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[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR PREPARING A SCREEN PRINTING SCREEN

(57) Abstract: A system or machine 10 is disclosed which takes pre-stretched emulsion coated screens 34, digitally prints thereon and exposes them before further processing and use in a screen printing machine.

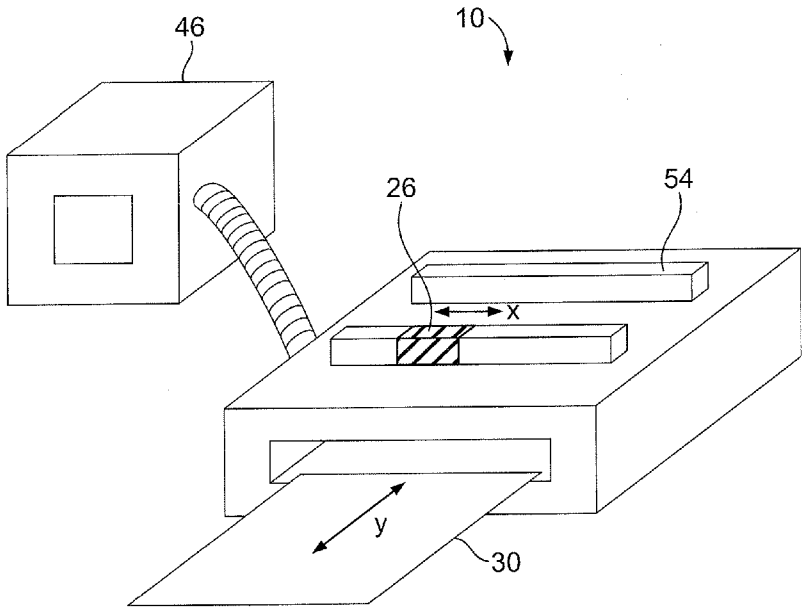

FIG. 1

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METHOD AND APPARATUS FOR PREPARING A SCREEN PRINTING SCREEN

DESCRIPTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This present application claims the benefit of U.S. Provisional Patent Application No. 61/791,300 filed March 15, 2013 and is a continuation-in-part application from pending U.S. Patent Application No. 14/060,172, both of which are hereby incorporated by reference.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] N/A

FIELD OF THE INVENTION

[0003] The present invention relates to a printing screen used in screen printing and the preparation thereof in a system that receives an emulsified coated screen and produces an exposed pattern thereon that can be processed by spraying and drying and then used on the screen printing machine.

DESCRIPTION OF THE PRIOR ART

[0004] Indicia applied permanently to articles of clothing and other textiles have become very popular. Fanciful indicia, such as logos, slogans, college names, sports team names and sayings, are now commonplace. As a result, screen printing has become very popular. Large, commercial operations screen printing textiles are common today.

[0005] Indicia can be one or more colors. Typically, a screen printing machine has at least one station for each color employed. For example, a design incorporating two colors will have at least two printing stations, one for each color. A design employing eight colors will have at least eight stations. Each station generally includes a printing head, which supports a single screen, the ink to be used at that station and a mechanism for applying the ink to the textile. Each color is carried by a single screen. The textile to be screened travels from printing station to printing station by one of a number of methods, such as a chain or a rigid arm. The textile is usually carried by a metal pallet, pallet support, flat bed, or platen.

Common printing machines include turret, oval and linear. In addition to printing stations, there may also be curing stations to heat and set the inks placed on the textile or substrate.

[0006] The general process for setting-up the screens for printing follows:

[0007] First, the artwork is set up. The artwork, in the form of a film positive, is secured on a layout board. Next, a carrier sheet (optically clear polyester film) is placed on the layout board. An individual separates the colors by transferring the artwork by hand to one or more carrier sheets. In this separation/transference process, each carrier sheet represents a separate color to be used in the final screened textile. Thus, if there are six (6) colors being screened, there will be six (6) carrier sheets (Art Separations) completed.

[0008] Second, the stenciled screens are made (one for each color or print head). The indicia or design is formed in the screen by a conventional process. The mesh of the screen is generally covered with an ultraviolet sensitive emulsion and put into a vacuum exposure unit, basically having a light source, a vacuum, a cover, and a table disposed therebetween. Each carrier sheet is aligned with an emulsion covered, pre-stretched screen such that the carrier sheet is disposed between the light source and the screen. The cover is closed and the screen/carrier sheet combination is subjected to a vacuum, to bring them into contact with one another, and UV light. The exposed screen is then chemically processed resulting in a printing screen. With modern techniques and chemicals, processing can be performed by applying a water spray, often a high power water spray, to the exposed screen.

[0009] When exposed to ultraviolet (UV) light and processed (often by a power water spray), those portions or mesh of the screen covered (such as by stencil) are left open (interstices are formed), permitting light, paint, or ink to pass through the mesh. Those portions of the screen mesh not covered by a stencil, once exposed and processed, become opaque, blocking the passage of light, paint, or ink through the mesh.

[0010] Specifically, those parts of the mesh not exposed to the UV light (the unexposed stencil/design) wash away and produce openings or interstices in the mesh for the ink to pass therethrough during the printing process. The interstices in screen represent the places where ink of a particular color is to be deposited onto the textile or other substrate.

[0011] Third, each printing screen is secured to a printing head. One color of ink is then placed into the each printing head.

[0012] With automated equipment, the textiles, one at a time, are loaded onto the travelling pallets and the pallets travel to each of the printing stations, each station having a different color of ink therein. The ink is applied to each textile through the screen at each station. Each textile is cured and the ink permitted to set.

SUMMARY OF THE INVENTION

[0013] The present invention eliminates many of the steps described-above. The improved process of the present invention is as follows:

1) The design is entered and stored into a computer associated with a machine.

2) On the computer, a designer/artist separates the design into individual color silhouettes, each silhouette representing a color and an individual screen.

3) Pre-stretched screens are individually coated with a UV sensitive emulsion.

4) The pre-stretched, emulsion coated screens are individually loaded into the machine.

5) For each screen, the machine takes the design associated with the color for that screen in the computer and digitally prints it on the emulsion coated screen for that color.

6) Each emulsion coated screen is then exposed in the machine.

7) Each exposed screen is then removed from the machine.

8) Each removed exposed screen is then processed (chemically or by power spraying with water).

9) Each screen is dried mechanically, electronically, or naturally.

[0014] In a second embodiment, the steps identified as Nos. 3 (Coating), 8 (Processing), and 9 (Drying) can be added to the machine so that the process becomes:

1) The design is entered and stored into a computer associated with a machine.

2) On the computer, a designer/artist separates the design into individual color silhouettes, each silhouette representing a color and an individual screen.

3) Pre-stretched screens are individually loaded into the machine.

4) The machine individually coats each screen with a UV sensitive emulsion.

5) For each screen, the machine takes each design in the computer representing each color and digitally prints it on each emulsion coated screen for each color.

6) Each emulsion coated screen is then exposed in the machine.

7) Each exposed screen is then processed (chemically or by power spraying with water).

8) Each screen is dried mechanically, electronically, or naturally.

9) Each exposed dried screen is then removed from the machine.

[0015] Another aspect of the present invention is directed to a method of preparing a screen for a screen printing machine comprising the steps of: (1) providing a digital printing machine comprising: a reservoir for holding a supply of an ultraviolet light blocking agent; an applicator in fluid communication with the reservoir; a screen bed in operative alignment with the applicator; and a source of ultraviolet light in operative alignment with the screen bed; (2) receiving a digitally encoded design with the digital printing machine; (3) loading a pre-stretched screen having an ultraviolet light sensitive emulsion coating a surface thereof onto the screen bed; (4) providing a first relative movement between the screen bed and the applicator while the screen is on the screen bed; (5) applying a quantity of the ultraviolet light blocking agent to the ultraviolet light sensitive emulsion coating during the providing the first relative movement step; and (6) exposing the ultraviolet light sensitive coating and the ultraviolet light blocking agent to the source of ultraviolet light.

[0016] This aspect of the present invention may comprise one or more of the following features, alone or in any reasonable combination. The method may further comprise the step of providing a second relative movement between the screen bed and the source of ultraviolet light while the screen is on the screen bed and subsequent to the ultraviolet light blocking agent application to the ultraviolet light sensitive emulsion coating. The exposing step may occur during the second relative movement step. The exposing step may be performed until a first portion of the ultraviolet light sensitive coating is substantially solidified and a second portion of the ultraviolet light sensitive coating beneath the ultraviolet light blocking agent and the ultraviolet light blocking agent remain at least substantially flowable. The exposing step may be performed continuously as the pre-stretched screen traverses on the screen bed. The source of ultraviolet light may comprise a narrow band of light emitting diodes, and the exposing step may include exposing only narrow portions of the pre-stretched screen continuously until a desired area of the surface of the pre-stretched screen is exposed during the second relative movement. The source of ultraviolet light may

operate on a wavelength wherein a first region of a layer of the ultraviolet light sensitive emulsion on the pre-stretched screen solidifies when exposed thereto and wherein a second region of the layer of the ultraviolet light sensitive emulsion masked by the ultraviolet light locking agent remains substantially flowable when exposed thereto. The exposure step may be performed in less than one minute. A gap between the source of ultraviolet light and the surface of the pre-stretched screen may be less than one inch. The wavelength of the source of ultraviolet light may be between 360 and 400 nanometers. The method may further comprise the step of rinsing the pre-stretched screen with a pressurized fluid subsequent to the exposing step exposed screen wherein a portion of the ultraviolet light sensitive emulsion that was exposed to the source of ultraviolet light remains on the pre-stretched screen and a portion of the ultraviolet light sensitive emulsion beneath the ultraviolet light blocking agent is removed by the rinsing step. The source of ultraviolet light may be capable of independent movement relative to the pre-stretched screen. The exposing the ultraviolet light sensitive coating and the ultraviolet light blocking agent to the source of ultraviolet light may occur when the screen bed is at least substantially stationary. The exposing the ultraviolet light sensitive coating and the ultraviolet light blocking agent to the source of ultraviolet light may occur when the screen bed is stationary. The source of ultraviolet light may be attached to a housing of the printing machine.

[0017] Another aspect of the present invention is directed to a screen preparation printing apparatus. The apparatus comprises an interface for receiving commands from a computer; a housing; a reservoir for holding a supply of an ultraviolet light blocking agent attached to the housing; a print head in fluid communication with the reservoir attached to the housing; a screen bed alignable with the print head; a means for providing relative movement between the print head and the screen bed along a two-dimensional plane attached to the housing; and a source of ultraviolet light alignable, or in alignment with, the screen bed and operating on a wavelength wherein a first region of a layer of emulsion deposited on an emulsion-coated, pre-stretched screen solidifies when exposed thereto and wherein a second region of the layer of emulsion masked by the ultraviolet light locking agent remains substantially flowable when exposed thereto.

[0018] This aspect of the invention may include one or more of the following features, alone or in any reasonable combination. The apparatus may further comprise a print head

carrier capable of providing movement to the print head over a two-dimensional plane in response to commands received from the computer. The apparatus may further comprise a registration system for aligning a pre-stretched screen on the screen bed with the print head. The wavelength of the source of ultraviolet light may be between 360 and 400 nanometers. The apparatus may further comprise an ultraviolet light blocking agent within the reservoir wherein the ultraviolet light blocking agent remains at least substantially flowable after an exposure to an ultraviolet light. The exposure may have a duration of less than one minute. The source of ultraviolet light may be attached to the housing in a fixed location. The source of ultraviolet light may comprise an exposure area large enough to expose an entire area of a portion of the screen bed on which a pre-stretched screen is supported. The source of ultraviolet light may be capable of independent movement relative to the screen bed. The source of ultraviolet light may be at least as wide as the screen bed and have a length substantially less than a length of the screen bed. The source of ultraviolet light may be attached to the housing.

[0019] Other features and advantages of the invention will be apparent from the following specification taken in conjunction with the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] To understand the present invention, it will now be described by way of example, with reference to the accompanying drawings and attachments in which:

[0021] FIG. 1 is schematic view of an embodiment of the present invention;

[0022] FIG. 2 is a top view of an embodiment of the present invention;

[0023] FIG. 3 is a top view of an embodiment of the present invention;

[0024] FIG. 4 is a perspective view of the embodiment of FIG. 3;

[0025] FIG. 5 is perspective view of a source of ultraviolet light removed from the apparatus showing a bank of light emitting diodes arranged in straight rows and angled columns to maximize exposure to the ultraviolet light;

[0026] FIG. 6 is a partial perspective view of an embodiment of the present invention showing the source of ultraviolet light attached to a housing;

[0027] FIG. 7 is a front view of an embodiment of the present invention showing the apparatus in use as a pre-stretched screen coated with an ultraviolet light sensitive emulsion and printed with an ultraviolet light blocking agent undergoes exposure to an ultraviolet light;

[0028] FIG. 8 is a partial perspective view of an embodiment of the present invention showing the apparatus in use as a pre-stretched screen coated with an ultraviolet light sensitive emulsion and printed with an ultraviolet light blocking agent undergoes exposure to an ultraviolet light with a shield on the housing lifted to show additional detail of the apparatus and process;

[0029] FIG. 9 is a partial perspective view an embodiment of the present invention showing the apparatus and a pre-stretched screen coated with an ultraviolet light sensitive emulsion and printed with an ultraviolet light blocking agent subsequent to exposure to the ultraviolet light;

[0030] FIG. 10 is a partial perspective view of a screen bed on an embodiment of the present invention showing a 3-point registration system;

[0031] FIG. 11 is a partial perspective view of the screen bed showing a slot for receiving an edge of a pre-stretched screen;

[0032] FIG. 12 is a spring-loaded member of the registration system; and

[0033] FIG. 13 is a view of retainers of the registration system arranged in a perpendicular orientation

[0034] FIG. 14 is a top view of an embodiment of the present invention;

[0035] FIG. 15 is a top view of an embodiment of the present invention;

[0036] FIG. 16 is a top view of an embodiment of the present invention;

[0037] FIG. 17 is a schematic side view of an embodiment of the present invention showing an apparatus of the present invention having a stationary source of ultraviolet light and a source of ultraviolet light having independent movement capability relative to movement of a screen bed or a pre-stretched screen;

[0038] FIG. 18 is a schematic side view of an embodiment of the present invention showing an apparatus of the present invention having a stationary source of ultraviolet light and a pre-stretched screen treated with an ultraviolet light sensitive emulsion and an ultraviolet light masking or blocking agent being exposed to an ultraviolet light energy as the pre-stretched screen on a screen bed is stationary or at least substantially stationary;

[0039] FIG. 19 is a schematic side view of an embodiment of the present invention showing an apparatus of the present invention having a stationary source of ultraviolet light and a pre-stretched screen treated with an ultraviolet light sensitive emulsion and an ultraviolet light masking or blocking agent being exposed to an ultraviolet light energy as the pre-stretched screen on a screen bed is stationary or at least substantially stationary; and

[0040] FIG. 20 is a schematic side view of an embodiment of the present invention showing an apparatus of the present invention having a pivotable source of ultraviolet light and a pre-stretched screen treated with an ultraviolet light sensitive emulsion and an ultraviolet light masking or blocking agent.

DETAILED DESCRIPTION

[0041] While this invention is susceptible of embodiments in many different forms, there is shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

[0042] The primary components of the system or machine 10 include the following:

Housing (Controls, Printing, and Exposing)

[0043] The housing system 14 is based on M&R Printing's i-IMAGE line of computer-to-screen imaging system. It comprises framework, supports, connectors, attachments, covers, shielding, etc. to protect and support the apparatus 10 components within the overall apparatus 10. It includes two portions, a portion to hold the controls and a portion to hold the printing and exposing assembly.

Control Housing

[0044] The control housing 18 includes the primary electronics for the system (the controller and software) and the controls and buttons (keypad, mouse, etc.) for controlling the print jobs, and is connected to a power source and a monitor (for visually displaying the operator's work and/or choices via a screen).

[0045] The electrical requirements of the system is 208/230 V, 1 ph, 5A, 50/60 Hz, 1.15 kW. The use of an uninterruptable power supply (UPS) is preferable. A 110 V electrical configuration can also be integrated.

Printer Housing

[0046] The printer housing 22 can be made integral with the control housing and includes the printer assembly which supports a moveable carriage 24 carrying one or more printer heads 26 and a moveable screen bed 30 for horizontally supporting a screen 34 being printed upon. The housing further has a front opening therein for receiving the screen bed 30 with the screen 34 positioned thereon and therein and for discharging the screen bed 30 and screen 34 back out. In another embodiment, a second opening and rear housing can be added for discharging the screen 34 and/or permitting the screen 34 to pass under an ultraviolet light.

[0047] It should be noted that the printer housing 22 is a light sensitive environment meaning it minimizes the amount of light permitted to enter the housing's inner chamber(s). A rear housing, if employed, is similarly constructed so as to maintain the light sensitive environment.

Printer

[0048] The system uses one or a plurality of applicators in fluid communication with a reservoir holding a supply of an ultraviolet light blocking agent 38. The applicators are generally print heads 26, preferably 1 to 3, which move laterally back and forth as the screen bed 26 moves longitudinally. Specifically the printer heads 26 move in the X-X (cross) direction while the screen bed 30 and screen 34 move in the Y-Y direction. Advanced high-resolution inkjet technology is used to quickly generate opaque images on emulsion-coated screens 34.

[0049] The distance between the printer head 26 and the screen 34 is to be kept very small. It is about 1-1/2 millimeters.

[0050] The printer heads 26 can move unidirectional or bidirectional when laying down chemicals. While unidirectional motion laying down the ink is slower, it is often more effective with more detailed designs or smaller mesh sizes.

[0051] Preferably, the printer head(s) 26 deliver a quantity of an ultraviolet light blocking agent 38, preferably a type of ink to an emulsion-coated, pre-stretched screen. The ultraviolet light blocking agent 38 is a photo resist, preventing an ultraviolet exposure light 100 from reaching an emulsion 42 in the area that has been printed with the ultraviolet light blocking agent 38. The ultraviolet light blocking agent 38 prevents a cross-linking process of the emulsion 42 under the blocking agent 38, and leaves the emulsion 42 below the ink water

soluble, so that it is easily washed away during a water rinse process, creating the printing stencil in a desired image to be later screen printed.

[0052] Alternatively, the printer head(s) 26 do not contain ink. Rather the printer heads support a chemical that reacts with the emulsion 42 on the screen when exposed to ultraviolet light.

[0053] It has been found that computer-to-screen images are superior to traditional film positives, delivering greater detail and smoother halftone transitions. Since the image is made directly on the screen, there is no need for vacuum hold-down during the exposure process. This, coupled with the fact that ultraviolet light does not have to penetrate layers of film and glass, can reduce exposure time up to half. There is no need for costly film positives, as well as the space and labor required to store and retrieve them. Because the image information is digital, it is easy to store and quick to retrieve.

Software

[0054] Using controls on the system, a design is entered into a computer 46 of the system manually or by other means such as a disc, USB Drive, internet connection, etc. A designer/artist then separates the design into individual color silhouettes 50, each silhouette 50 representing a color and an individual screen 34. To accomplish this, the system includes an interface such as a computer 46 with a monitor connected thereto and raster image processing (RIP) software. In essence, the RIP software permits conversion of type, vector graphics, continuous tone images, screens and all other content into a high resolution grid of binary pixels that the printer (e.g., laser, ink jet, dot matrix, etc.) will render onto a printing plate. The RIP software performs the functions of interpretation, rasterisation and color/screen separation. The software interprets the commands in a formatted code, such as Adobe PostScript and PDF, and redraws the objects and elements as vector graphics. In rasterisation, the independent vector shapes are then converted into pixels (a bitmap). Then, the raster image undergoes separation to form individual screens. For example, a 5080 dots-per-inch grid at a size of 40"x30" with various pixels turned on or off. This is a printing plate. Since a printing press cannot print continuous tone, these tiny little dots create the illusion of continuous tone.

[0055] By providing complete control of the print parameters, the RIP software ensures high-quality images at production-level speed. It provides full image scaling and positioning,

has presets for common applications, and can be user-customized for specific art types and various mesh counts.

[0056] The printing apparatus 10 receives or uses a digitally encoded design or color silhouette 50 and uses the print head 26 to transfer an ultraviolet light blocking agent 38 to a pre-stretched screen 34.

Screen Bed

[0057] Screens 34 are processed with the emulsion 42 facing upward (i.e., on an upper surface of a pre-stretched screen 34), the side with a source of light (described below) and the printer heads 26. The screen bed 30 is sized so as to support a maximum frame profile of 4.1 x 4.1 cm (1.625" x 1.625") and a maximum frame size of 66 x 91 cm (26" x 36"), and a maximum image area of 51 x 53 cm (20" x 21"). The bed 30 moves longitudinally in a Y-Y direction into and out of the housing, generally in operative alignment with the applicator. While moving, the print head(s) 26 is printing onto the emulsion coated screen 34 and moving in an X-X direction. The screen bed 30 has a biasing mechanism therein so that screens of different sizes can be processed and to ensure uniform registration of each screen being processed.

[0058] A means for providing relative movement between the screen bed 30 and the applicators may provide movement to either or both of the applicators and the screen bed 30. Preferably, the applicators move in an X-X direction while the screen bed traverses in a Y-Y direction. This is a typical relative movement provided by most printers in the industry. It should be understood that any type or mechanism providing the desired relative movement can be substituted for the preferred action described here.

Ultraviolet Light Blocking Agent

[0059] The ultraviolet light blocking agent 38 is delivered by the applicator or applicators. The ultraviolet light blocking agent 38 is preferably applied to a pre-stretched screen 34 while relative movement between the screen 34 and the applicator takes place. The blocking agent 38 is preferably an ink, such as a specially-formulated i-Pak water-based ultraviolet light blocking ink. Regardless of the type of particular agent 38 used, the ultraviolet light blocking agent 38 will be substantially unaffected by exposure to a source of ultraviolet light 54 at least over the duration of a preselected or predetermined exposure time. This will be explained in more detail below.

Registration System

[0060] The bed 30 for the screens incorporates a three-point registrations system thereon. Thus, screens 34 for multicolor jobs are quickly generated in perfect registration. The system employed is an appropriately-sized TRI-LOC pallet system described and claimed in M&R's US Patent Nos. 5,921,176; 5,943,953; and 5,953,987, the contents of which are hereby incorporated by reference as if fully set forth herein. The TRI-LOC pallet system permits the quick and accurate registering of the screens on the bed and on the press. The entire process—from screen imaging to the first finished print—is dramatically shortened by this process and procedure, with registration time greatly reduced.

[0061] In an illustrated embodiment, the registration system includes three points of contact with the screen 34. The screen 34 is introduced into a slot 58 in the Y-Y direction unit it engages a spring-loaded barrier 62. The spring-loaded barrier 62 is biased outwardly relative to the print heads 26 and internal workings of the printer. The screen 34 is forced forward against the force of the spring-loaded barrier 62 and snap fit within perpendicularly oriented retainers 64,68 on the printer at an opposite end of the screen 34, one retainer 64 aligned parallel to a rearward edge of the screen 34 and one retainer 68 aligned perpendicular to the rearward edge of the screen 34. The spring-loaded barrier 62 then provides a force to the screen 34 against the retainer 68 aligned parallel to the rearward edge of the screen 34. This provides registration or alignment of the screen 34 with the print head 26.

Screen

[0062] The screens 34 used are pre-stretched and are well-known in the art. One such screen stretcher is the MAX NEWTON offered by M&R. This is an economical pneumatic screen stretcher that delivers high-tension stretching on virtually any mesh/frame combination. The MAX NEWTON's air cylinders compensate for variations in mesh elasticity and fully extend after tensioning. Warp and weft are independently tensioned and controlled, and the durable PVC-coated locking bars grip tightly without tearing mesh.

[0063] Before being placed into the device, the pre-stretched screens 34 are individually coated with an ultraviolet light sensitive emulsion 42. When such an emulsion is exposed to a UV light source a chemical reaction called crosslinking occurs. Crosslinking is a bonding process, an interlocking of molecular chains. It can be described as the ability of a material to form a skin. To cause a solution to crosslink, you need a catalyst. The catalyst that makes

direct emulsions crosslink comes from the energy supplied by UV light. The part of the emulsion that reacts to the UV is the sensitizer.

[0064] One emulsion used is ULANO RLX Multi-Purpose Diazo Photopolymer Emulsion made by Ulano Corporation, 110 Third Avenue, Brooklyn, NY 11217(USA) (www.ulano.com). RLX is a multi-purpose high speed Diazo photopolymer direct emulsion. RLX's very high solids content provides better stencil build per coat, excellent bridging of coarse mesh, and faster drying. RLX has superb coating properties and durability, and is resistant to a wide variety of solvent- and water-based ink systems. RLX/CL is supplied clear for easier see-through registration. RLX is recommended for imprinted sportswear, P-O-P, and advertising specialty printing.

[0065] It should further be noted that mesh sizes for screens 34 range from about 86 threads per inch (TPI) to about 305 threads per inch (TPI). The 305 TPI requires less exposure because less emulsion is on the screen.

[0066] It should also be noted that the emulsion 42 coating the screen 34 must be dried before it is exposed. Practice is to always dry in a horizontal position to allow gravity to "pull" the emulsion coating to the garment side of the screen. In addition, when spraying the screens 34 after exposing them, the practice is to vertically orient the screens 34.

Light Bank

[0067] A source of ultraviolet light 54 is attached to the housing 22. One or more banks of ultraviolet light are provided within the housing. Thus, once the pre-stretched screen 34 is printed upon using the ultraviolet light blocking agent 38, it is exposed to an ultraviolet light emitted from the source of ultraviolet light 54 for a predetermined length of time, typically less than a minute. The light bank can be a single light source, like a fluorescent ultraviolet light tube, a row of lights, or an array of lights.

[0068] In one embodiment, the light source 54 is at the front of the housing 22, generally in operative alignment with the screen bed 30. It can, of course, be positioned in the back of the housing if a rear housing is used. One embodiment is 36 inches wide (in the X-X direction) and 7 inches deep and comprises light emitting diodes (LED). The light source 53 can be, but is not limited to LED lights, CFL bulbs of ultraviolet frequency, Multi-Spectrum Metal Halide, fluorescent, and incandescent light sources. The distance between the screen

34 and the source 54 can vary recognizing that as the distance between the screen 34 decreases, the heat generated by the bulb and screen 34 increases.

[0069] In another embodiment, the light source 54 is at the front of the housing relative to the print head 26. In this embodiment, the source 54 is about 29.63 inches wide (in the X-X direction) and 2.07 inches deep and comprises a plurality of LEDs 72. The light source 54 can be, but is not limited to LED lights 72, CFL bulbs of ultraviolet frequency, Multi-Spectrum Metal Halide, fluorescent, and incandescent light sources. The LEDs 72 are arranged in rows and angled columns to provide suitable ultraviolet light exposure coverage to a passing screen, preferably about a 30% overlap from of one row of LEDs to the next. This arrangement promotes elimination of ultraviolet gaps during exposure, which reduces or eliminates "striping," where uneven exposure of the emulsion takes place, post-exposure. The distance between the screen and the source 54 can vary recognizing that as the distance between the screen 54 decreases, the heat generated by the bulb and screen 34 increases. Preferably, a gap of less than one inch is created between the source of ultraviolet light 54 and a surface of the pre-stretched screen 34 coated with the ultraviolet light sensitive emulsion 42 and the ultraviolet light blocking agent 38. More preferably, the gap is on the order of one-eighth of an inch. In this embodiment, the source of ultraviolet light 54 is preferably at least as wide as the screen bed 30 in the X-X direction and has a length in the Y-Y direction which is substantially less than a length of the screen bed 30.

[0070] The source of ultraviolet light 54 preferably operates or emits light at a wavelength between 360 and 400 nanometers. When exposing the screen 34 subsequent to application of a layer of the ultraviolet light blocking agent 38, the desired wavelength will have the effect of substantially solidifying a first region 76 of a layer of the ultraviolet light sensitive emulsion 42 on the pre-stretched screen 34 while a second region 80 of the layer of the ultraviolet light sensitive emulsion 42 masked by the ultraviolet light locking agent 38 remains substantially flowable.

[0071] A means for providing relative movement between the ultraviolet light source 54 and the screen bed 30 is generally provided. In the embodiments illustrated, Y-Y movement is provided to the screen bed 30 using the same mode as described in the printing step, namely a motor drives the screen bed 30 in the Y-Y direction based on commands received via the interface.

[0072] However, due to differences in response to ultraviolet light exposure exhibited by various types and brands of emulsions, the apparatus can have a fixed or stationary source of ultraviolet light 54 (e.g., FIGS. 3 and 14; and preferably a LED bank), a source of ultraviolet light 154 capable of independent movement relative to the screen bed 30 (e.g., FIG. 15; and preferably a LED bank), a combination of a stationary source of ultraviolet light 54 with a separate source of ultraviolet light 154 capable of independent movement relative to movement of the screen bed 30 (e.g., FIG. 16), or the stationary aspect of the source of ultraviolet light can be combined with the moving source of ultraviolet light in a single bank of a source of ultraviolet light. These combinations can be employed to perform exposure using either or both scanning or stationary exposure of the emulsion on the pre-stretched screen subsequent to a deposit of ultraviolet light blocking agent on the emulsion coated pre-stretched screen by the print head. Scanning exposure is intended to indicate an exposure of the emulsion carried out during relative movement between the screen bed 30 and/or pre-stretched screen 34 and the source of ultraviolet light, as illustrated in, e.g., FIG. 17. Stationary exposure is intended to indicate an exposure of the emulsion carried out when the source of ultraviolet light 354 and the screen bed 30 and/or the pre-stretched screen 34 are in a fixed position and not moving or traversing relative to each other or at the very least exhibit a substantially stationary condition, as illustrated in, e.g., FIGS. 18 and 19. Substantially stationary is defined as no greater than 10% of the relative rate of speed of the screen bed 30 as it enters the print housing 22 to begin the ultraviolet light masking deposit on the pre-stretched screen 34

[0073] As depicted in FIGS. 15 and 16, the source of ultraviolet 154 is capable of independent movement relative to the screen bed 30 and/or the pre-stretched screen 34 and moves in the X-X direction as indicated by the arrows, for example using the same electro-mechanical system that provides movement to the carriage 24; however, as depicted in the schematic-type drawing in FIG. 17, this source of ultraviolet light 154 may also move in the Y-Y direction as indicated by the arrows. Alternatively, the source of ultraviolet light 254 depicted schematically in FIG. 17 can move in both the X-X and Y-Y directions, similar to a plotter pen.

[0074] Thus, exposure of the surface of the pre-stretched screen 34 coated with the ultraviolet light sensitive emulsion 42 having portions of the emulsion masked or blocked by

the ultraviolet light blocking agent 38 may be performed continuously as the pre-stretched screen 34 traverses on the screen bed 30. When the source of ultraviolet light 54 comprises a narrow band of LEDs 72, the exposure process includes exposing only narrow portions of the pre-stretched screen 34 continuously until a desired area of the surface of the pre-stretched screen 34 is exposed during the second relative movement. This is preferably performed in one minute or less, more preferably 30 seconds or less.

[0075] Referring in particular to FIGS. 14, 18, and 19, a stationary source of ultraviolet light 354 is provided. In these embodiments, the ultraviolet light sensitive emulsion 42 is exposed to the stationary source of ultraviolet light 354 after the pre-stretched screen 34 has been masked by the ultraviolet light blocking agent 38 and when the pre-stretched screen 34 on the screen bed 30 is stationary or at least substantially stationary (see schematic representation in FIGS. 18 and 19). Here, a bank of lights, e.g., an LED bank comprising a plurality of the sources illustrated in FIG. 5 arranged appropriately, is larger so as to provide an exposure area at least equal to the upper surface of the portion of the pre-stretched screen 34 carrying the image to be silk screen printed. Stated another way, the exposure step is accomplished when the pre-stretched screen 34 is stationary under a stationary source of ultraviolet light 354. The embodiments of FIGS. 18 and 19 include a second source of ultraviolet light 454, which may be a scanning or stationary source as described above.

[0076] In particular to the embodiment of FIGS. 14 and 19, the stationary source of ultraviolet light 354 is located opposite an entry end 84 of the apparatus 10 where the pre-stretched screen 34 would be loaded. This embodiment may be outfitted with or without a second stationary source of ultraviolet 54 which treats the emulsion 38 as the pre-stretched screen is traversing in the Y-Y direction. Thus, in a method of preparing screen for screen printing, the pre-stretched screen 34 once treated or partially printed with a layer of the ultraviolet blocking agent would continue in the Y-Y direction, exiting the printer housing 22 on the opposite side from which it entered the printer housing 22 for exposure to an ultraviolet light emitted from the stationary source of ultraviolet 354 as the source of ultraviolet light and the pre-stretched screen 34 and/or the screen bed 30 are stationary or at least substantially stationary. Once the exposure step is completed, the screen bed 30 and pre-stretched screen 34 would traverse back to the side of the apparatus 10 where the pre-stretched screen 34 was loaded onto the screen bed 30. However, it would be an obvious

variation thereof to locate the stationary source of ultraviolet 354 on the same side of the printer housing 22 as the pre-stretched screen 34 loading area, as schematically illustrated in Fig. 18, to accommodate for a smaller foot print of the apparatus 10 or for any other electro or mechanical reason.

[0077] Finally, in one embodiment illustrated in FIG. 20, a source of ultraviolet light 554 is mounted on a pivot 560. As such, it can pivot between an "up" position during loading and unloading of the screen 34, as shown in FIG. 20, and "down" position during exposure of the screen 34, which is a similar position to what is shown in FIG. 18.

[0078] The source of ultraviolet light 54, preferably the LED arrangement shown in FIG. 5, is powered by an adjustable power supply. A photo-sensor monitors ultraviolet output of the LEDs and produces, or converts to, a DC signal which is looped back to a PLC. The PLC controls ultraviolet output from the LEDs 72.

[0079] The source of ultraviolet light 54 is controlled by the presence of a pre-stretched screen 34. Accordingly, the source of ultraviolet light 54 is not "on" unless a screen 34 is present. The apparatus uses a proximity switch to control the power to the source of ultraviolet light. This minimizes leakage.

The Process

[0080] As noted, the pre-stretched, emulsion coated screens 34 are individually loaded into a printer device/machine and registered on the bed 30 at the entry end 84 of the apparatus 10. For each screen 34, the individual silhouettes 50 generated by the software for each color (and print head on the printing machine) are digitally printed on each emulsion coated screen 34. Each emulsion coated screen 34 is then exposed by one or more of the sources of ultraviolet light mounted on the machine, or associated in another manner therewith, described herein. Each exposed screen 34 is next removed from the machine and processed by power spraying or by chemical reaction. Rinsing of the pre-stretched screen 34, thus, may be accomplished with a pressurized fluid subsequent to the exposing step wherein a portion of the ultraviolet light sensitive emulsion 42 that was exposed to the light 100 emitted by the source of ultraviolet light remains on the pre-stretched screen 34 and a portion of the ultraviolet light sensitive emulsion 42 beneath the ultraviolet light blocking agent 38 is removed by the rinsing step. Each screen 42 finally dried mechanically, electronically, or naturally. Once dried, the screen 42 is ready for use on the printing machine.

[0081] The present development combines the teaching of those two products, and other teachings to accomplish an "all-in-one" system.

[0082] M&R Printing Equipment, Inc., assignee of the present invention, manufactures and sells a line of computer to screen imaging systems under the trademark i-IMAGE™, that being the i-IMAGE ST and a line of multi-spectrum screen exposure systems under the trademark TRI-LIGHT™, that being the TRI-LIGHT, TRI-LIGHT CTS, and TRI-LIGHT ST. Three i-IMAGE ST models are presently available: the i-IMAGE ST 1, with one industrial print head capable of processing up to 150 screens per 8-hour shift; the i-IMAGE ST 2, with two industrial print heads for processing up to 250 screens per 8-hour shift; and, the i-IMAGE ST 3, with three industrial print heads for processing up to 350 screens per 8-hour shift. In fact, the i-IMAGE ST 3 can create a full-size image in as little as 30 seconds. All i-IMAGE ST models process image areas up to 51 x 53 cm (20" x 21") and accept most static and retensionable screen frames in sizes up to 66 x 91 cm (26" x 36").

[0083] The TRI-LIGHT CTS by M&R Printing System's NuArc's division exposes screens generated by a computer-to-screen (CTS) system. Exposures are powered by NuArc's multi-spectrum metal-halide System 631™, which idles at 1 kW and operates at user-selected settings of 6 kW, 3 kW and 1 kW. The 3 kW and 1 kW settings allow operators to slow down exposures when necessary. They also extend TRI-LIGHT's ability to adapt to future emulsion formulas. The system also features NuArc's exclusive Proportional Temperature Control (PTC). PTC continuously monitors lamp temperature, turning the cooling fans on and off to keep the lamp at the optimum operating temperature. The system can be located in areas housing unexposed screens because the light source and vacuum frame are enclosed, and the exposure lamp can't be turned on while the blanket frame is open.

[0084] In one embodiment, a design is entered into a computer 46. The design is separated into desired individual color silhouettes 50. Each color silhouette 50 represents a separate or different color and a separate screen 34 to be printed with an ultraviolet light blocking agent 38. A surface of a pre-stretched screen 34 is coated with an emulsion 42, and the screen 34 is loaded onto a digital printing machine 10. The digital screen printing machine 10 then digitally prints or applies the ultraviolet light blocking agent 38 onto the emulsion-coated screen 34 in a pattern of a color silhouette 50. The emulsion-coated and

digitally printed screen 34 is then exposed to an ultraviolet light emitted from a source of ultraviolet light. The source of ultraviolet light is preferably associated with the digital printing machine 10 such that movement provided by the digital printing machine 10 to the screen 34 or the ultraviolet light controls exposure of portions of the screen 34 continuously. The screen 34 is then removed from the digital printing machine 10 and processed by fluidly rinsing the screen.

[0085] In another embodiment, the digital printing machine 10 has a reservoir 88 which is capable of holding a quantity of an ultraviolet light blocking agent 38. An applicator, e.g., one or more print heads 26, is in fluid communication with the reservoir 88. A screen bed 30 is in operative alignment with the applicator. A source of an ultraviolet light is in operative alignment with the screen bed 30. Digitally encoded data corresponding to a desired design, e.g., a color silhouette 50, is received by the digital printing machine 10 typically by way of an interface in electronic communication with a computer 46 having a memory and a software loaded thereon. The interface and the computer 46 may be provided as components of the digital printing machine 10. A pre-stretched screen 34 having an ultraviolet light sensitive emulsion coating 42 on a surface thereof can be loaded onto a screen bed 30 as described above. A first relative movement between the screen bed 30 and the applicator is provided while the screen 34 is on the screen bed 30. A quantity of the ultraviolet light blocking agent 38 is applied by the digital printing machine 10 via the applicator to the ultraviolet light sensitive emulsion coating 42 as the first relative movement is actuated. Subsequent to the first relative movement, a second relative movement between the screen bed 30 and the source of ultraviolet light is actuated while the screen 30 is on the screen bed 34 and subsequent to the ultraviolet light blocking agent 38 application to the ultraviolet light sensitive emulsion coating 42. During the second relative movement, the ultraviolet light sensitive emulsion coating 42 and the ultraviolet light blocking agent 38 are exposed to a light emitted by the source of ultraviolet light.

[0086] In another embodiment, an apparatus for preparing a screen 34 for a screen printing machine comprises an interface for receiving electronic commands from a computer 46. The commands pertain to a color silhouette 50 for which a screen 34 is desired to be produced. The apparatus has a housing 14 which includes frames, supports, and enclosures for supporting, shielding, and protecting the inter-workings of the apparatus.

[0087] A reservoir 88 is supplied for holding a supply of an ultraviolet light blocking agent 38 attached to the housing 14. The reservoir 88 may be considered any fluid conduit which is used to supply the ultraviolet light blocking agent 38 to an applicator, such as a print head 26. It follows that a print head 26 is in fluid communication with the reservoir 88 and is either directly or indirectly attached to the housing 14.

[0088] A screen bed 30, which generally holds and registers the screen 34 to be printed, is alignable with the print head 26.

[0089] The apparatus includes a means for providing relative movement between the print head 26 and the screen bed 30 along a two dimensional plane attached to the housing 14. This may be motor and accompanying gears, belts, etc. that drives the screen bed 30. Alternatively, it may be a motor that drives the print head 26. However, preferably, this means for providing relative movement drives the screen bed 30 in a Y-Y direction and the print head 26 in an X-X direction. In this case, movements by the screen bed 30 and the print head 26 are coordinated to allow the ultraviolet light blocking agent 38 to be deposited on the screen 34 in the desired locations.

[0090] A source of ultraviolet light 54,154,254,354,454 is attached to the housing 14. The source of ultraviolet light can be in a fixed location or capable of independent movement. The source of ultraviolet light operates on a preferred wavelength. Rather than exposing and curing the fluid (i.e., the ultraviolet light blocking agent 38) deposited by the print head 26, here, the source of ultraviolet light operates on or exhibits a wavelength wherein a first region of a layer of an emulsion 42 deposited on an emulsion-coated, pre-stretched screen 34 substantially solidifies when exposed thereto and wherein a second region of the layer of emulsion 42 which is masked by the ultraviolet light blocking agent 38 remains at least substantially flowable when exposed thereto. This allows the ultraviolet light blocking agent 38 and the substantially flowable emulsion 42 to be rinsed, cleansed, or power-washed from the screen using normal or typical screen preparation technique.

[0091] The terms "first," "second," "upper," "lower," "top," "bottom," etc. are used for illustrative purposes relative to other elements only and are not intended to limit the embodiments in any way. The term "plurality" as used herein is intended to indicate any number greater than one, either disjunctively or conjunctively as necessary, up to an infinite number. The terms "joined," "attached," and "connected" as used herein are intended to put

or bring two elements together so as to form a unit, and any number of elements, devices, fasteners, etc. may be provided between the joined or connected elements unless otherwise specified by the use of the term "directly" and/or supported by the drawings. The phrase "substantially flowable" and variations thereof is intended to indicate a capability of being rinsed from the surface of the pre-stretched screen using a fluid under pressure or other chemical means. The phrase "substantially solidified" is intended to indicate an incapability of being rinsed from the surface of the pre-stretched screen using a fluid under pressure.

[0092] Many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood within the scope of the appended claims the invention may be protected otherwise than as specifically described.

Claims

CLAIMS

What is claimed is:

1. A method of preparing a screen for a screen printing machine, comprising the steps of

a) entering a design into a computer;

b) separating the design into individual color silhouettes, each silhouette representing a color and an individual screen;

c) coating individual pre-stretched screens with an ultraviolet light sensitive emulsion;

d) loading each pre-stretched, emulsion coated screen into digital printing machine;

e) digitally printing a silhouette on each emulsion coated screen with an ultraviolet light blocking agent;

f) exposing each printed-upon emulsion coated screen to ultraviolet light;

g) removing each exposed screen from the digital printing machine;

h) processing each removed exposed screen chemically or by power spraying; and,

i) drying each screen mechanically, electronically, or naturally.

2. The method of Claim 1 wherein the source of ultraviolet light operates on a wavelength wherein the ultraviolet light sensitive emulsion solidifies upon exposure thereto and the ultraviolet light blocking agent remains at least substantially flowable.

3. The method of Claim 2 wherein the digitally printing step and the exposing step are carried out on a single apparatus.

4. The method of Claim 3 wherein a means for providing relative movement between each pre-stretched screen and a print head on the printer further provides relative movement between each pre-stretched screen and a source of ultraviolet light.

5. The method of Claim 4 further comprising a means for registering each pre-stretched, emulsion coated screen with a print head.

6. A method of preparing a screen for a screen printing machine comprising the steps of:

providing a digital printing machine comprising:

a reservoir for holding a supply of an ultraviolet light blocking agent;

an applicator in fluid communication with the reservoir;

a screen bed in operative alignment with the applicator; and

a source of ultraviolet light in operative alignment with the screen bed;

receiving a digitally encoded design with the digital printing machine;

loading a pre-stretched screen having an ultraviolet light sensitive emulsion coating a surface thereof onto the screen bed;

providing a first relative movement between the screen bed and the applicator while the screen is on the screen bed;

applying a quantity of the ultraviolet light blocking agent to the ultraviolet light sensitive emulsion coating during the providing the first relative movement step; and

exposing the ultraviolet light sensitive coating and the ultraviolet light blocking agent to the source of ultraviolet light.

7. The method of Claim 6 further comprising the step of:

providing a second relative movement between the screen bed and the source of ultraviolet light while the screen is on the screen bed and subsequent to the ultraviolet light blocking agent application to the ultraviolet light sensitive emulsion coating wherein the exposing the ultraviolet light sensitive coating and the ultraviolet light blocking agent to the source of ultraviolet light occurs during the second relative movement step.

8. The method of Claim 7 wherein the source of ultraviolet light is capable of independent movement.

9. The method of Claim 7 wherein the exposing step is performed continuously as the pre-stretched screen traverses on the screen bed.

10. The method of Claim 6 wherein the exposing the ultraviolet light sensitive coating and the ultraviolet light blocking agent to the source of ultraviolet light occurs when the screen bed is at least substantially stationary.

11. The method of Claim 6 wherein the exposing the ultraviolet light sensitive coating and the ultraviolet light blocking agent to the source of ultraviolet light occurs when the screen bed is stationary.

12. The method of Claim 6 wherein the exposing step is performed until a first portion of the ultraviolet light sensitive coating is substantially solidified and a second portion of the ultraviolet light sensitive coating beneath the ultraviolet light blocking agent and the ultraviolet light blocking agent remain at least substantially flowable.

13. The method of Claim 6 wherein the source of ultraviolet light comprises a narrow band of light emitting diodes and wherein the exposing step includes exposing only narrow portions of the pre-stretched screen continuously until a desired area of the surface of the pre-stretched screen is exposed during the second relative movement.

14. The method of Claim 6 wherein the source of ultraviolet light operates on a wavelength wherein a first region of a layer of the ultraviolet light sensitive emulsion on the pre-stretched screen solidifies when exposed thereto and wherein a second region of the layer of the ultraviolet light sensitive emulsion masked by the ultraviolet light locking agent remains substantially flowable when exposed thereto.

15. The method of Claim 14 wherein the exposure step is performed in less than one minute.

16. The method of Claim 14 wherein a gap between the source of ultraviolet light and the surface of the pre-stretched screen is less than one inch.

17. The method of Claim 14 wherein the wavelength is between 360 and 400 nanometers.

18. The method of Claim 6 further comprising the step of:

rinsing the pre-stretched screen with a pressurized fluid subsequent to the exposing step exposed screen wherein a portion of the ultraviolet light sensitive emulsion that was exposed to the source of ultraviolet light remains on the pre-stretched screen and a portion of the ultraviolet light sensitive emulsion beneath the ultraviolet light blocking agent is removed by the rinsing step.

19. The method of Claim 6 wherein the source of ultraviolet light is attached to a housing of the digital printing machine

20. A screen preparation printing apparatus comprising:

an interface for receiving commands from a computer;

a housing;

a reservoir for holding a supply of an ultraviolet light blocking agent attached to the housing;

a print head in fluid communication with the reservoir attached to the housing;

a screen bed alignable with the print head;

a means for providing relative movement between the print head and the screen bed along a two dimensional plane attached to the housing;

a source of ultraviolet light alignable with the screen bed and operating on a wavelength wherein a first region of a layer of emulsion deposited on an emulsion-coated, pre-stretched screen solidifies when exposed thereto for a predetermined duration and wherein a second region of the layer of emulsion masked by the ultraviolet light locking agent remains substantially flowable when exposed thereto for the predetermined duration.

21. The apparatus of Claim 20 further comprising:

a print head carrier capable of providing movement to the print head over a two-dimensional plane in response to commands received from the computer.

22. The apparatus of Claim 20 further comprising:

a registration system for aligning a pre-stretched screen on the screen bed with the print head.

23. The apparatus of Claim 20 wherein the wavelength of the source of ultraviolet light is between 360 and 400 nanometers.

24. The apparatus of Claim 20 further comprising:

an ultraviolet light blocking agent within the reservoir wherein the ultraviolet light blocking agent remains at least substantially flowable after an exposure to an ultraviolet light.

25. The apparatus of Claim 24 wherein the predetermined duration is less than one minute.

26. The apparatus of Claim 20 wherein the source of ultraviolet light is attached to the housing in a fixed location.

27. The apparatus of Claim 26 wherein the source of ultraviolet light comprises an exposure area large enough to expose an entire area of a portion of the screen bed on which a pre-stretched screen is supported.

28. The apparatus of Claim 20 wherein the source of ultraviolet light is capable of independent movement.

29. The apparatus of Claim 20 wherein the source of ultraviolet light is at least as wide as the screen bed and has a length substantially less than a length of the screen bed.

30. The apparatus of Claim 20 wherein the source of ultraviolet light is attached to the housing.

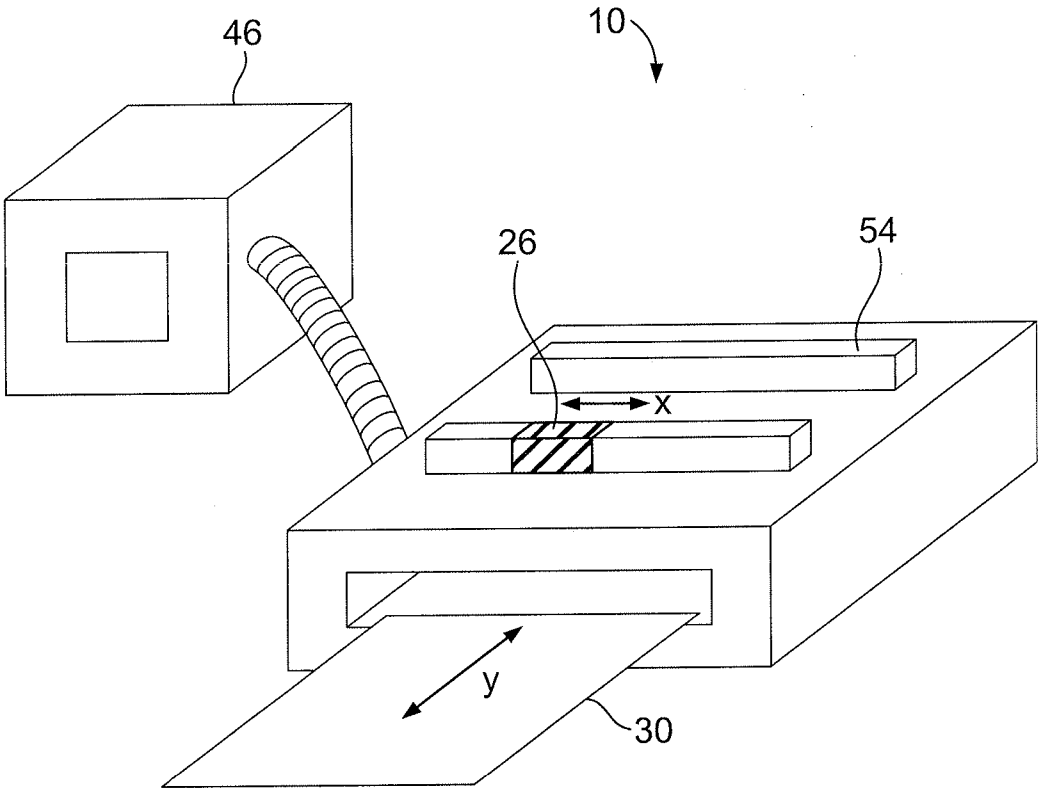


FIG. 1

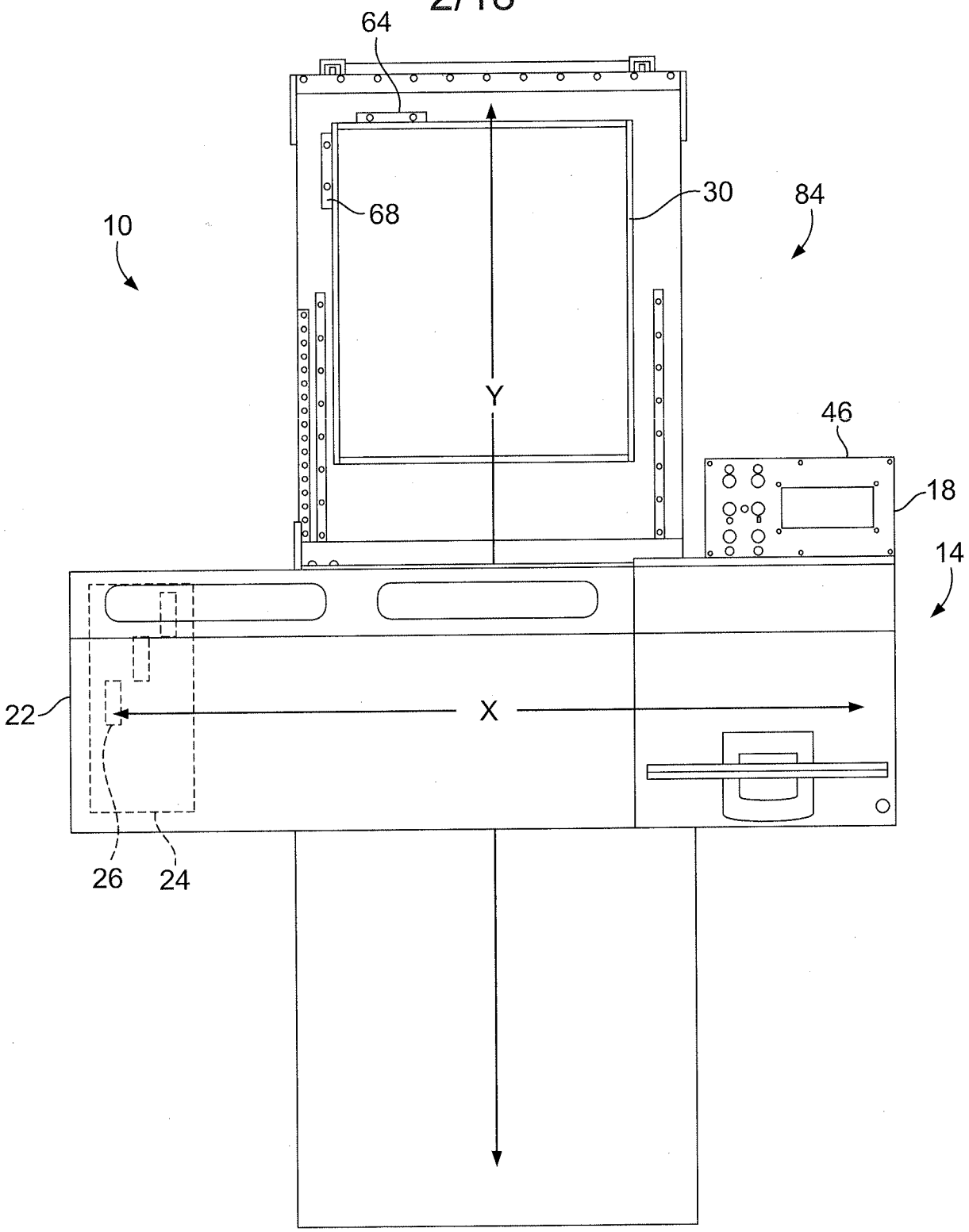


FIG. 2

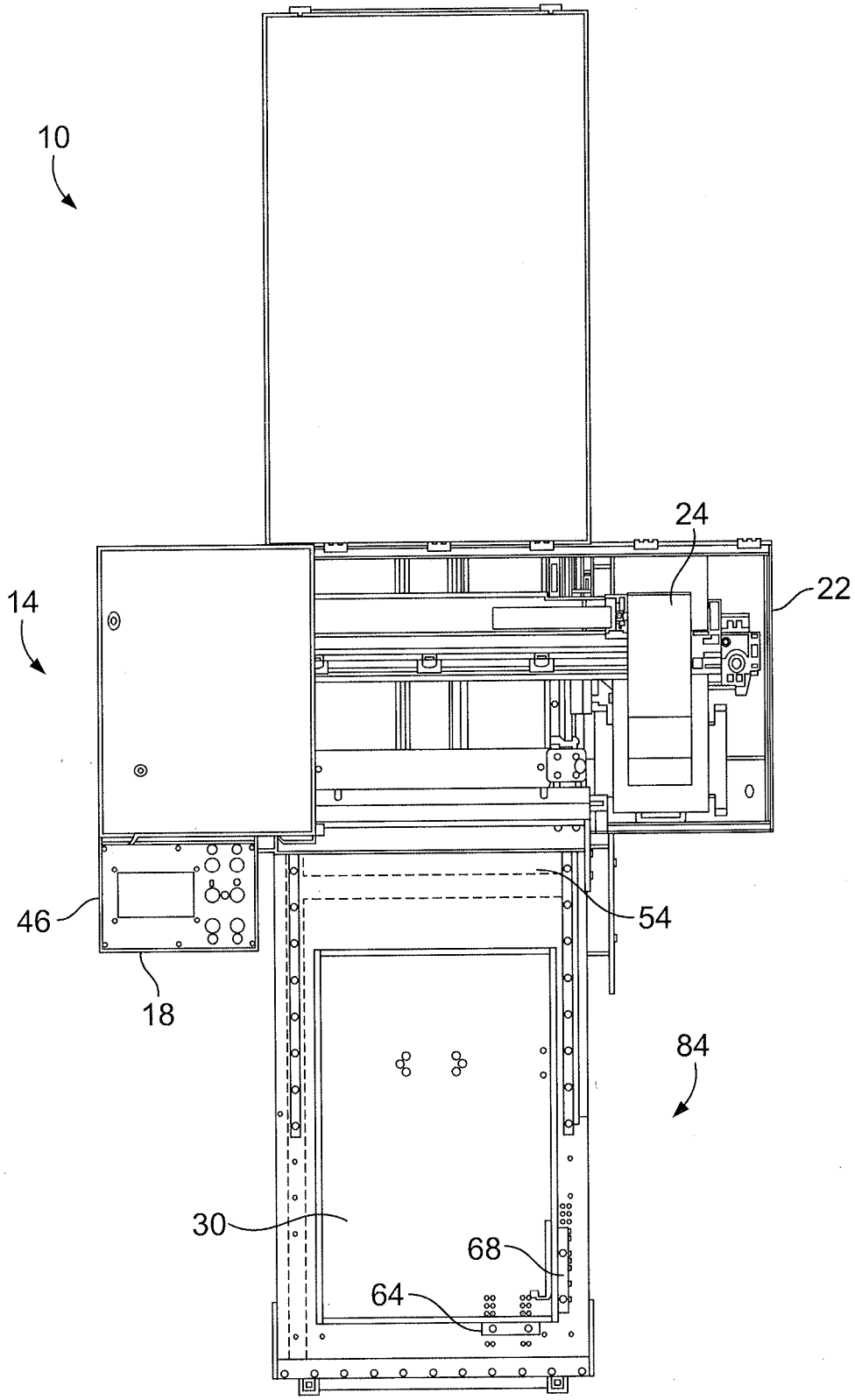


FIG. 3

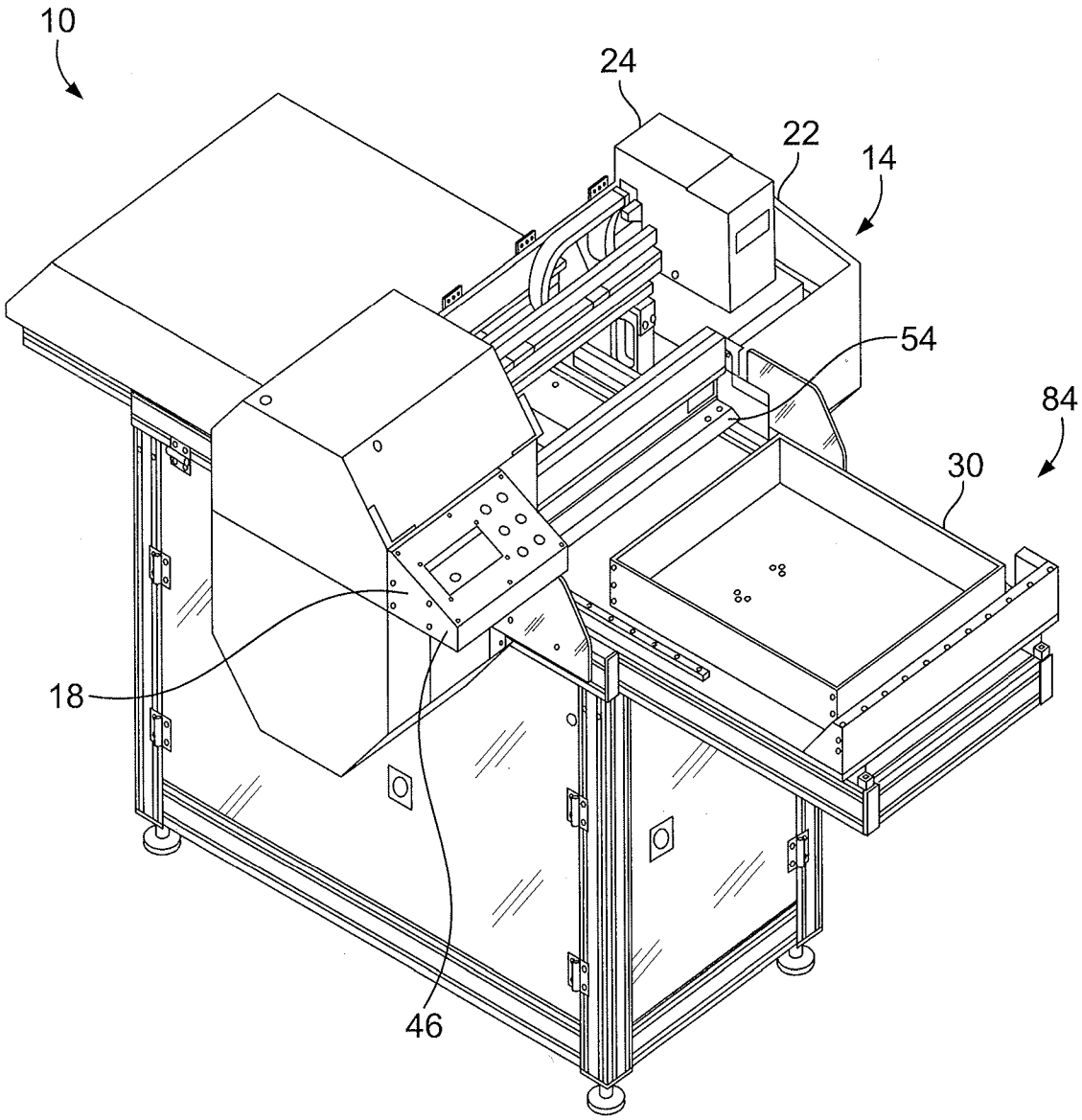


FIG. 4

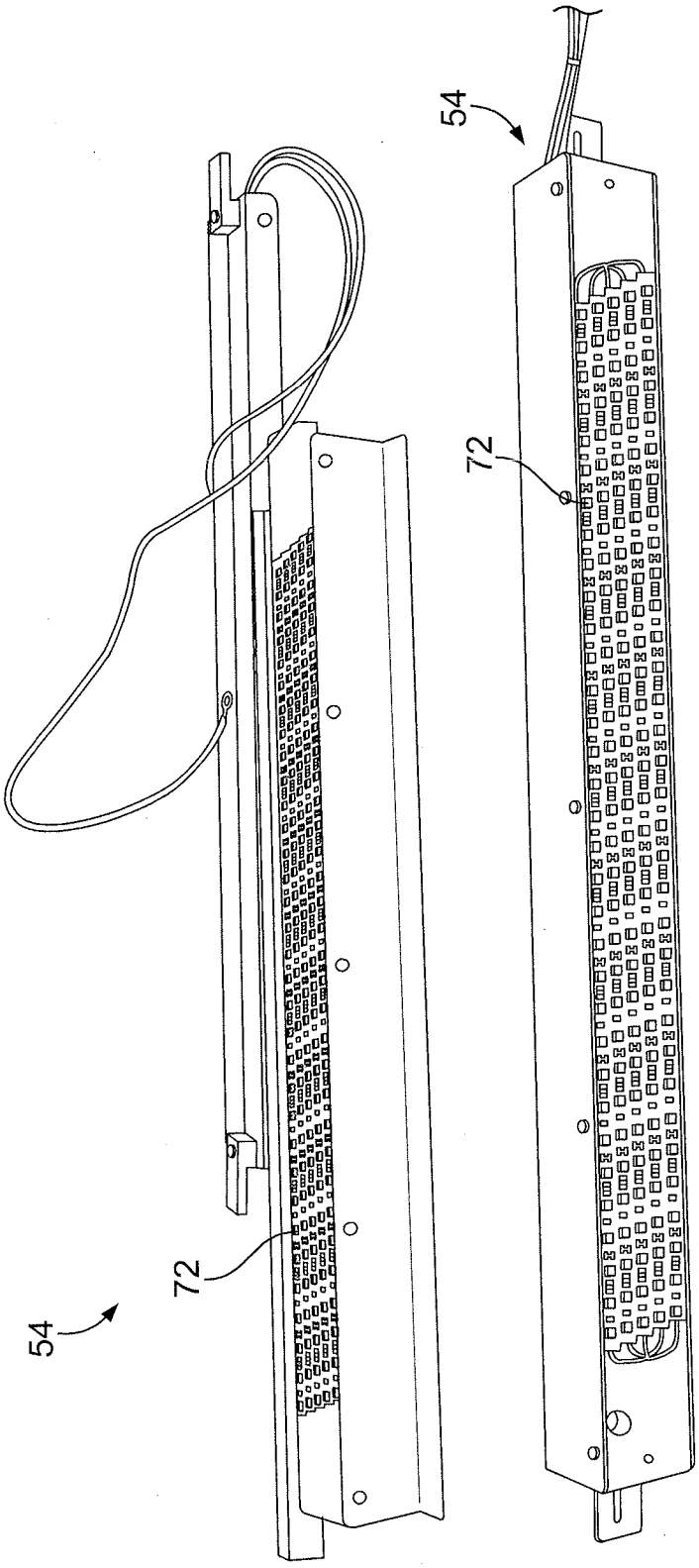


FIG. 5

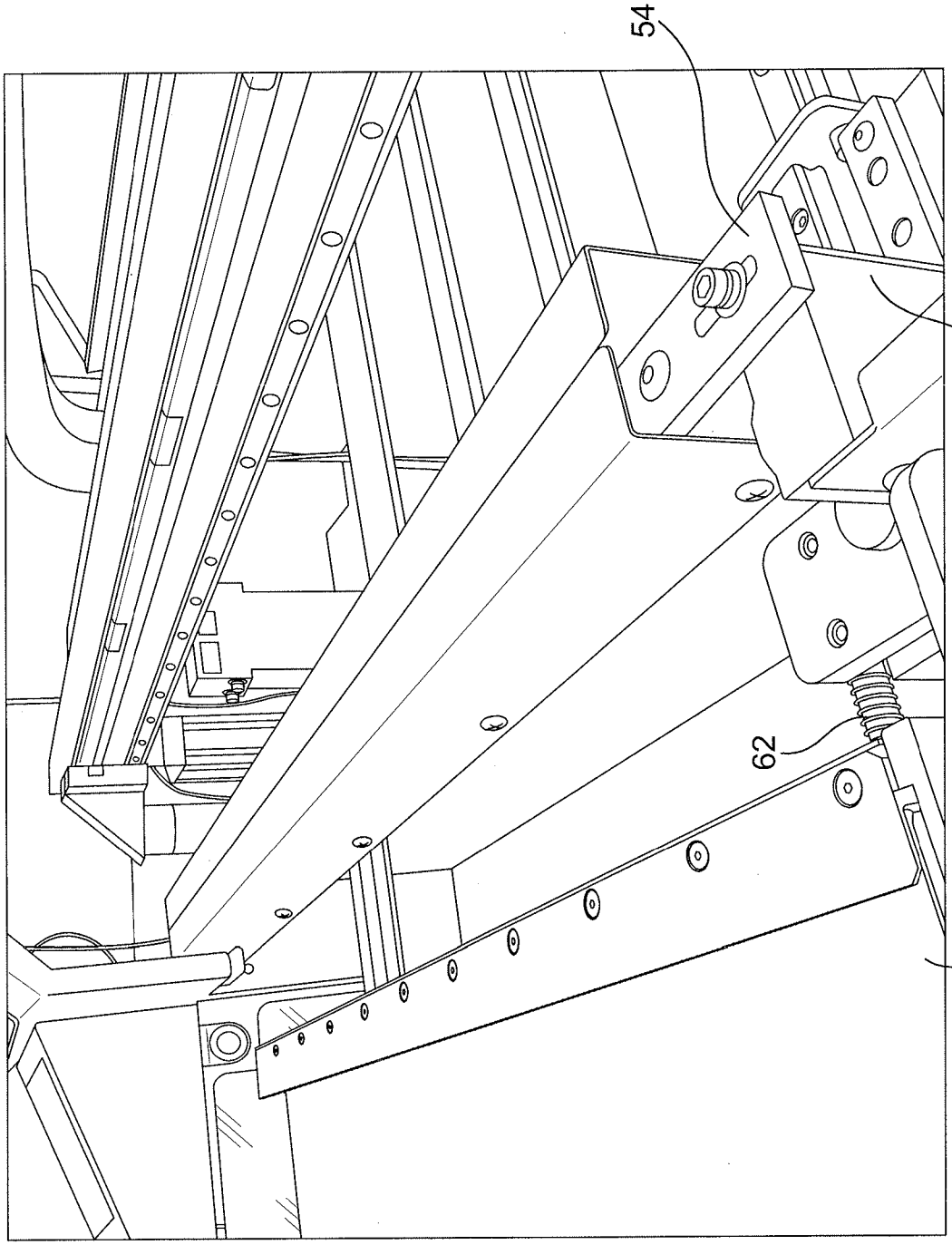


FIG. 6

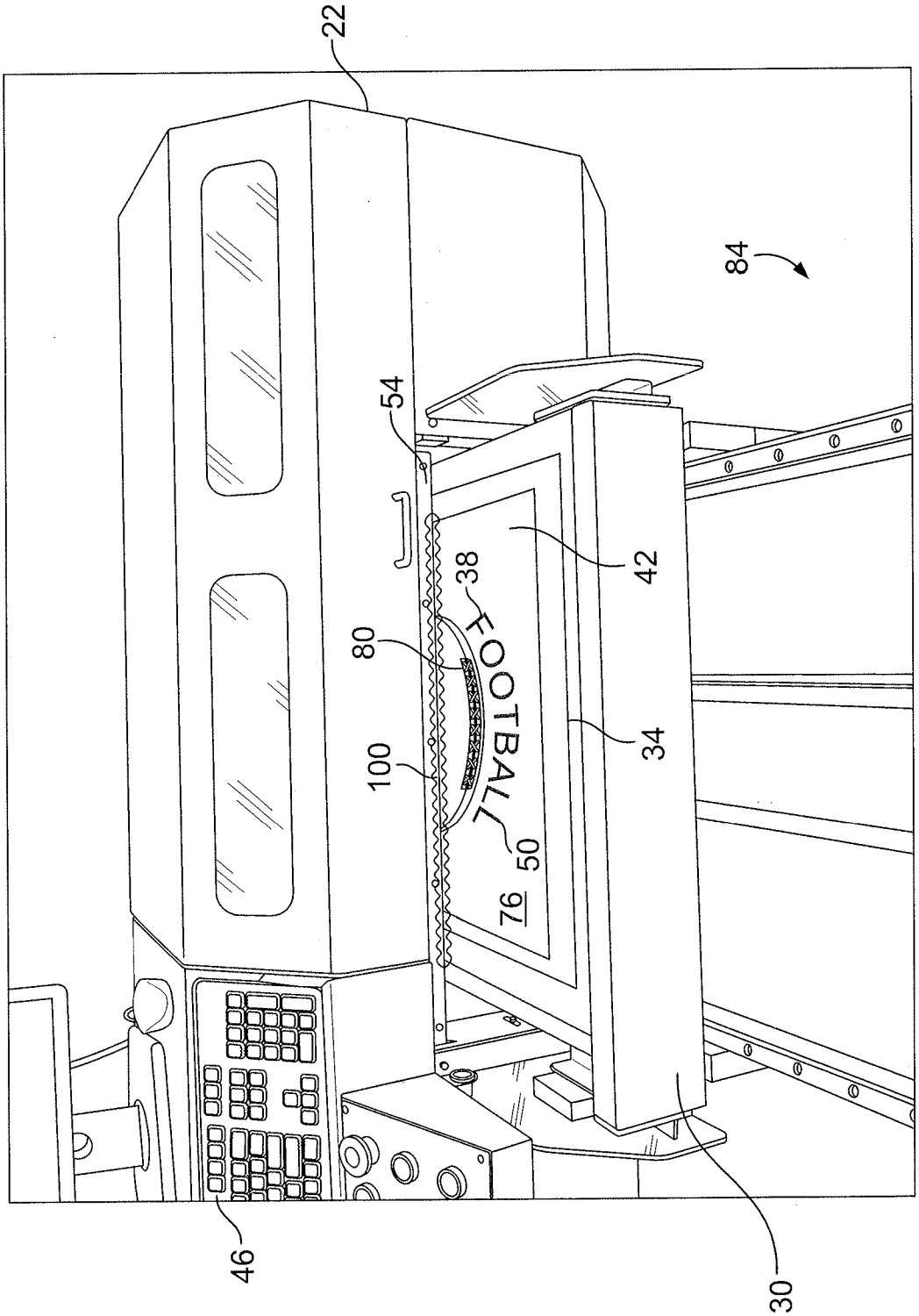


FIG. 7

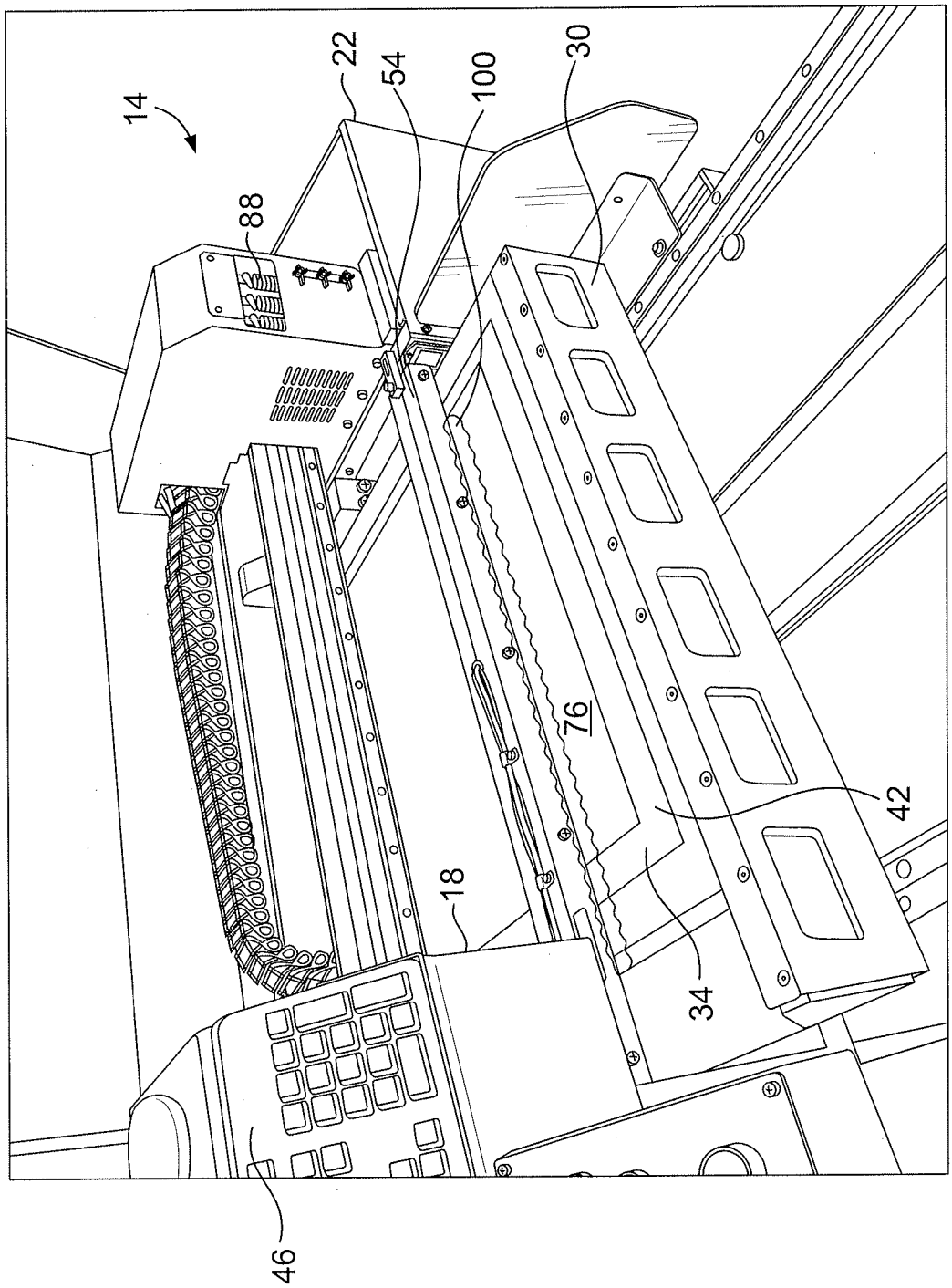


FIG. 8

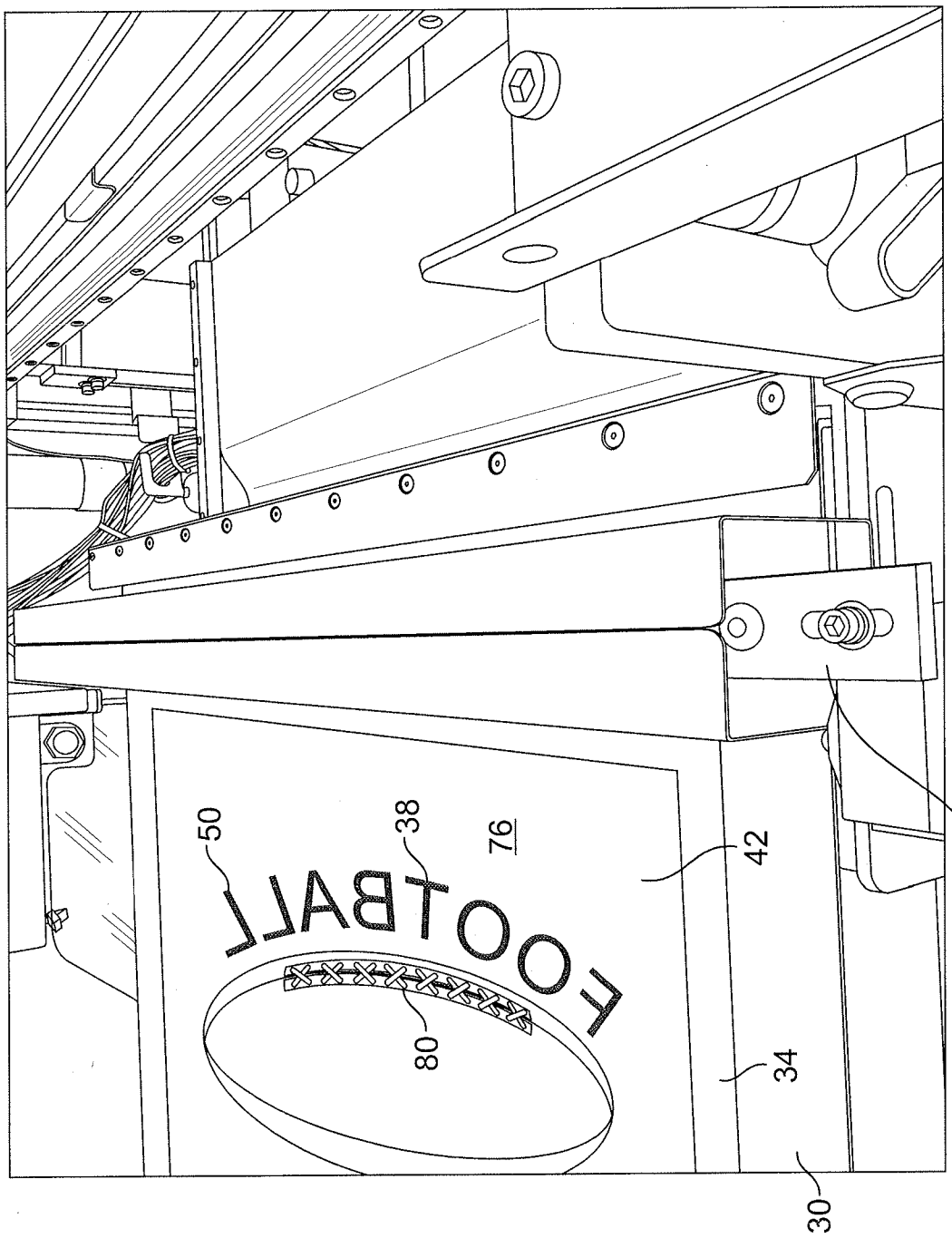


FIG. 9

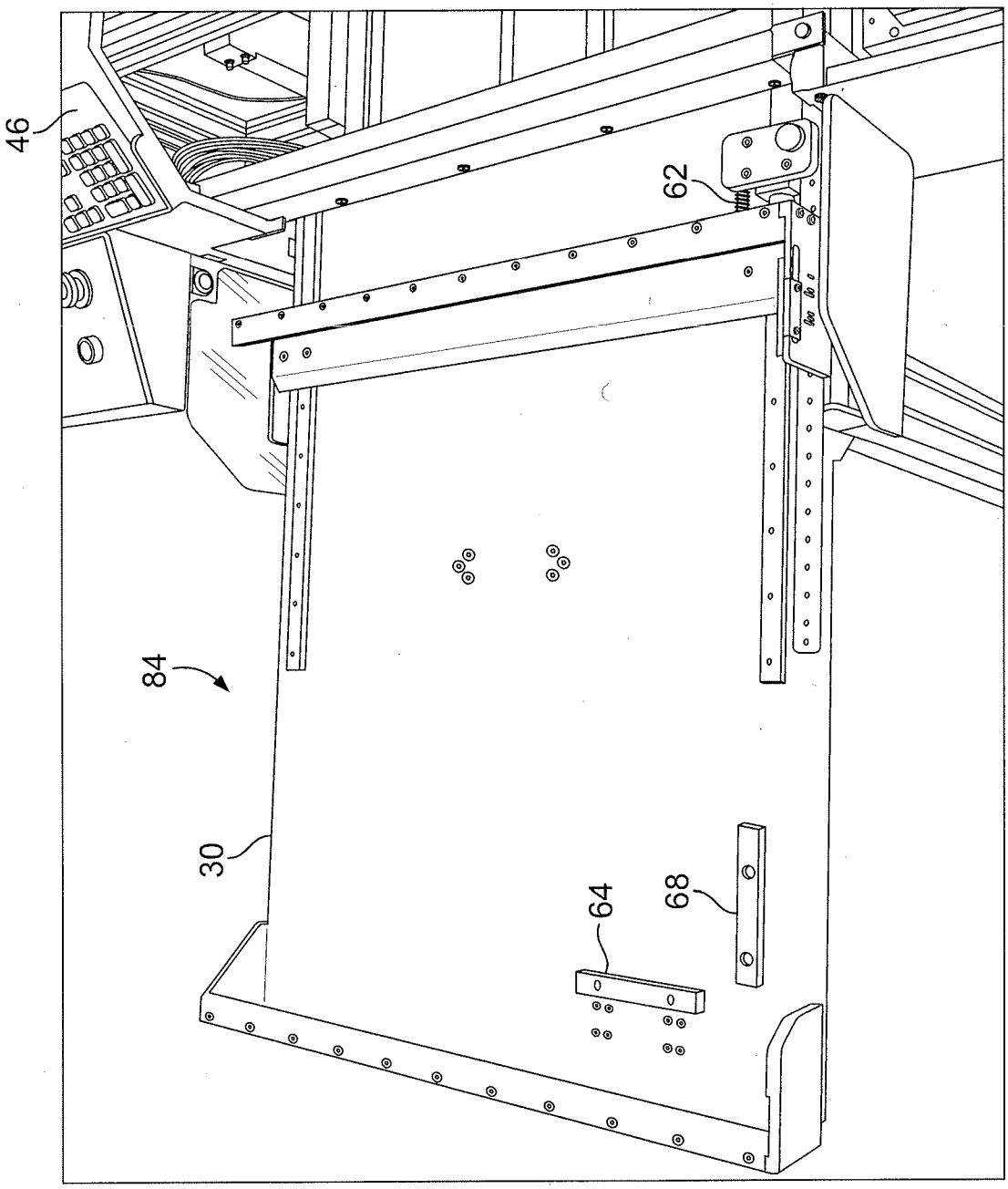


FIG. 10

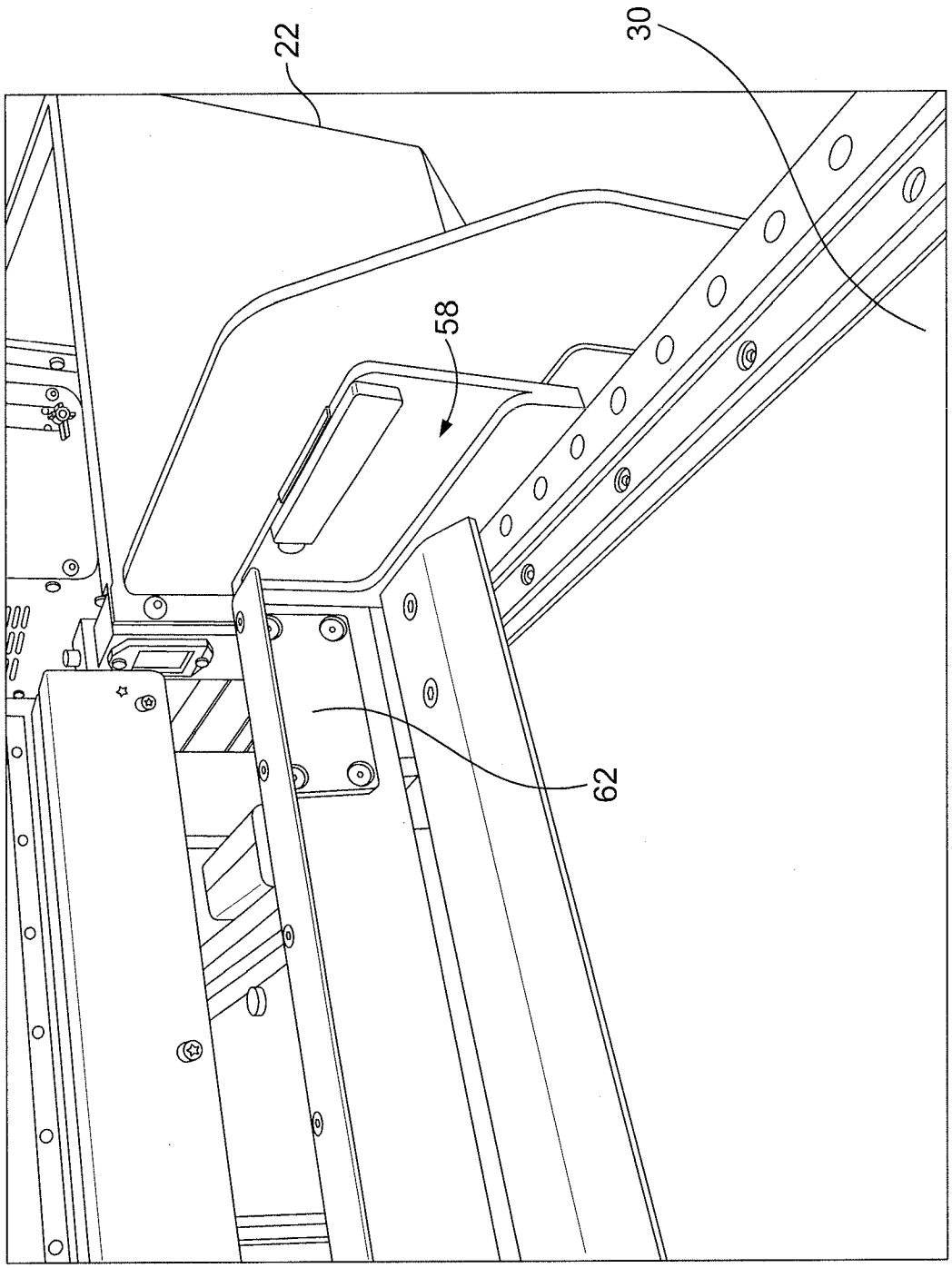


FIG. 11

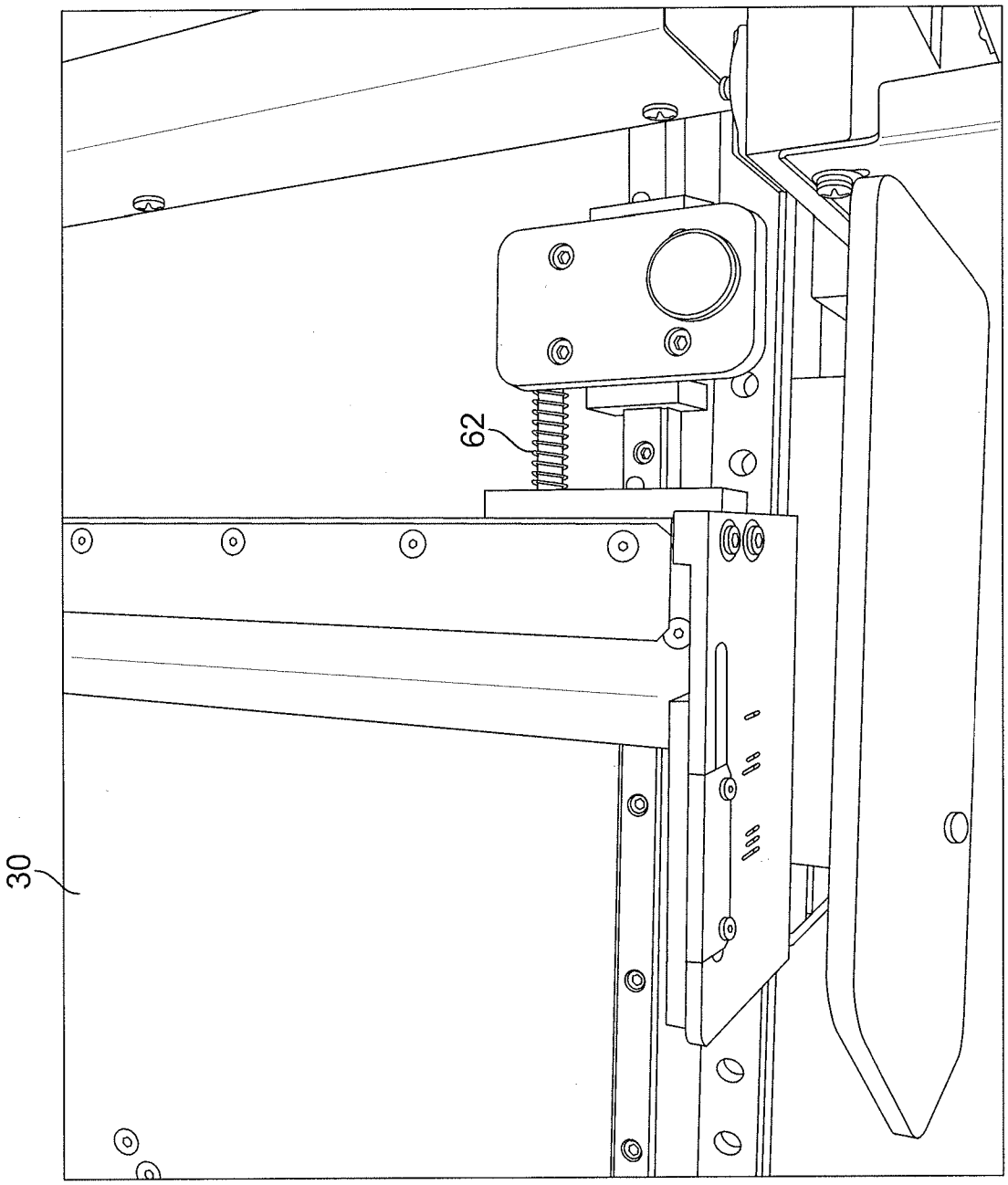
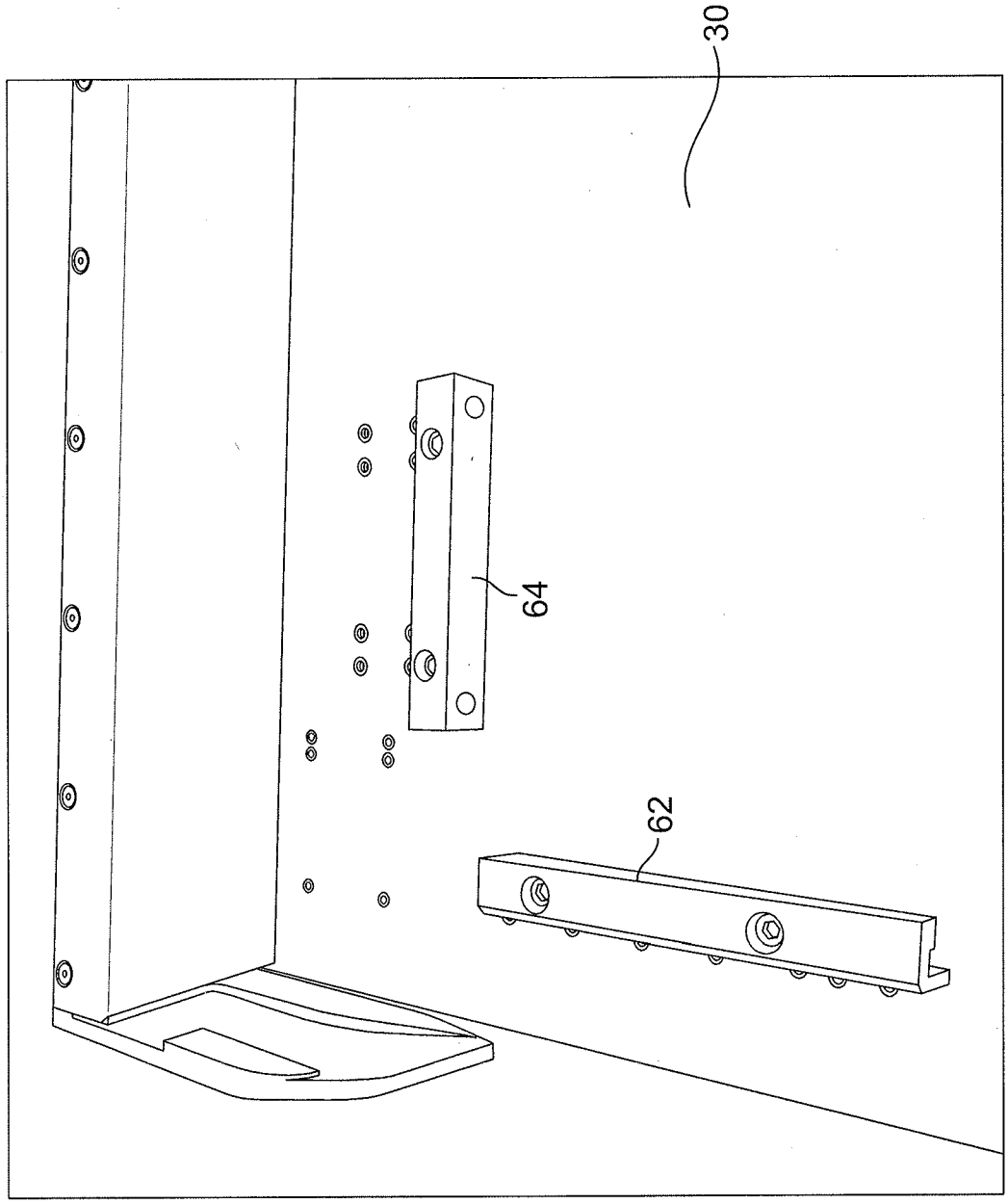


FIG. 12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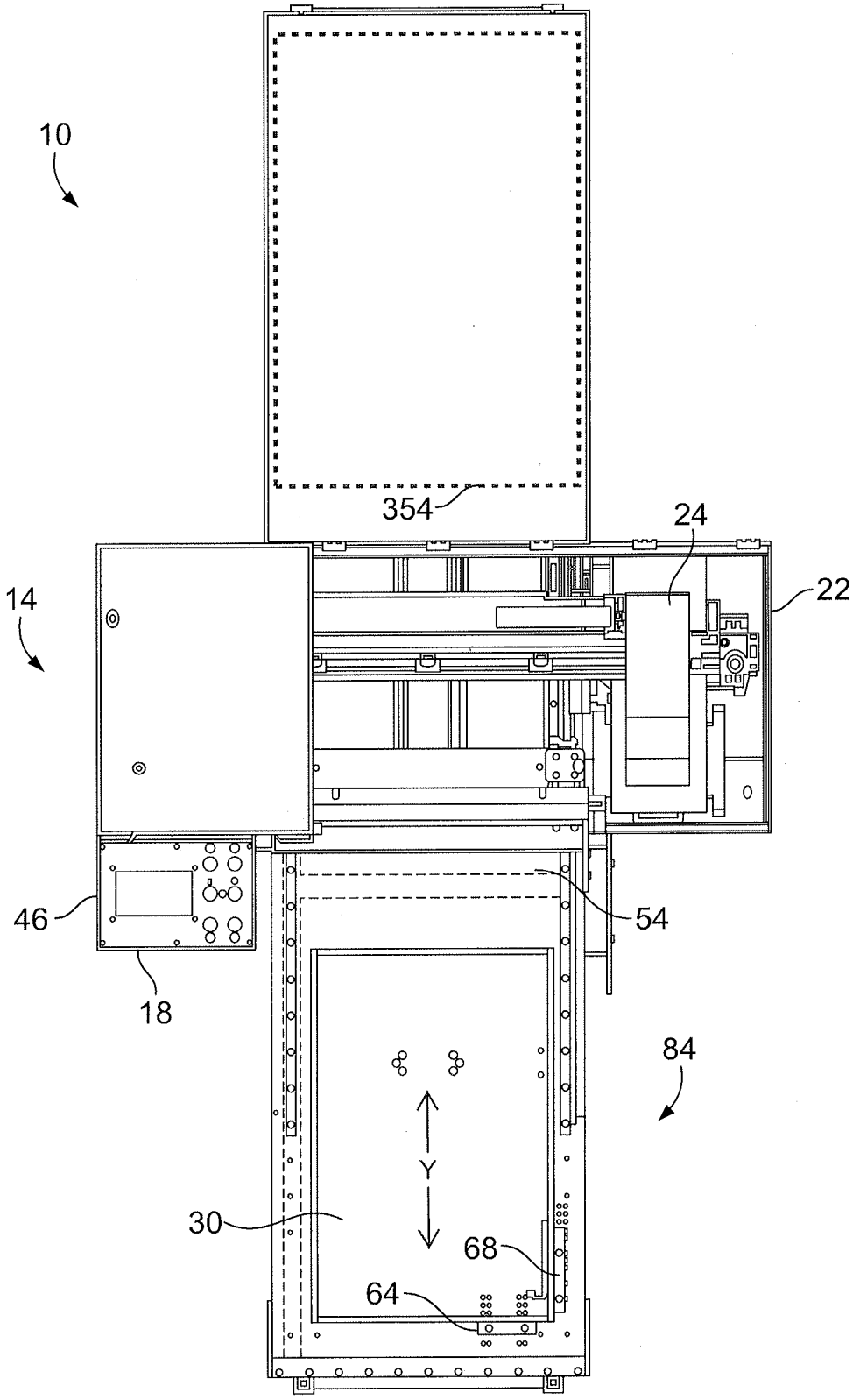

FIG. 14

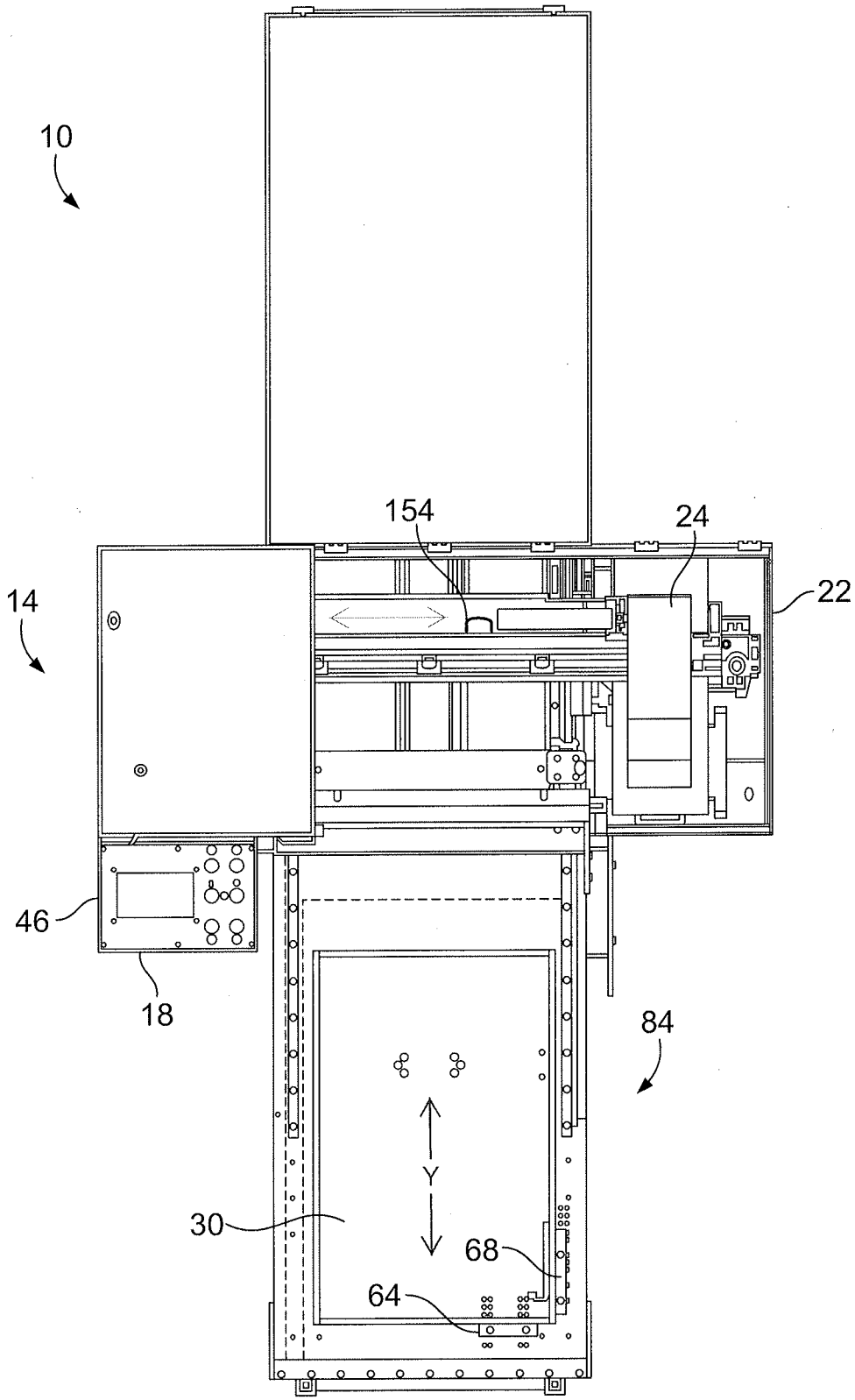

FIG. 15

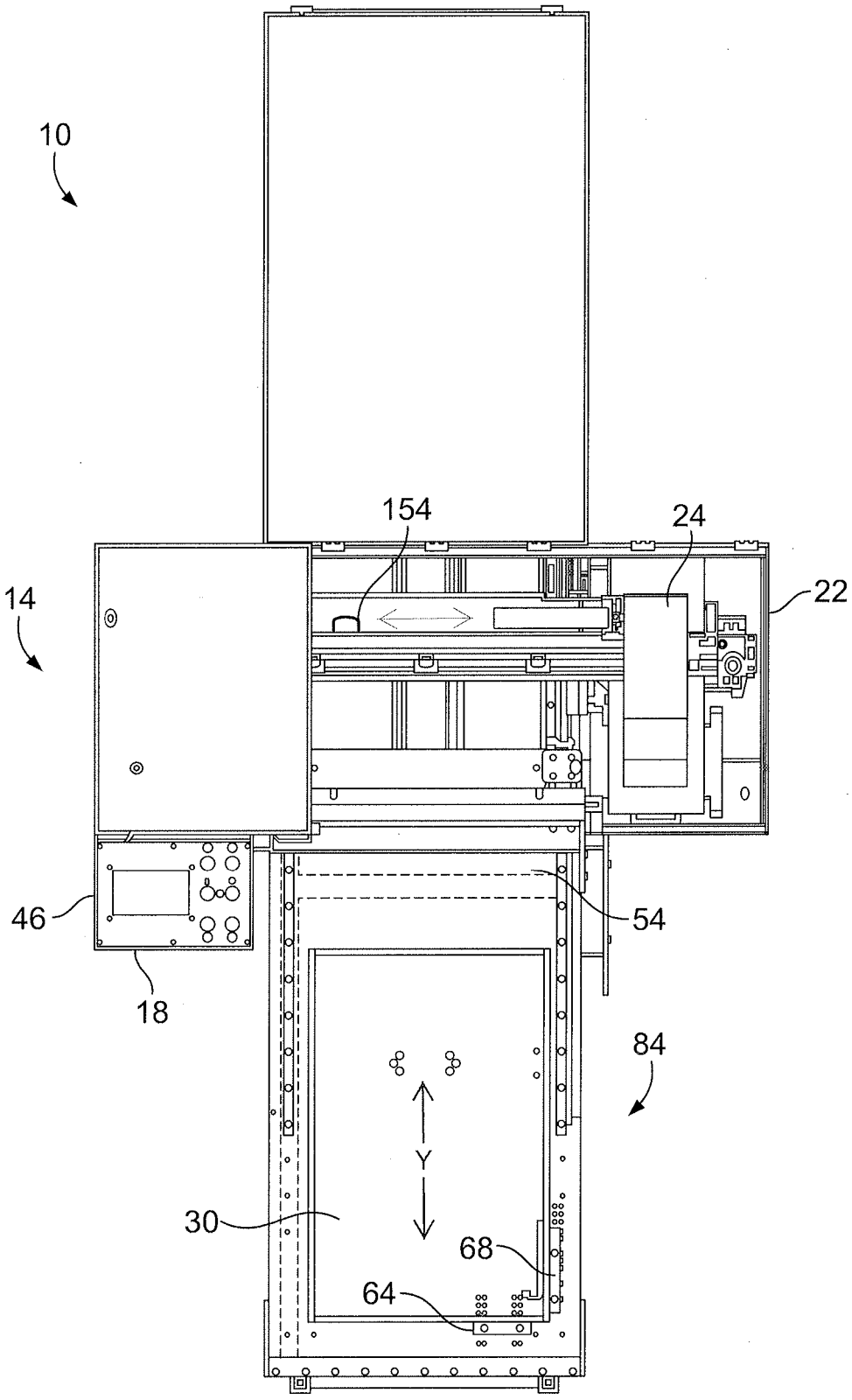

FIG. 16

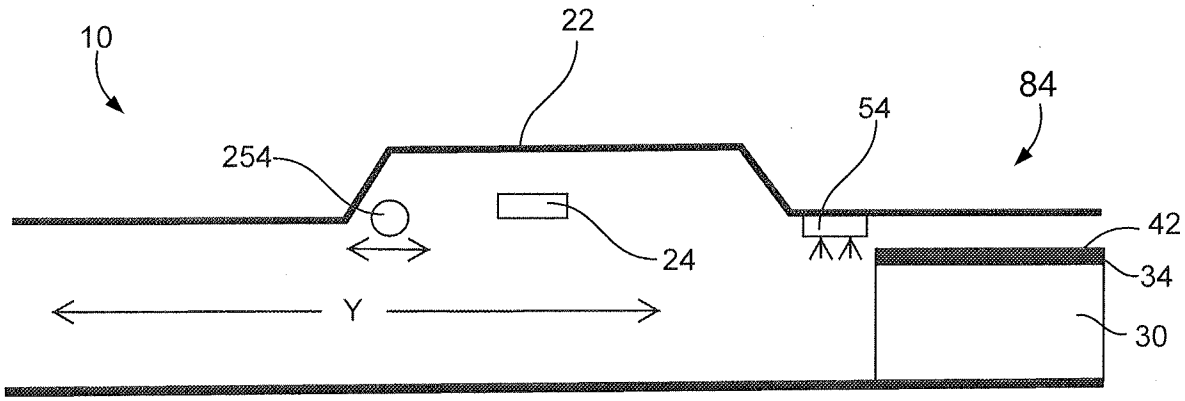

FIG. 17

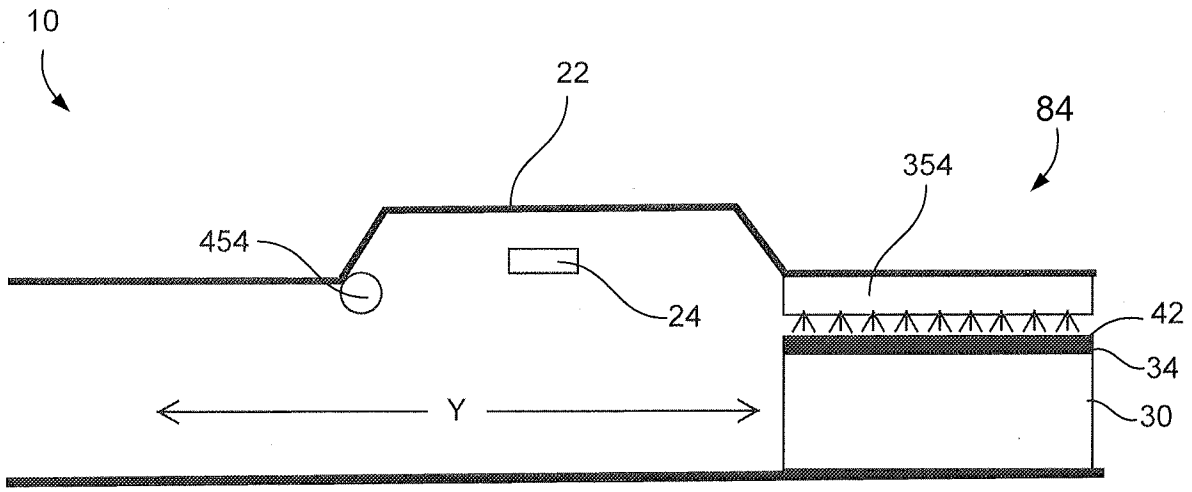

FIG. 18

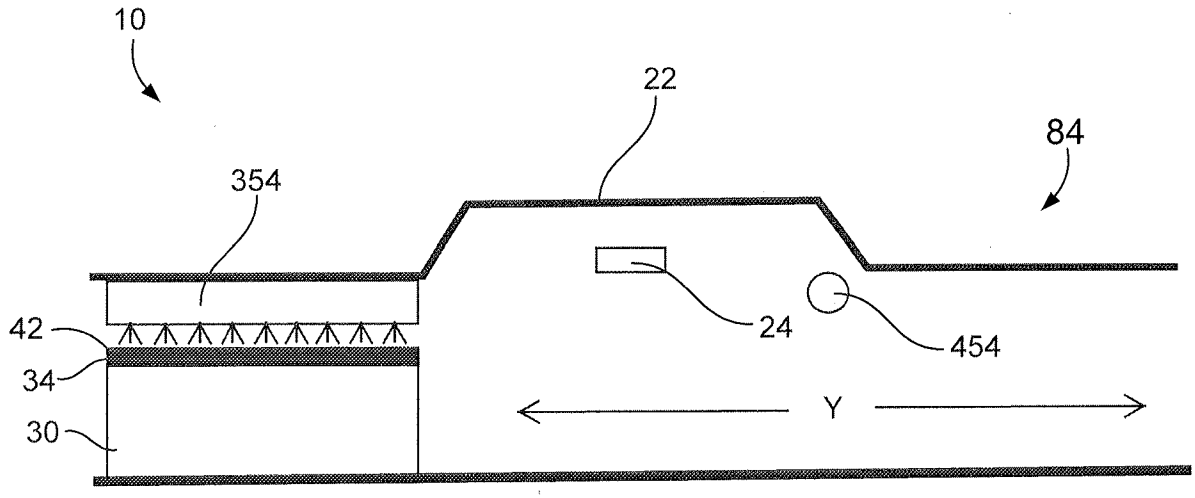

FIG. 19

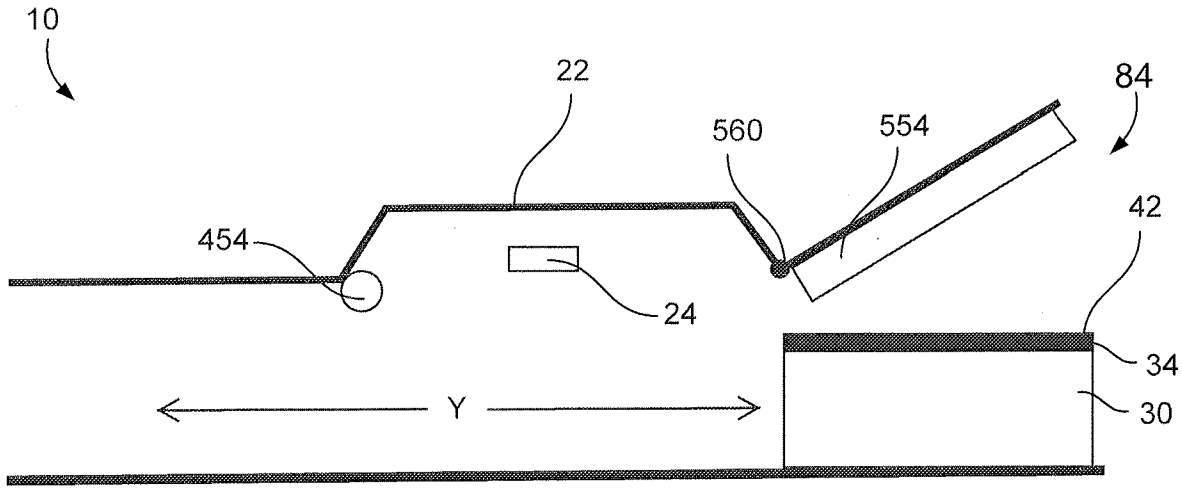

FIG. 20

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/028114

A. CLASSIFICATION OF SUBJECT MATTER
INV. B41C1/14 G03F1/00 G03F7/20 G03F7/12
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B41C G03F B41M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00/77576 A1 (CREOSCITEX CORP LTD [IL]; FIGOV MURRAY [IL]) 21 December 2000 (2000-12-21) page 3, line 15 - page 4, line 21 page 5, line 16 - page 6, line 11 page 10, line 21 - page 13, line 8 claims 1-3 figures 6A-6E	1-30
X	EP 0 492 351 A1 (GERBER SCIENT PRODUCTS INC [US]) 1 July 1992 (1992-07-01) column 2, line 9 - column 8, line 20 claims 1-22; figures 1,2	1-30

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 August 2014	03/09/2014

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/028114

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X A	EP 2 395 396 A2 (VAN HEIJNINGEN DIRK JAN [NL]) 14 December 2011 (2011-12-14) paragraphs [0008], [0018] - paragraph [0025] paragraph [0046] - paragraph [0050] figures 5a,5b,6a,6b,6c -----	1-3,6, 10-19 4,5,7-9, 20-30
A	EP 1 245 400 A1 (AGFA GEVAERT [BE]) 2 October 2002 (2002-10-02) paragraphs [0068], [0069] -----	1-30

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Information on patent family members

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