the registration mechanism based on the determined linear distance.

[0060] At **5050**, the remote registration mechanism causes a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the registration mechanism.

[0061] While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of disclosed concept which is to be given the full breadth of the claims appended and any and all equivalents thereof.

Claims

1. A remote registration and print pressure adjustment system, comprising: a can decorator including a plurality of plate cylinders and a plurality of inking stations, each plate cylinder being associated with an individual inking station; a magnetic encoder position sensor disposed in proximity to a rotatory component of the can decorator and structured to detect rotational position parameters of the rotatory component, the rotatory component being structured to move one of a registration mechanism and a print pressure adjustment mechanism by a linear distance based on rotations of the rotatory component; and a remote registration and print pressure control system communicatively coupled to the can decorator and the magnetic encoder position sensor, the remote registration and print pressure control system being structured to receive a position signal including the rotational position parameters from the magnetic encoder position sensor, determine the linear distance based on the position signal and instant position of one of the registration mechanism and the print pressure adjustment mechanism based on the determined linear distance, and cause a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of one of the registration mechanism and the print pressure adjustment mechanism.
2. The system of claim 1, wherein the rotational position parameters include an angular information and speed of the rotations.
3. The system of claim 2, wherein for determining the linear distance, the remote registration and print pressure control system is further structured to convert the angular information into the linear distance.
4. The system of claim 1, wherein for causing the corresponding actuator of the rotatory component to adjust the rotational positional parameters, the remote registration and print pressure control system is further structured to determine instant print parameters associated with the registration mechanism or the print pressure adjustment mechanism and determine that the instant print parameters fall outside of predefined thresholds.
5. The system of claim 4, wherein the remote registration and print pressure control system comprises a programmable logic circuit, a database module, and a comparison module.
6. The system of claim 5, wherein the programmable logic circuit is structured to convert an angular information of the rotations of the rotatory component into the linear distance, and the database module comprises the predefined thresholds and predefined printing parameters including at least predefined registration parameters, predefined ink thickness, predefined print pressure parameters based on the predefined ink thickness or predefined ink colors.
7. The system of claim 6, wherein the comparison module is structured to compare the instant print parameters to the predefined thresholds and determine that the instant position of one of the registration mechanism and the print pressure adjustment mechanism associated with the rotatory component is to be adjusted based on the determination that the instant print parameters fall outside

of the predefined thresholds.

8. The system of claim 7, wherein the remote registration and print pressure control system adjusts the instant position of one of the registration mechanism and the print pressure adjustment mechanism by adjusting the rotational position parameters of the rotatory component by the corresponding actuator.

9. The system of claim 1, wherein the magnetic encoder position sensor comprises a magneto-resistive sensor.

10. The system of claim 1, wherein the magnetic encoder position sensor comprises a Hall effect sensor.

11. The system of claim 1, wherein the magnetic encoder position sensor comprises a permanent magnet disposed at the rotatory component and a magnetic sensor aligned with the permanent magnet and disposed in proximity to the rotatory component, the magnetic sensor being structured to detect change in magnetic field of the permanent magnet based on the rotations of the rotatory component and convert the change in the magnetic field into an angular information of the rotations.

12. The system of claim 1, wherein the magnetic encoder position sensor does not comprise a linear inductive sensor structured to directly measure a linear distance of one of the registration mechanism and the print pressure adjustment mechanism caused by the rotations of the rotatory component.

13. The system of claim 1, wherein the position of one of the registration mechanism and the print pressure adjustment mechanism detected by the magnetic encoder position sensor based on an angular information of the rotations of the rotatory component has a higher accuracy as compared to a detected position of one of the registration mechanism and the print pressure adjustment mechanism based on a direct measurement of linear distance by a linear inductive sensor.

14. The system of claim 1, wherein the rotatory component comprises a plate cylinder helical gear a circumferential adjustment assembly, a worm gear of a printing plate cylinder adjustment assembly, an eccentric bushing of the printing plate cylinder adjustment assembly, or any rotatory component affecting the registration or the print pressure.

15. The system of claim 1, wherein the registration mechanism comprises at least a printing cylinder shaft of a circumferential adjustment assembly, a printing plate of a printing plate cylinder or a printing plate cylinder drive shaft of the printing plate cylinder assembly.

16. The system of claim 1, wherein the corresponding actuator comprises at least a printing plate cylinder assembly circumferential adjustment assembly actuator or an air motor.

17. A method of remotely adjusting registration for a can decorator, comprising: providing a remote registration adjustment system that comprises: (i) a can decorator including a plurality of plate cylinders and a plurality of inking stations, each plate cylinder being associated with an individual inking station; (ii) a magnetic encoder position sensor disposed in proximity to a rotatory component of the can decorator and structured to detect rotational position parameters of the rotatory component, the rotatory component being structured to move a registration mechanism by a linear distance based on rotations of the rotatory component; and (iii) a remote registration and print pressure control system communicatively coupled to the can decorator and the magnetic encoder position sensor, the remote registration and print pressure control system being structured to receive a position signal including the rotational position parameters from the magnetic encoder position sensor, determine the linear distance based on the position signal and instant position of the registration mechanism based on the determined linear distance, and cause a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the registration mechanism; detecting, by the magnetic encoder position sensor, the rotational position parameters of the rotatory component; receiving, by the remote registration control system, the position signal from the magnetic encoder position sensor; determining, by the remote registration control system, the linear distance based on the position signal and instant

position of the registration mechanism based on the determined linear distance; and causing, by the remote registration control system, a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the registration mechanism.

18. The method of claim 17, wherein the rotational position parameters include an angular information and speed of the rotations and wherein the determining the linear distance comprises converting the angular information into the linear distance.

19. A method of claim 17, wherein causing the corresponding actuator of the rotatory component to adjust the rotational positional parameters comprises: determining, by the remote registration and print pressure control system, instant print parameters associated with the registration mechanism or the print pressure adjustment mechanism; and determining, by the remote registration and print pressure control system, the instant print parameters fall outside of predefined thresholds.

20. A method of remotely adjusting print pressure of a can decorator, comprising: providing a remote print pressure adjustment system that comprises: (i) a can decorator including a plurality of plate cylinders and a plurality of inking stations, each plate cylinder being associated with an individual inking station; (ii) a magnetic encoder position sensor disposed in proximity to a rotatory component of the can decorator and structured to detect rotational position parameters of the rotatory component, the rotatory component being structured to move a print pressure adjustment mechanism by a linear distance based on rotations of the rotatory component; and (iii) a remote registration and print pressure control system communicatively coupled to the can decorator and the magnetic encoder position sensor, the remote registration and print pressure control system being structured to receive a position signal including the rotational position parameters from the magnetic encoder position sensor, determine the linear distance based on the position signal and instant position of the print pressure adjustment mechanism based on the determined linear distance, and cause a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the print pressure adjustment mechanism; detecting, by the magnetic encoder position sensor, the rotational position parameters of the rotatory component; receiving, by the remote registration control system, the position signal from the magnetic encoder position sensor; determining, by the remote registration control system, the linear distance based on the position signal and instant position of the print pressure adjustment mechanism based on the determined linear distance; and causing, by the remote registration control system, a corresponding actuator of the rotatory component to adjust the rotational positional parameters based on the instant position of the print pressure adjustment mechanism.
