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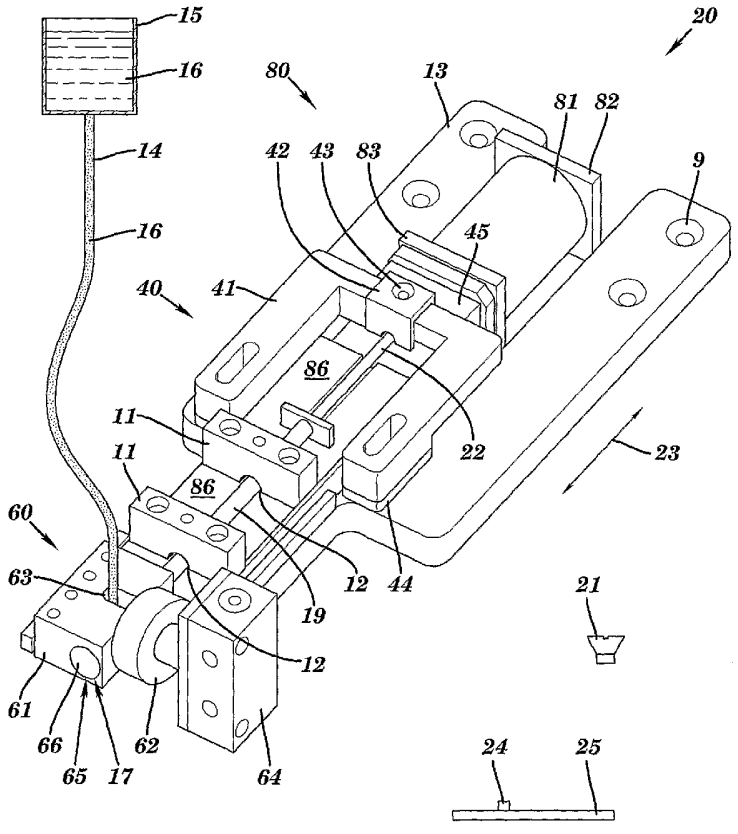
(54) Title: DISPENSING DEVICE FOR MATERIALS, METHOD AND SYSTEM OF USE THEREOF



(57) Abstract: The invention relates generally to a device for dispensing materials, especially reactive and abrasive fluids; and a system and method of use thereof. Disclosed is a device for dispensing material from a syringe which includes a plunger retainer, a drive mechanism, a receiver for a syringe, a multi-directional flow valve, and a sensor. Also disclosed is a method for dispensing material which includes providing a device for dispensing the material, providing a syringe, providing a reservoir for containing the material, operatively coupling the dispensing device to a multi-degree of freedom robotic apparatus; and dispensing the material onto a workpiece. Also disclosed is a system for dispensing materials which includes a device for dispensing materials, a reservoir for containing the material, a syringe wherein the syringe is cooperable with the device, a multi-degree of freedom robotic apparatus operatively coupled to the device; and a drive system for supplying motive power.

WO 2006/116561 A2

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DISPENSING DEVICE FOR MATERIALS, METHOD AND SYSTEM OF USE THEREOF

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates to a device, a method, and a system for dispensing materials, and in particular, reactive and abrasive fluids.

2. Related art

In the field of material dispensing, efforts toward devices and systems able to effectively dispense materials are continuously being made, especially, costly materials such as reactive and abrasive fluids. Due to the complexity and material composition of present day devices, their utilization for such materials is limited and impractical due the required frequent disassembly for cleaning, maintenance, and/or rebuilding with new parts. .

Further, the costs of maintenance and cleaning of the devices and the systems is highly regarded. With most material dispensing devices and systems, significant man-hours and manufacturing downtime, which translate into costs, must be expended to clean the devices and the systems between dispensing cycles, uses, work shifts, or material changes.

Thus, there is a need for a device, system and method which overcomes the aforementioned, and other, deficiencies in the art of dispensing materials.

SUMMARY OF THE INVENTION

In a first general aspect of the present invention is provided a device for dispensing material from a syringe, said syringe having a plunger with a terminal plate and a piston; and a syringe barrel for receiving the piston comprising: a plunger retainer, for releasably attaching the terminal plate of said plunger; a drive mechanism, adapted to provide motive force to said plunger head retainer; a receiver for said syringe; a multi-directional flow valve capable of fluid communication with a reservoir; and a sensor for determining an amount of material dispensed from said syringe.

In a second general aspect of the present invention is provided a method for dispensing material from a syringe, said syringe having a plunger with a terminal plate and a piston; and a syringe barrel for receiving the piston comprising: providing a device for dispensing material, wherein said dispensing device is co-operable with a syringe; providing said syringe, said syringe being co-operable with said dispensing device; providing a reservoir for containing said material, wherein said reservoir is in fluid communication with said dispensing device; operatively coupling said dispensing device to a multi-degree of freedom robotic apparatus; and dispensing said material onto a workpiece.

In a third general aspect of the present invention is provided a system for dispensing material from a syringe, said syringe having a plunger with a terminal plate and a piston; and a syringe barrel for receiving the piston comprising: a device for dispensing material, wherein said dispensing device is co-operable with a syringe; a reservoir for containing said material wherein said reservoir is in fluid communication with said dispensing device; a syringe wherein said syringe is co-operable with said device; a multi-degree of freedom robotic apparatus operationally coupled to said device; and a drive system, for supplying motive power to move said robotic apparatus in multi-degrees of freedom, said drive system operationally coupled to said robotic apparatus.

In a fourth general aspect of the present invention is provided a device dispensing material comprising: a syringe for dispensing material, said syringe having a plunger with a terminal plate and a piston; and a syringe barrel for receiving said piston; a sensor for determining an amount of said material dispensed from said syringe; a multi-directional flow valve, wherein the flow valve is in fluid communication with a reservoir, wherein said reservoir is for containing said material; and a receiver for securing various size syringes.

In a fifth general aspect of the present invention is provided a system for dispensing material comprising: a device, wherein the device is operably coupled to a syringe, said syringe having a plunger and a piston; and a syringe barrel for receiving said piston and further wherein said dispensing device has a multi-directional flow valve; a reservoir for containing a material wherein said reservoir is in fluid communication with said dispensing device; a multi-degree of freedom robotic apparatus operationally coupled to said dispensing device; and a drive system, for supplying motive power to move said robotic apparatus in multi-degrees of freedom, said drive system operationally coupled to said robotic apparatus.

The foregoing and other features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that those skilled in the art will be better able to practice the invention, reference will be made to the drawings, wherein:

FIG. 1 depicts a perspective view of a dispensing device in accordance with the present invention;

FIG. 2 depicts a perspective view of the dispensing device of FIG. 1 in co-operation with a syringe in accordance with the present invention;

FIG. 3 depicts a partially exploded view of a 3-way stopcock in accordance with the present invention;

FIG. 4 depicts a block diagram of a controller for use with the dispensing device and a dispensing system in accordance with the present invention;

FIG. 5 depicts a perspective view of a dispensing device in accordance with present invention;

FIG. 6 depicts a Cartesian coordinate system used in describing the motion of a method and a system for dispensing material in accordance with the present invention;

FIG. 7 depicts a top view of a dispensing system in accordance with the present invention;

FIG. 8 depicts a side view of the dispensing system in accordance with the present invention;

FIG. 9 depicts a front view of the dispensing system in accordance with the present invention;

FIG. 10 depicts a top view of a dispensing system in accordance with the present invention;

FIG. 11 depicts a side view of the dispensing system in accordance with the present invention; and

FIG. 12 depicts a front view of the dispensing system in accordance with the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Although certain embodiments of the present invention will be shown and described in detail, it should be understood that various changes and modifications may be made without departing from the scope of the appended claims. The scope of the present invention will in no way be limited to the number of constituting components, the materials thereof, the shapes thereof, the relative arrangement thereof, etc., and are disclosed simply as an example of the embodiment.

The present invention offers a device for dispensing materials, especially reactive and abrasive fluids. Reactive and abrasive fluids are two classes of materials often used in dispensing devices and systems. Reactive fluids are fluids having the properties: anaerobic, shear sensitive, light sensitive, moisture sensitive, pressure sensitive, and the like. Examples of reactive fluids include but are not limited to cyanoacrylate type fluids, moisture sensitive silicones, and UV sensitive urethanes. Abrasive fluids are fluids having solid or semi-solid materials suspended within a uniform, liquid medium. Abrasive fluids are often referred to as filled materials. Examples of abrasive fluids include but are not limited to filled silicones and room temperature vulcanizing (RTV) silicones, thermal transfer compounds, and silver filled coating.

Although for purposes of illustration only, an embodiment that can be used for dispensing *inter alia* reactive or abrasive fluids is disclosed herein. The apparatus and method can be readily used for dispensing other materials. For example, materials having a viscosity in a range from about 0 centipoise to about 10,000 centipoise or any material where dispensing of the material is required can utilize the present invention.

FIG. 1 depicts a device **20** for dispensing materials, especially reactive and abrasive fluids, in accordance with the present invention. An embodiment of the present invention is the dispensing device **20** comprising: a plunger retainer **40**, a multi-directional flow valve **60**, a receiver **75**, a drive mechanism **80**, and a sensor **95**.

FIG. 2 depicts a device **20** for dispensing materials, especially reactive and abrasive fluids, with a syringe **19** operatively adapted to the device **20** in accordance with the present invention. Referring to FIG. 1 and FIG. 2, the receiver **75** is a space, region, area, or the like located on a first side, top, of a ball screw cover **86** of the device **20**. The receiver **75** can accommodate any syringe **19** that is capable of being integrally or non-integrally adaptable to

occupy the receiver **75**. The volume range of the syringes **19** typically used in the device **20** ranges from about 0.5 μL to about 10 mL. Further, the syringes **19** typically used in the device **20** may be made of materials comprising: glass, silicate, boro-silicate, plastic, rubber, metal, Pyrex®, nanocomposites, and the like as well as combinations thereof.

The device **20** further comprises syringe brackets **11** having syringe accommodators **12** operatively adaptable to secure the syringe **19** to a first side, top, of a ball screw cover **86**. The syringe brackets **11** are secured to the first side, top, of the cover **86** via at least one thumb screw **21**. The accommodators **12** are operatively adaptable to secure syringes **19** having volumes in a range from about 0.5 μL to about 10 mL.

The plunger retainer **40** comprises: a syringe yolk **41**, a syringe yolk fastener **42**, a syringe yolk screw **43**, and a syringe yolk carriage **44**. The syringe yolk **41** is operatively coupled to the syringe carriage **44** and is operatively adapted to retain a terminal plate **26** of a syringe plunger **22**. The terminal plate **26** may be flat or have any perpendicular extension capable of being held in the yolk **41**. The syringe yolk screw **43** secures the plate **26** of the plunger **22** to the yolk **41** preventing the plunger **22** from becoming disengaged from the yolk **41**. The yolk carriage **44** is operatively coupled to a ball screw shaft **85**.

The drive mechanism **80** comprises: a motor **81**, a communication interface **82**, a motor mount **83**, a ball screw slide **84**, and the ball screw shaft **85**. A first end of the motor **81** is coupled to a base plate **13** via the motor mount **83**. The mount **83** may be a NEMA® (i.e., National Electrical Manufacturers Association) mount, or other suitable mechanical interface. A second end of the motor **81** is coupled to the communication interface **82**. The interface **82** acts as a communication interface between the motor **81** and a control system **105** (See e.g., FIG. 3)

The motor **81** may be a gear motor, servo motor, stepper motor, and the like. Beyond the mount **83** and interconnected thereto is the ball screw slide **84**. On the slide **84** is the ball screw shaft **85**. The motor **81** causes rotation of the ball screw shaft **85** subsequently translating, along a directional arrow **23** parallel to the screw shaft **85**, the syringe yolk carriage **44** to which is engaged the terminal flat plate **26** of the syringe plunger **22**.

The device **20** further comprises an material conduit **14** operationally coupled to a material inlet port **63** of the multi-directional flow valve **60**. The material conduit **14** interconnects a material supply, or reservoir **15**, of the material **16**, shown schematically, to the flow valve **60** allowing fluid communication between the reservoir **15** and the flow valve **60**.

The multi-directional flow valve **60** comprises: a stopcock aligning bracket **61**, a 3-way stopcock rotary bracket **62**, the material inlet port **63**, a stopcock actuator **64**, a 3-way stopcock **65**, and a needle **66**. The aligning bracket **61** operatively brings into cooperation the 3-way stopcock **65** with a syringe tip **17** and the material conduit **14** via inlet port **63**. The 3-way stopcock rotary bracket **62** interconnects the 3-way stopcock **65**, the stopcock actuator **64**, and the needle **66**, and is operatively coupled to each of the aforementioned.

The actuator **64** supplies and transmits a measured amount of force to the 3-way stopcock **65** via the 3-way stopcock rotary bracket **62**. The force transmitted allows for the stopcock **65** to be set to one of three positions (See e.g., FIG. 3): a first position **67** allowing for fluid **16** flow from a material reservoir **15** to a syringe **19**; a second position **68** allowing for fluid **16** flow from the syringe **19** to a workpiece **18**; and a third position **69** preventing the material **16** flowing from the material reservoir **15** to the syringe **19** and from the syringe **19** to the workpiece **18**.

The sensors **95** are below the ball screw cover **86** and operatively in the vicinity of the ball screw slide **84**. The sensors **95** are capable of precisely detecting a home/zero setting of the ball screw slide **84** and communicating the extent of the setting to the computer control system **105** (See e.g., FIG. 4).

FIG. 4 depicts a block diagram of a controller **105** for use with the dispensing device and a dispensing system in accordance with the present invention. The controller **105** comprises: a non-volatile memory, an Input/Output (I/O) device **106**, and a central processing unit (CPU) **107**. Although the controller **105** can take various forms, the controller **105** comprises a microprocessor based, stand-alone microcomputer. The controller **105** is programmably operable to perform simultaneous multi-axis coordinated motion with precision, accuracy, and repeatability.

A non-volatile memory **108** stores the control program and inputs, via the I/O device **106**, and may comprise, for example, EEPROMs. The I/O device **106** may comprise, for example, a keyboard. The CPU **107** is at least 32-bit microprocessor. Performance characteristics include at least 8 million encoder inputs per second axis feedback, and at least 125 microsecond per axis position update rate.

Referring to FIGS. 1 - 4, another embodiment of the present invention is the device **20** dispensing material **16** onto a workpiece **18** such as a component **24** of a circuit board **25**. To

prepare the device **20** for dispensing the material **16**, a user must first install a syringe **19** onto the device **20**.

In order to install the syringe **19**, a user can remove the syringe brackets **11** from the ball screw cover **86** via loosening of the thumbscrews **21**. The syringe **19** then is placed within the receiver **75** and the syringe brackets **11** may be reinstalled. The brackets **11** secure the barrel of the syringe **19** to the ball screw cover **86** via the syringe accommodators **12**. The syringe accommodators **12** may be integrally or non-integrally coupled to the brackets **12**. The accommodators **12** are designed and made of materials that are form fitting to the syringe **19** being secured. Thus the brackets **12** are able to secure syringes **19** of various volumes without having to use brackets **12** solely dedicated to a syringe **19** of a particular volume.

Having secured the syringe **19** to the dispensing device **20** with the syringe brackets **11**, the plunger retainer **40** then can be coupled to the syringe plunger. The top of the syringe yolk **41** is operatively adaptable to engage the terminal flat plate **26** of the syringe plunger **22**. This may include a general indentation, recess, notch, and the like in the yolk **41**. The recess of the yolk **41** is fitted onto the plunger **22** and secured to the yolk **41** via the yolk fastener **42**. The fastener **42** is tightened to the yolk **41** using the thumbscrew **43**. The yolk screw **43** secures the plunger **22** to the yolk **41** preventing the plunger **22** from becoming disengaged from the yolk **41** during use.

The multi-directional flow valve **60** then is coupled to the syringe **19**. The 3-way stopcock **65** is operatively fitted onto the tip **17** of the syringe **19**. This may entail snapping, screwing, non-integrally locking, and the like. Similarly, the 3-way stopcock rotary bracket **62** and the needle **66** may be fitted onto the stopcock **65**. The stopcock actuator **64** then is fitted onto the rotary bracket **62**. The stopcock aligning bracket **61** operatively maintains in cooperation the stopcock **65** with the syringe tip **17** and the fluid conduit **14** via the inlet port **63**.

The steps of installing the syringe **19** onto the dispensing device **20**, securing the syringe **19** to the plunger retainer **40**, and coupling the syringe **19** to the multi-directional flow valve **60** can be performed in any order or combination thereof.

In operation of the device **20**, the user enters dispensing parameters desired such as a motor **81** energization rate, a time interval for the plunger retainer **40**, a volume increment of the material **16** to be dispensed, a rate of the material **16** to be dispensed, a volume flow of the material **16** from the reservoir **15** to the multi-directional flow assembly **60**, the syringe **19**

dimensions, a material **16** dispensing pattern, and the like into the computer control system **105**. The control system **105** communicates the operational dispensing parameters to the drive mechanism **80** via the communication interface **82** and to the stopcock actuator **64** of the multi-directional flow valve **60**.

The material **16** is supplied under pressure from the material reservoir **15**, schematically drawn, through the material dispensing conduit **14** to the stopcock aligning bracket **61** of the multi-directional flow valve **60** via the material inlet port **63**. The reservoir **15** is operatively connected to and in fluid communication with the device **20** via the fluid dispensing conduit **14**. The conduit **14** may be of any length and size that allows for fluid communication between the reservoir **15** and the device **20**.

The dispensing conduit **14**, the inlet port **63**, and the reservoir **15** are made of materials resistant to the material **16** thereby preventing curing or setting of the material **16** therein. Such materials include but are not limited to linear polyoxymethylene acetal resin, polyetherimide, fluoropolymers such as polytetrafluoroethylene (PTFE), and the like. The reservoir **15** is a physical body for containing the material **16**. The reservoir **15** may be in any form that is capable of containing the material **16**. For example, a reusable cartridge, a reusable bag, a reusable container, a disposable cartridge, a disposable bag, a disposable container, and the like. The reservoir **15** is designed for containing materials such as reactive and abrasive fluids. Examples of such materials **16** include but are not limited to cyanoacrylates, silicones, urethanes, filled silicones, RTVs, thermal transfer compounds, silver filled coatings, and the like.

The computer control system **105**, programmably or manually, simultaneously controls the operation of the multi-directional assembly **60** and the drive mechanism **80** such as to provide operation of the aforementioned in a synchronous fashion. Thus, allowing for a controlled and a precise uptake of the material **16** from the material reservoir **15** into the syringe **19**, and a controlled and a precise dispensement of the material **16** from the syringe **19** onto a workpiece **18**.

FIG. 3 depicts a cross-sectional view of a 3-way stopcock **65**. In accordance with the present invention, an embodiment includes further operation of the device **20** typically having three operational positions of the 3-way stopcock **65**: a fill position **67** (FILL), a purge position **69** (PURGE), and a dispense position **68** (DISPENSE).

FILL **67** allows for uptake of the material **16** into the syringe **19**. On command, programmably or manually, the computer control system **105** sends a signal to the stopcock actuator **64** to turn the 3-way stopcock **65** to the FILL **67** connecting to the material reservoir **15**. The control system then signals, simultaneously or subsequently, the drive mechanism **80**, via the communication interface **82**, causing the motor **81** to be engaged. The motor **81** rotates the ball screw shaft **85** which in turn translates the syringe yolk carriage **44** upward along the directional arrow **23**. The carriage **44** subsequently translates the syringe yolk **41**, to which is engaged the syringe plunger **22**, upward along the directional arrow **23**. As the plunger **22** is retracted, the material **16** is pulled into the syringe **19** hence filling the syringe **19** with the material **16**.

The volume of the material **16** taken up into the syringe **19** is regulated by the sensors **95**. As the yolk **41** and subsequently the plunger **22** is retracted, the motor **81** rotates a certain number of rotations. This rotational data is communicated to the control system **105**. The control system **105**, through proprietary software, is able to convert the number of rotations to a distance traveled by the ball screw slide **84**, to a distance displaced by the plunger **22** and into volume data. When the syringe **19** has been filled with the preset volume of material **16**, the control system **105** sends a signal to the drive mechanism **80** discontinuing any more uptake of the fluid **16**.

DISPENSE **68** allows for dispensing of the material **16** from the syringe **19** onto a workpiece **18**. On command, programmably or manually, the computer control system **105** sends a signal to the stopcock actuator **64** to turn the 3-way stopcock **65** to the DISPENSE **69** connecting to the needle **66**. The control system then signals, simultaneously or subsequently, the drive mechanism **80**, via the communication interface **82**, causing the motor **81** to be engaged. The motor **81** rotates the ball screw shaft **85** which in turn translates the syringe yolk carriage **44** downward along the directional arrow **23**. The carriage **44** subsequently translates the syringe yolk **41**, to which is engaged the syringe plunger **22**, downward along the directional arrow **23**. As the plunger **22** is displaced downward, the material **16** is dispensed from the syringe **19** through the needle **66** onto the workpiece **18**, hence emptying or partially emptying the syringe **19** of the material **16**.

The volume of material **16** dispensed out of the syringe **19** is regulated by the computer control system **105**. As the yolk **41** and subsequently the plunger **22** are displaced forward, the

displacement is equivalent to a predetermined number of rotations by the motor **81**. The control system **105**, through proprietary software, is able to convert the number of rotations to a distance traveled by the ball screw slide **84**, to a distance displaced by the plunger **22** and into volume data. When the syringe **19** has been emptied of a preset volume of material **16**, the control system **105** sends a signal to the drive mechanism **80** discontinuing dispensing of the material **16**.

PURGE **69** allows for emptying of the material reservoir **15** of the material **16** and/or cleaning of the needle **66**. On command, programmably or manually, the computer control system **105** sends a signal to the stopcock actuator **64** to turn the 3-way stopcock **65** to the PURGE **68** connecting to the material reservoir **15** and the needle **66**. The material **16** may be operatively forced out the material reservoir **15** through the material conduit **14** and out the needle **18** via the 3-way stopcock **65**. Alternatively, a cleaning fluid, may be operatively forced out the material reservoir **15** through the material conduit **14** and out the needle **18** via the 3-way stopcock **65**.

The operations of FILL **67**, DISPENSE **68**, and PURGE **69** can be performed in any combination thereof for the device **20** to dispense the material **16** onto a workpiece **18**.

The syringe **19** that is installed onto the dispensing device **20** may be of various volumes ranging from about 0.5 μL to about 10 ml. The volume range of the syringe **19** is not meant to limit scope of the syringes **19** that can be installed on the device **20** for dispensing material **16** in an embodiment of the present invention. Any syringe **19** that is capable of being operationally adapted to the device **20** by the syringe accommodators **12** of the syringe brackets **11** as well as the plunger retainer **40** and combinations thereof is viable for use in accordance with the device, method, and system of the present invention. The syringe **19** is made of materials resistant to the material **16** thereby preventing curing or setting of the material **16** therein. Such materials include but are not limited to linear polyoxymethylene acetal resin, polyetherimide, fluoropolymers such as polytetrafluoroethylene (PTFE), and the like.

FIG. 5 depicts an embodiment of the device **20** from FIG. 1 wherein a syringe **19** has been integrally or non-integrally pre-installed on the device **20** thus transforming the device **20** into a second dispensing device **115** for dispensing material **16**. Referring to FIG. 5, the device **115** comprises: a syringe **19** for dispensing the material **16**; a position sensor **95**; a multi-directional flow valve **60**; and a syringe accommodator **12** for securing various size syringes **19**

interchangeably. The syringe **19** comes pre-installed in the dispensing device **115** within the receiver **75** and secured to the device **115** via the syringe accommodators **12** of the syringe brackets **11**. The syringe **19** may be removed and replaced with a syringe **19** of a different size/volume without affecting the operation of the device **115**.

FIG. 6 depicts a Cartesian coordinate system **121** showing four axes of movement relevant to the present invention. The coordinate system **121** comprises an X axis **122**, a Y axis **123**, a Z axis **124**, and a θ (theta) axis **125**. The θ axis **125** constitutes circular motion between 0° to 360° of rotation about the Z axis **124**.

FIG. 7 depicts a top view of a dispensing system **130** for a material **16**, in accordance with the present invention, comprising: a reservoir **15**; a device **20** for dispensing material; a syringe **19**; and a multi-degree of freedom robotic apparatus **131** operationally coupled to the device **20**. The reservoir **15** is a physical body for containing the material **16**. The reservoir **15** may be in any form that is capable of containing the material **16**. For example, a reusable cartridge, a reusable bag, a reusable container, a disposable cartridge, a disposable bag, a disposable container, and the like. The reservoir **15** is designed for containing materials **16** such as reactive fluids, abrasive fluids, cyanoacrylate type materials, and the like.

The reservoir **15** is made of materials that prevent setting or curing of the material **16** therein. The materials are chosen from a group consisting of linear polyoxymethylene acetal resin, polyetherimide, and fluoropolymers such as polytetralfuoroethylene, and the like. The reservoir **15** is operatively connected to and in fluid communication with the device **20** via the material dispensing conduit **14**. The conduit **14** may be of any length and size that allows for fluid communication between the reservoir **15** and the device **20**.

The device **20**, previously described, has the syringe **19** installed for operation of the device **20**. The device **20** receives the material **16** from the reservoir **15** and then dispenses the material **16** via the syringe **19** onto a workpiece **18**. The device **20** may be operationally coupled to an apparatus, such as a multi-degree of freedom robotic positioning apparatus **131**. The base plate **13** interconnects the dispensing device **20** and the robotic apparatus **131**.

The multi-degree of freedom robotic positioning apparatus **131** comprises: a frame **132**, a Y axis ball screw slide **132**, an X axis ball screw slide **134**, an end effector **135**, a first frame member **136**, and a second frame member **137**. The effector **135** is capable of rotation about the θ axis **125** by moving left and right along the Y axis **123** by sliding along the Y axis ball screw

slide **132**. Similarly, the effector **135** moves back and forth along the X axis **122** by sliding, with the frame member **136** and the frame member **137**, along the X axis ball screw slide **134**.

FIG. 8 depicts a side view of the dispensing system **130** of FIG. 7. The end effector **135** moves up and down on the Z axis **124** by sliding on the Z axis ball screw slide **138**. The dispensing system **130** is shown in use dispensing the material **16** onto a workpiece **18**. In this example, the workpiece **18** is an electrical component **139** on a circuit board **140**. As shown, the dispensing device **20** is operatively attached to the Z axis screw slide **138** via the base plate **13**.

FIG. 9 depicts a front view of a dispensing system **130** of FIG 7. As shown in FIG. 9, attached to the end effector **135** is the dispensing device **20** having an installed syringe **19**. The dispensing system **130** dispenses the material **16** onto a workpiece **18**. Also shown, attached to the frame **132** is a belt conveyor **141**. The conveyor **141** is used to move a workpiece **18** or object through the dispensing system **130** along to another station in a production process.

FIG. 10 depicts an embodiment of the dispensing system **130** from FIG. 7 wherein the dispensing system **130** has, operably attached, a dispensing device **115** thus transforming the dispensing system **130** into a second dispensing system **150** for dispensing materials **16**. Referring to FIG. 10, the dispensing system **130** comprises: a material reservoir **15**; a dispensing device **115** for dispensing the material wherein the device includes a syringe **19** and further wherein includes a syringe accommodator **12** for syringes **19** of various sizes; a multi-degree of freedom robotic apparatus **131** operationally coupled to the dispensing device **115**; and a drive system, for supplying motive power to move the robotic apparatus in multi-degrees of freedom, the drive system operationally coupled to the robotic apparatus.

The syringe **19** comes pre-installed in the dispensing device **115** within the receiver **75** and secured on the device **115** via the syringe accommodators **12** of the syringe brackets **11**. The syringe **19** may be removed and replaced with a syringe **19** of a different size/volume without affecting the operation of the device **115** or the system **130**.

FIG. 11 depicts a side view of the dispensing system **150** of FIG. 10. The end effector **135** moves up and down on the Z axis **124** by sliding on the Z axis ball screw slide **138**. The dispensing system **130** is shown in use the material **16** onto a workpiece **18**. In this example, the workpiece **18** is an electrical component **139** on a circuit board **140**. As shown, the dispensing device **115** is operatively attached to the Z axis screw slide **138** via the base plate **13**.

FIG. 12 depicts a front view of a dispensing system **150** of FIG 10. As shown in FIG. 12, attached to the end effector **135** is the dispensing device **115** having an installed syringe **19**. The dispensing system **130** dispenses the material **16** onto a workpiece **18**. Also shown, attached to the frame **132** is a belt conveyor **141**. The conveyor **141** is used to move a workpiece **18** or object through the dispensing system **130** along to another station in a production process.

Various modifications and variations of the described apparatus and methods of the invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention. Although the invention has been described in connection with specific embodiments, outlined above, it should be understood that the invention should not be unduly limited to such specific embodiments. Various changes may be made without departing from the spirit and scope of the invention as defined in the following claims.

CLAIMS

What is claimed is:

1. A device for dispensing material from a syringe, said syringe having a plunger with a terminal plate and a piston; and a syringe barrel for receiving the piston comprising:

a plunger retainer, for releasably attaching the terminal plate of said plunger;

a drive mechanism, adapted to provide motive force to said plunger head retainer;

a receiver for said syringe;

a multi-directional flow valve capable of fluid communication with a reservoir; and

a sensor for determining an amount of material dispensed from said syringe.

2. The device of claim 1, wherein said plunger retainer further comprises a syringe yolk.

3. The device of claim 1, wherein said receiver is able to accommodate syringes of variable volumes wherein the volume of said syringe is in a range from about 0.5 μL to about 10 mL.

4. The device of claim 1, further comprising syringe accommodators, said accommodator is adaptable to a syringe of variable volumes, wherein the volume of said syringe is in a range from about 0.5 μL to about 10 mL.

5. The device of claim 1, wherein said material includes a fluid selected from the group consisting a reactive fluid, an abrasive fluid, and combinations thereof.

6. The device of claim 5, wherein said reactive fluid and said abrasive fluid include a fluid selected from the group consisting of cyanoacrylate type fluid, a moisture sensitive silicone, a UV sensitive urethane, a filled silicone, a room temperature vulcanizing silicone, a thermal transfer compound, a silver filled coating, and combinations thereof.

7. The device of claim 1, wherein said material is a member of an acrylate group.

8. The device of claim 7, wherein said acrylate group consists of cyanoacrylate.

9. A method for dispensing material from a syringe, said syringe having a plunger with a terminal plate and a piston; and a syringe barrel for receiving the piston comprising:

providing a device for dispensing material, wherein said dispensing device is co-operable with a syringe;

providing said syringe, said syringe being co-operable with said dispensing device;

providing a reservoir for containing said material, wherein said reservoir is in fluid communication with said dispensing device;

operatively coupling said dispensing device to a multi-degree of freedom robotic apparatus; and

dispensing said material onto a workpiece.

10. The method of claim 9, wherein said dispensing device further comprises a plunger retainer.

11. The method of claim 9, wherein a component of said dispensing device is selected from the group consisting of linear polyoxymethylene acetal resin, polyetherimide, polytetrafluorethylene, and combinations thereof.

12. The method of claim 9, wherein said material includes a fluid selected from the group consisting a reactive fluid, an abrasive fluid, and combinations thereof.

13. The method of claim 12, wherein said reactive fluid and said abrasive fluid include a fluid selected from the group consisting of cyanoacrylate type fluid, a moisture sensitive silicone, a UV sensitive urethane, a filled silicone, a room temperature vulcanizing silicone, a thermal transfer compound, a silver filled coating, and combinations thereof.

14. The method of claim 9, wherein said material comprises an acrylate group.

15. The method of claim 9, wherein said acrylate group comprise a cyanoacrylate.

16. A system for dispensing material from a syringe, said syringe having a plunger with a terminal plate and a piston; and a syringe barrel for receiving the piston comprising:

a device for dispensing material, wherein said dispensing device is co-operable with a syringe;

a reservoir for containing said material wherein said reservoir is in fluid communication with said dispensing device;

a syringe wherein said syringe is co-operable with said device;

a multi-degree of freedom robotic apparatus operationally coupled to said device; and

a drive system, for supplying motive power to move said robotic apparatus in multi-degrees of freedom, said drive system operationally coupled to said robotic apparatus.

17. The system of claim 16, wherein a material resistant component of said dispensing device is selected from the group consisting of linear polyoxymethylene acetal resin, polyetherimide, polytetrafluoroethylene, and combinations thereof.

18. The method of claim 16, wherein said material includes a fluid selected from the group consisting of a reactive fluid, an abrasive fluid, and combinations thereof.

19. The method of claim 18, wherein said fluid includes a fluid selected from the group consisting of cyanoacrylate type fluid, a moisture sensitive silicone, a UV sensitive urethane, a filled silicone, a room temperature vulcanizing silicone, a thermal transfer compound, a silver filled coating, and combinations thereof.

20. A device dispensing material comprising:

a syringe for dispensing material, said syringe having a plunger with a terminal plate and a piston; and a syringe barrel for receiving said piston;

a sensor for determining an amount of said material dispensed from said syringe;

a multi-directional flow valve, wherein the flow valve is in fluid communication with a reservoir, wherein said reservoir is for containing said material; and

a receiver for securing various size syringes.

21. The device of claim 20, wherein said receiver is adaptable to a syringe of variable volumes wherein the volume of said syringe is in a range from about 0.5 μL to about 10 mL.

22. The method of claim 20, wherein said material includes a fluid selected from the group consisting of a reactive fluid, an abrasive fluid, and combinations thereof.

23. The method of claim 22, wherein said fluid includes a fluid selected from the group consisting of cyanoacrylate type fluid, a moisture sensitive silicone, a UV sensitive urethane, a filled silicone, a room temperature vulcanizing silicone, a thermal transfer compound, a silver filled coating, and combinations thereof.

24. The method of claim 20, wherein said material comprises an acrylate group.

25. The method of claim 20, wherein said acrylate group comprises a cyanoacrylate.

26. A system for dispensing material comprising:

a device, wherein the device is operably coupled to a syringe, said syringe having a plunger and a piston; and a syringe barrel for receiving said piston and further wherein said dispensing device has a multi-directional flow valve;

a reservoir for containing a material wherein said reservoir is in fluid communication with said dispensing device;

a multi-degree of freedom robotic apparatus operationally coupled to said dispensing device; and

a drive system, for supplying motive power to move said robotic apparatus in multi-degrees of freedom, said drive system operationally coupled to said robotic apparatus.

27. The system of claim 26, wherein said reservoir of material includes a fluid selected from a group consisting of a reactive fluid, an abrasive fluid, an acrylate, and combinations thereof.

28. The system of claim 26, wherein said dispensing device comprises at least one component resistant to said material.

29. The system of claim 28, wherein said material resistant component is selected from the group consisting of linear polyoxymethylene acetal resin, polyetherimide, polytetrafluoroethylene, and combinations thereof.

30. The method of claim 26, wherein said material includes a fluid selected from the group consisting of a reactive fluid, an abrasive fluid, and combinations thereof.

31. The method of claim 30, wherein said fluid includes a fluid selected from the group consisting of cyanoacrylate type fluid, a moisture sensitive silicone, a UV sensitive urethane, a filled silicone, a room temperature vulcanizing silicone, a thermal transfer compound, a silver filled coating, and combinations thereof.

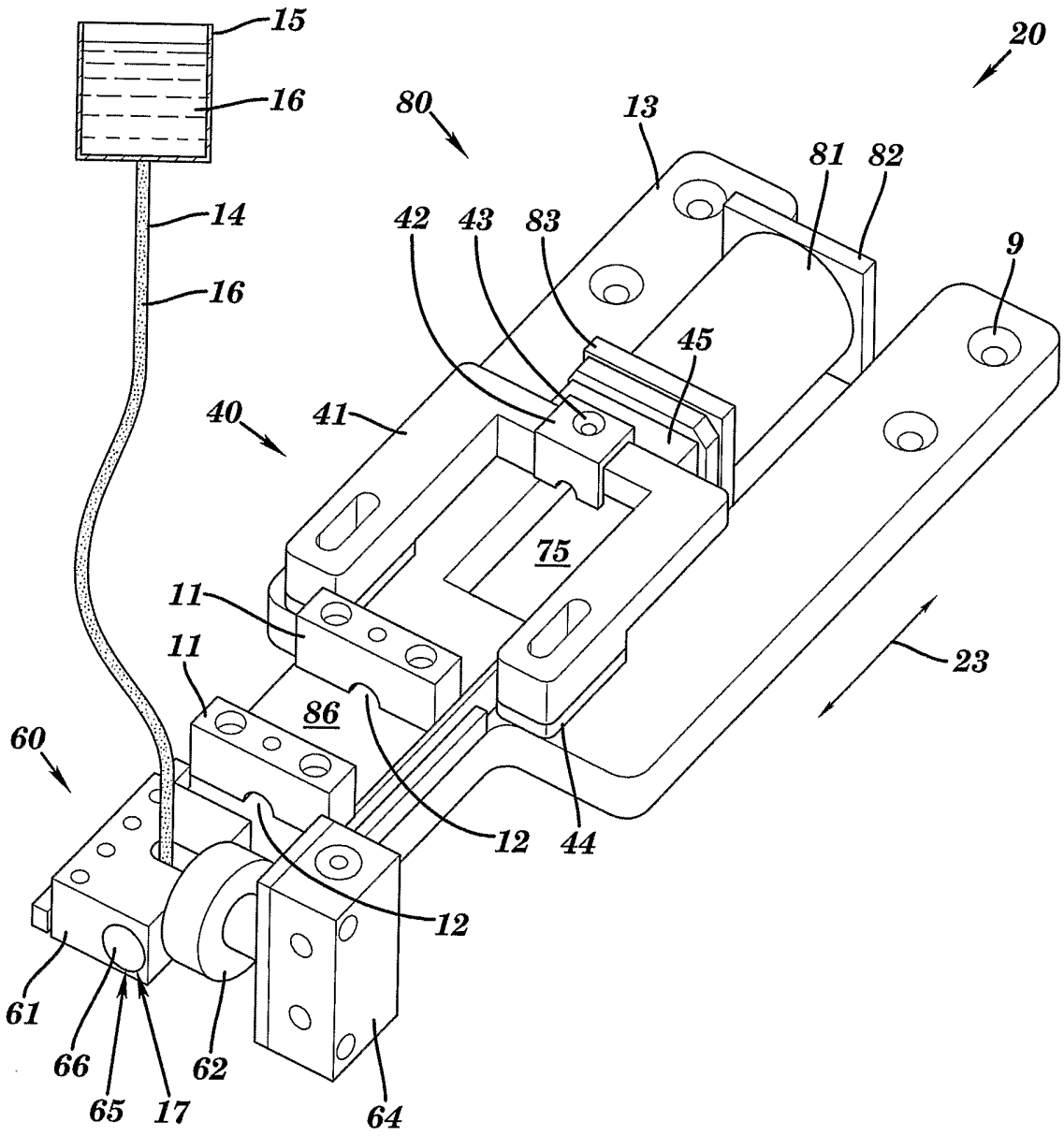

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FIG. 1

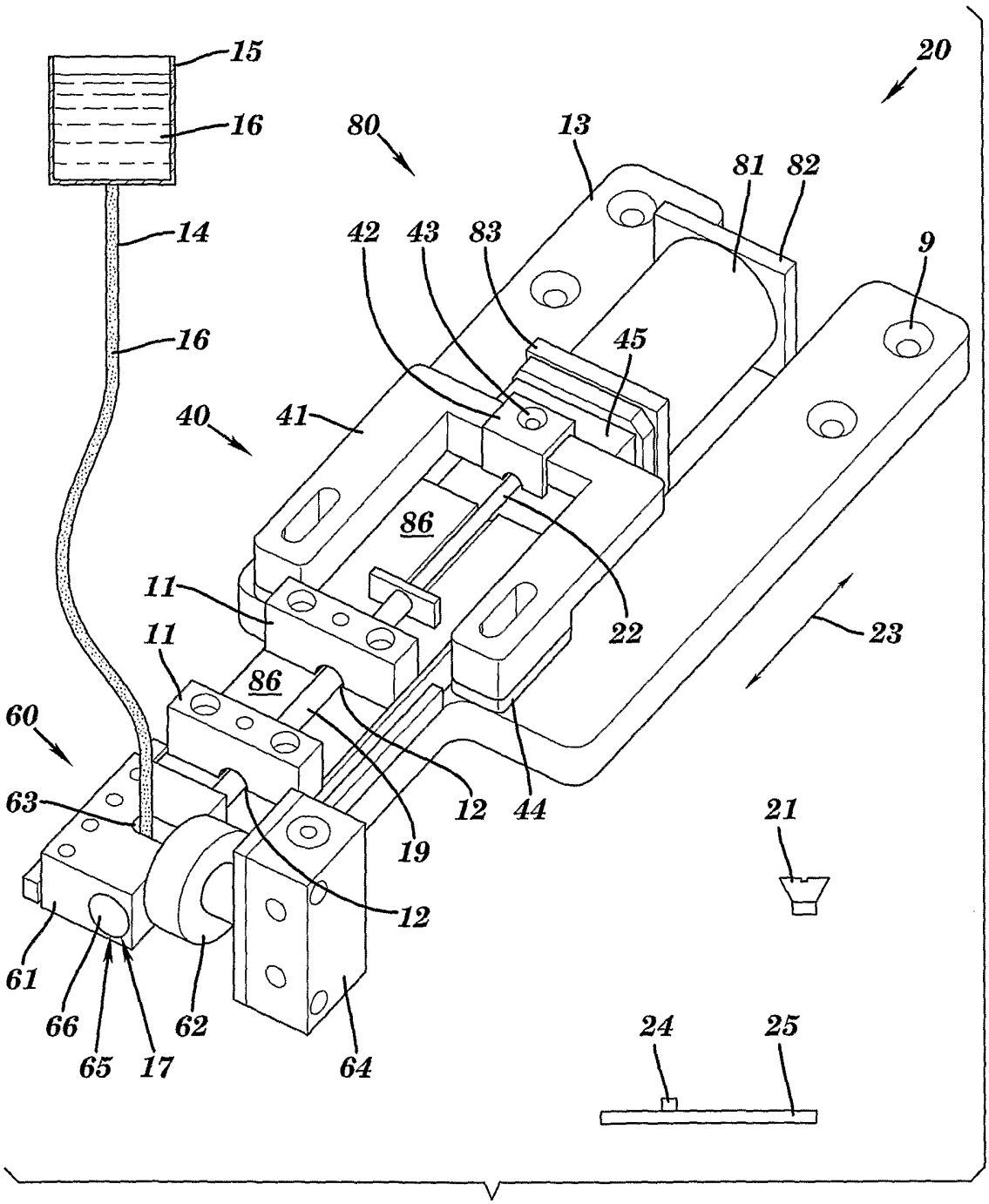
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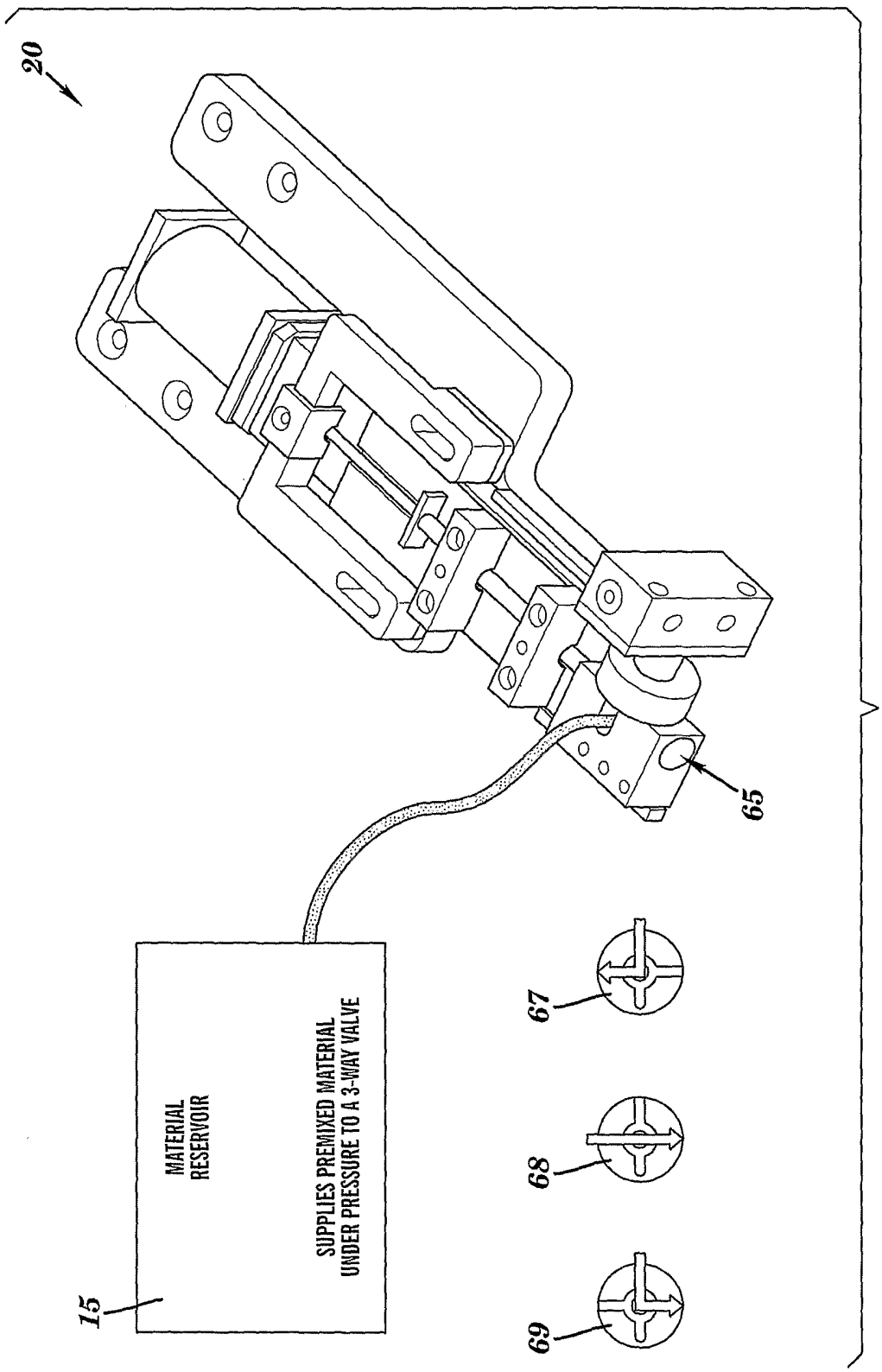
FIG. 2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MATERIAL RESERVOIR
SUPPLIES PREMIXED MATERIAL UNDER PRESSURE TO A 3-WAY VALVE
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FIG. 3

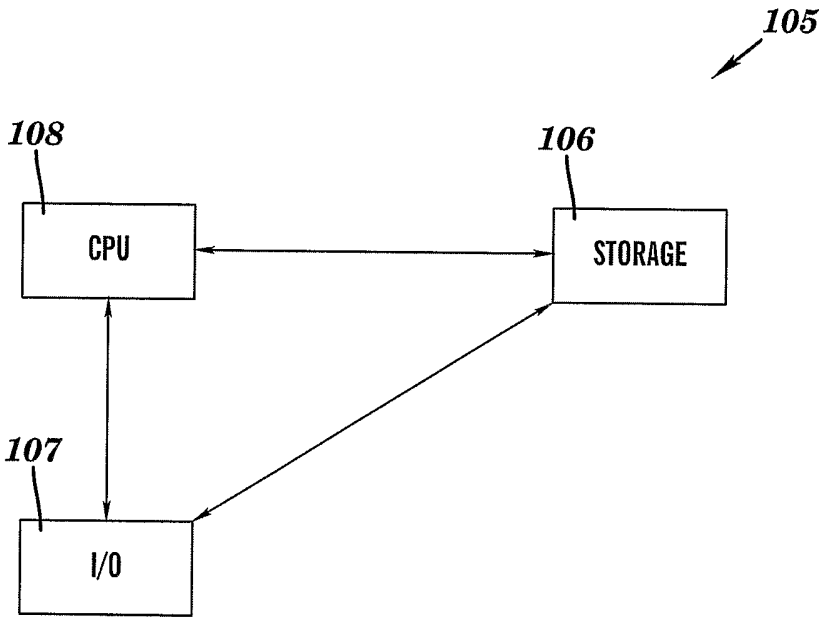

FIG. 4

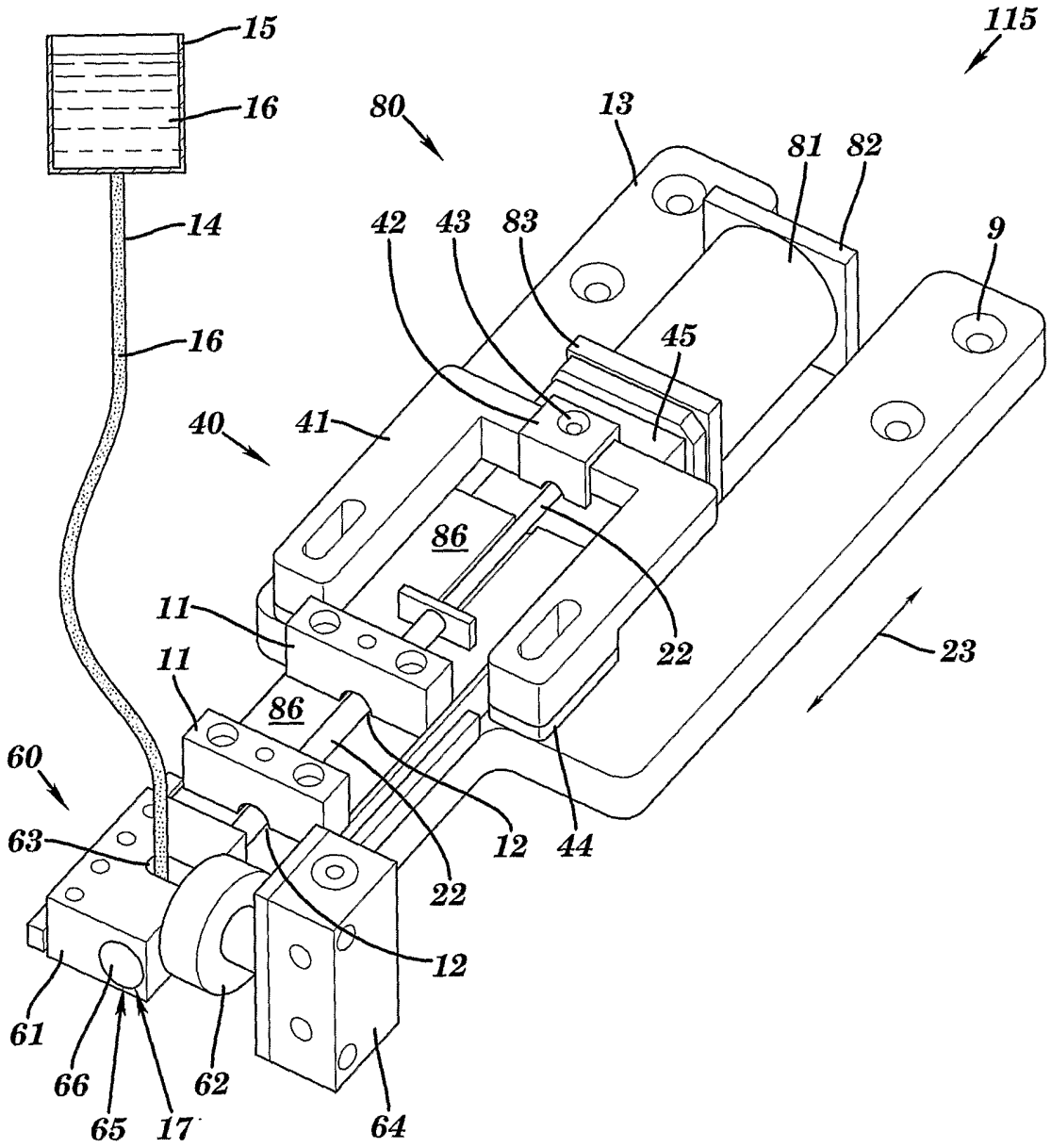
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FIG. 5

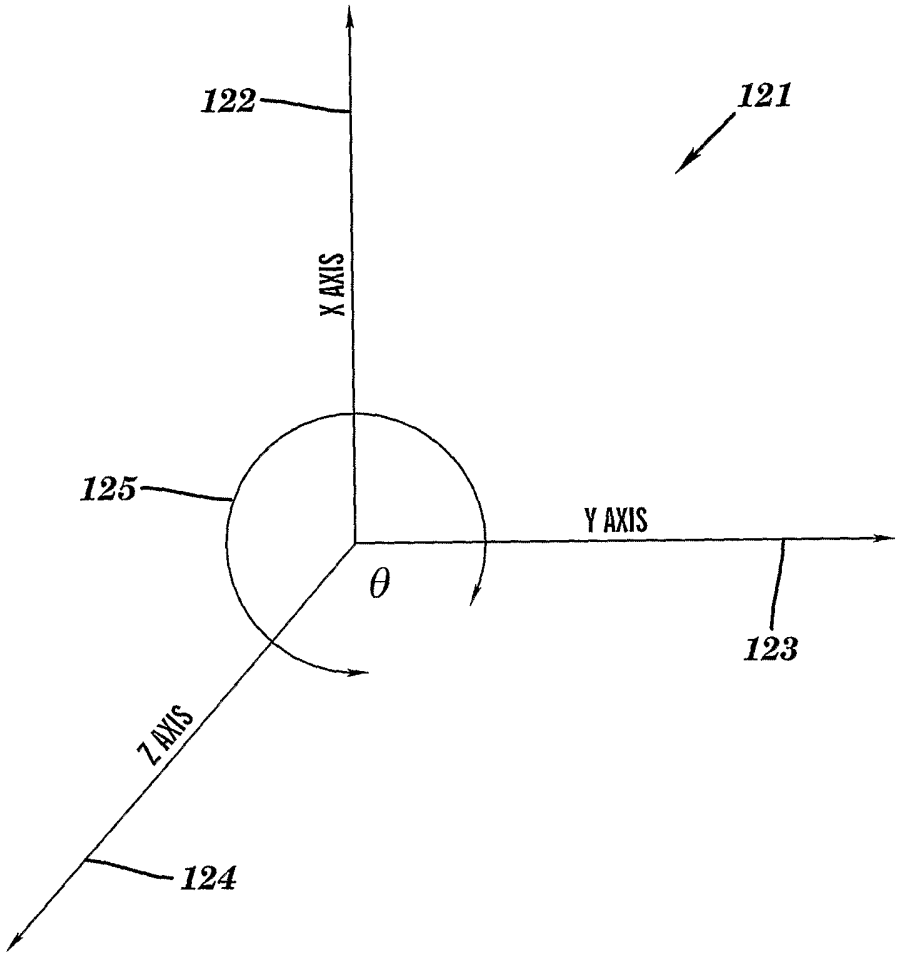

FIG. 6

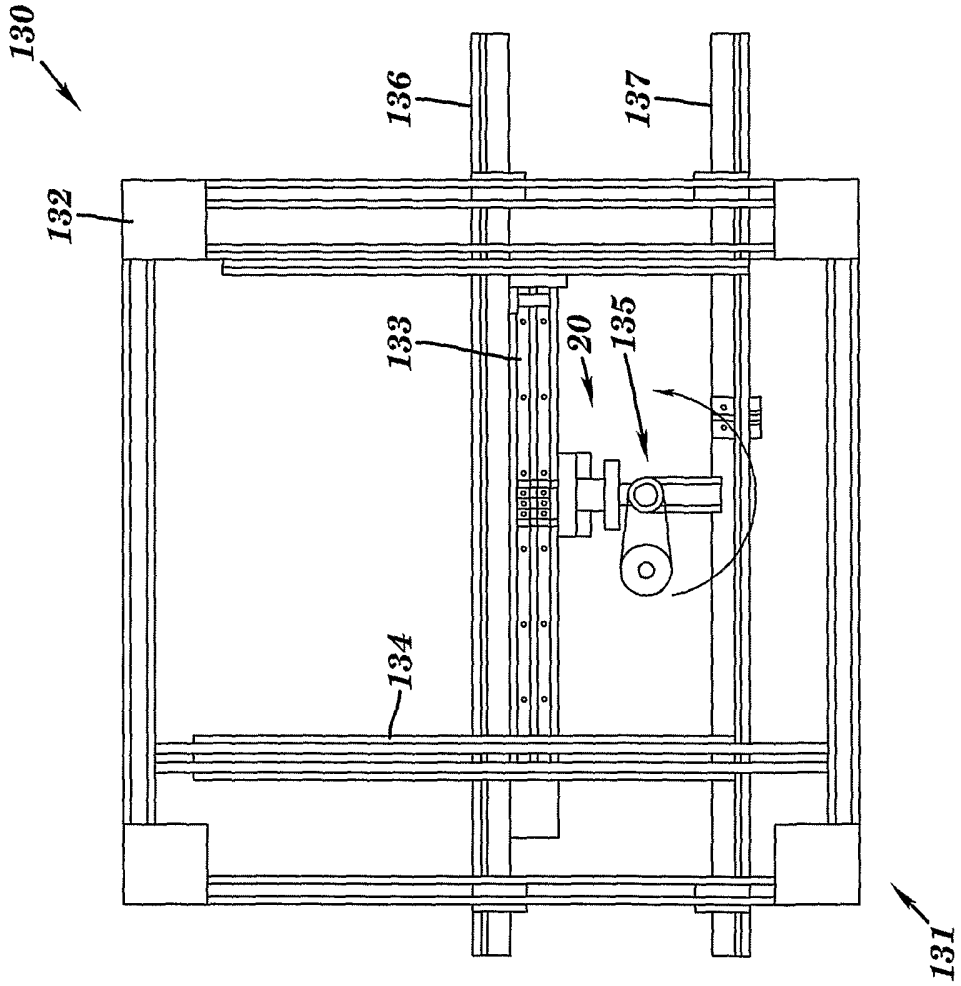

FIG. 7

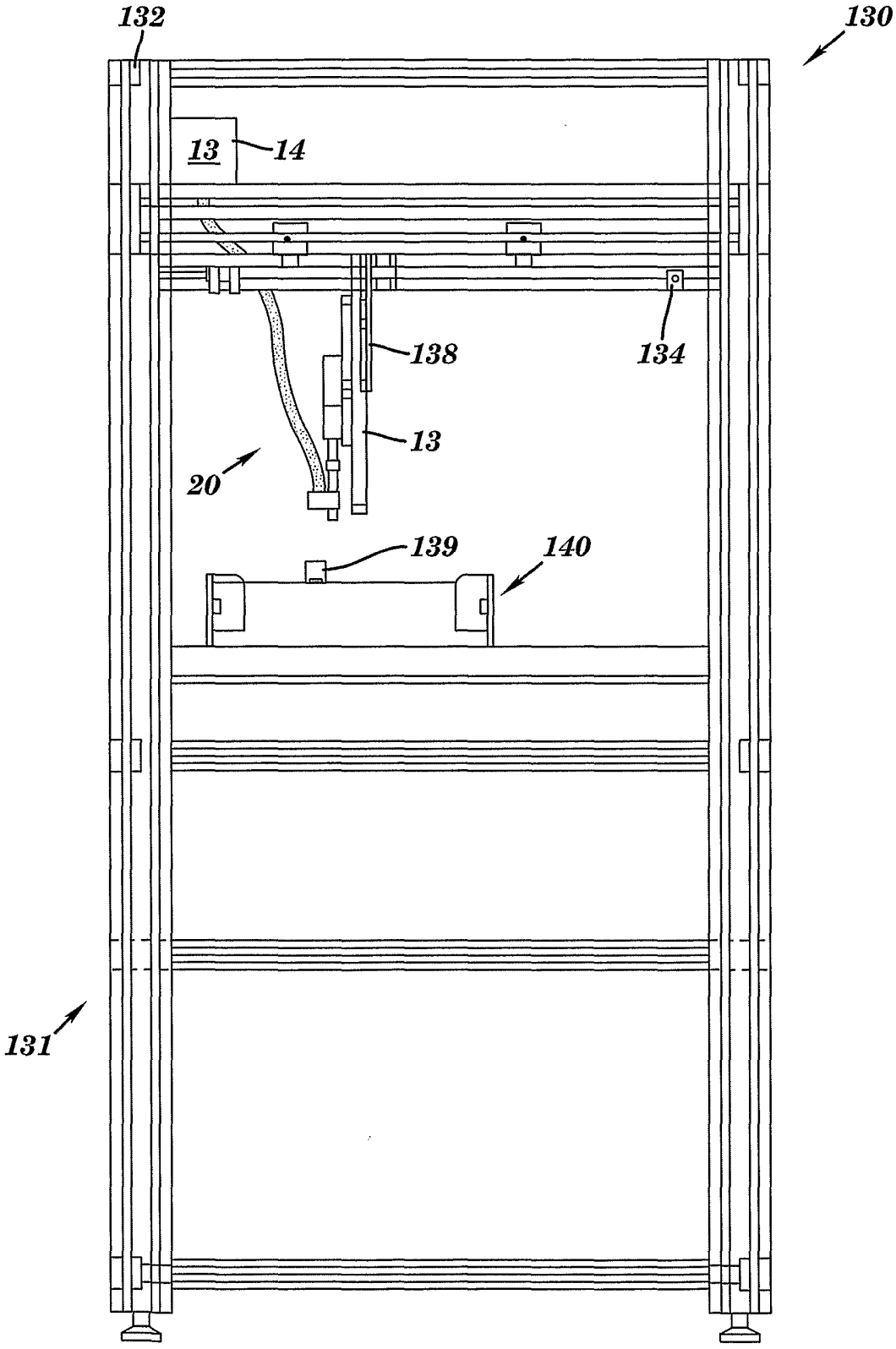

FIG. 8

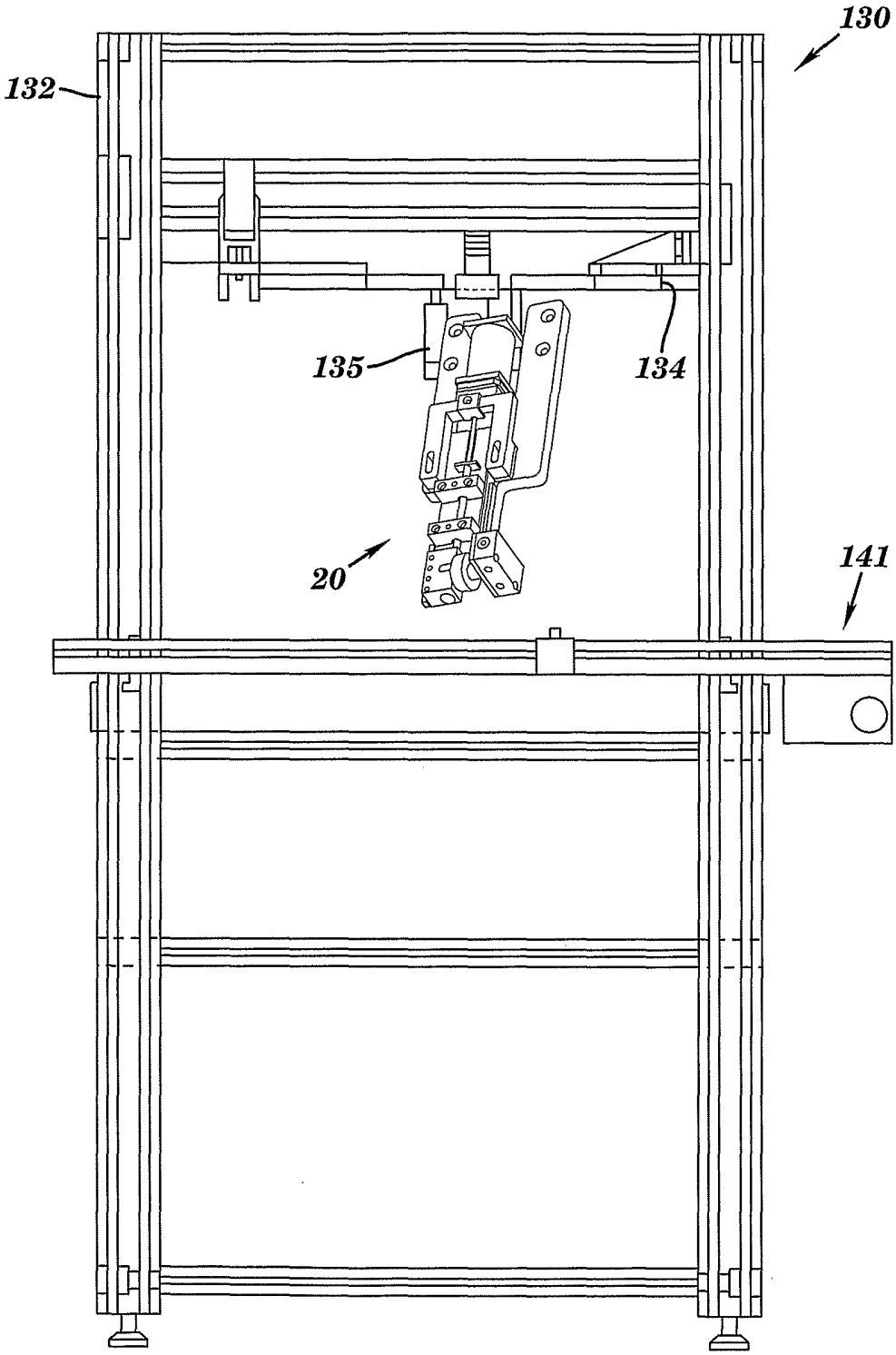

FIG. 9

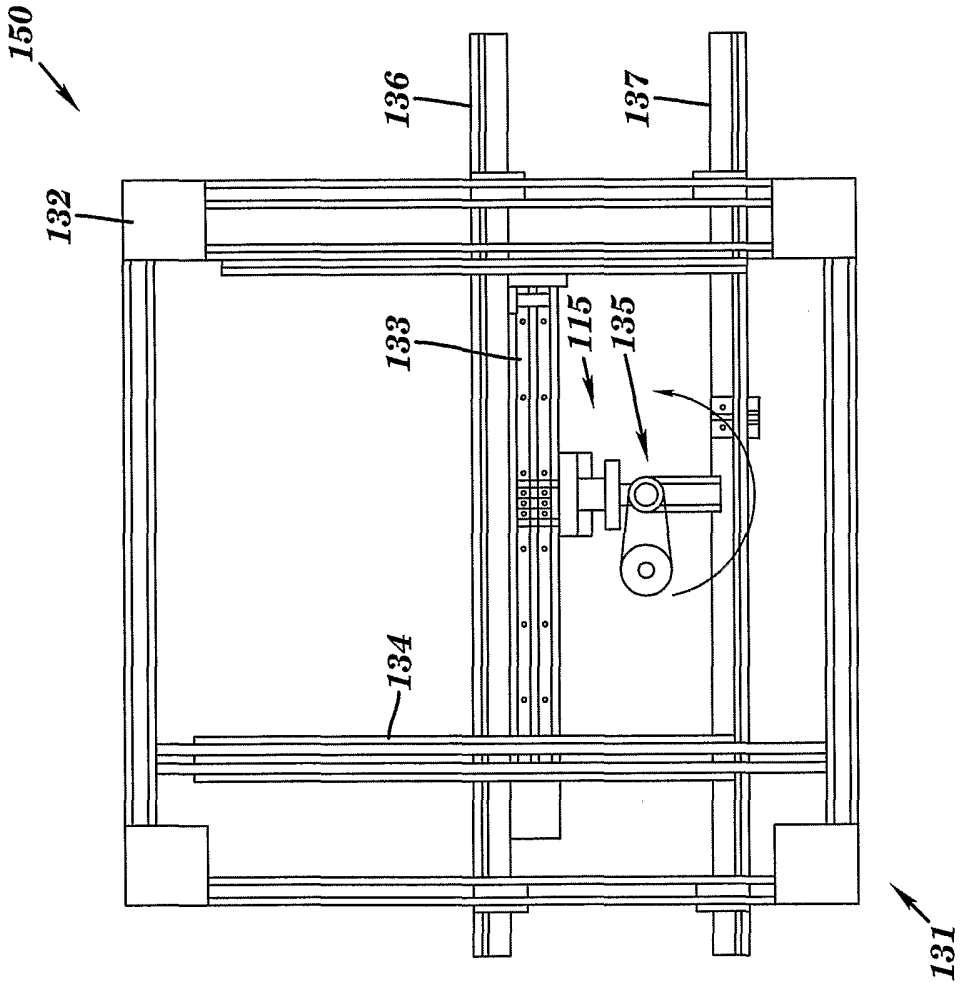

FIG. 10

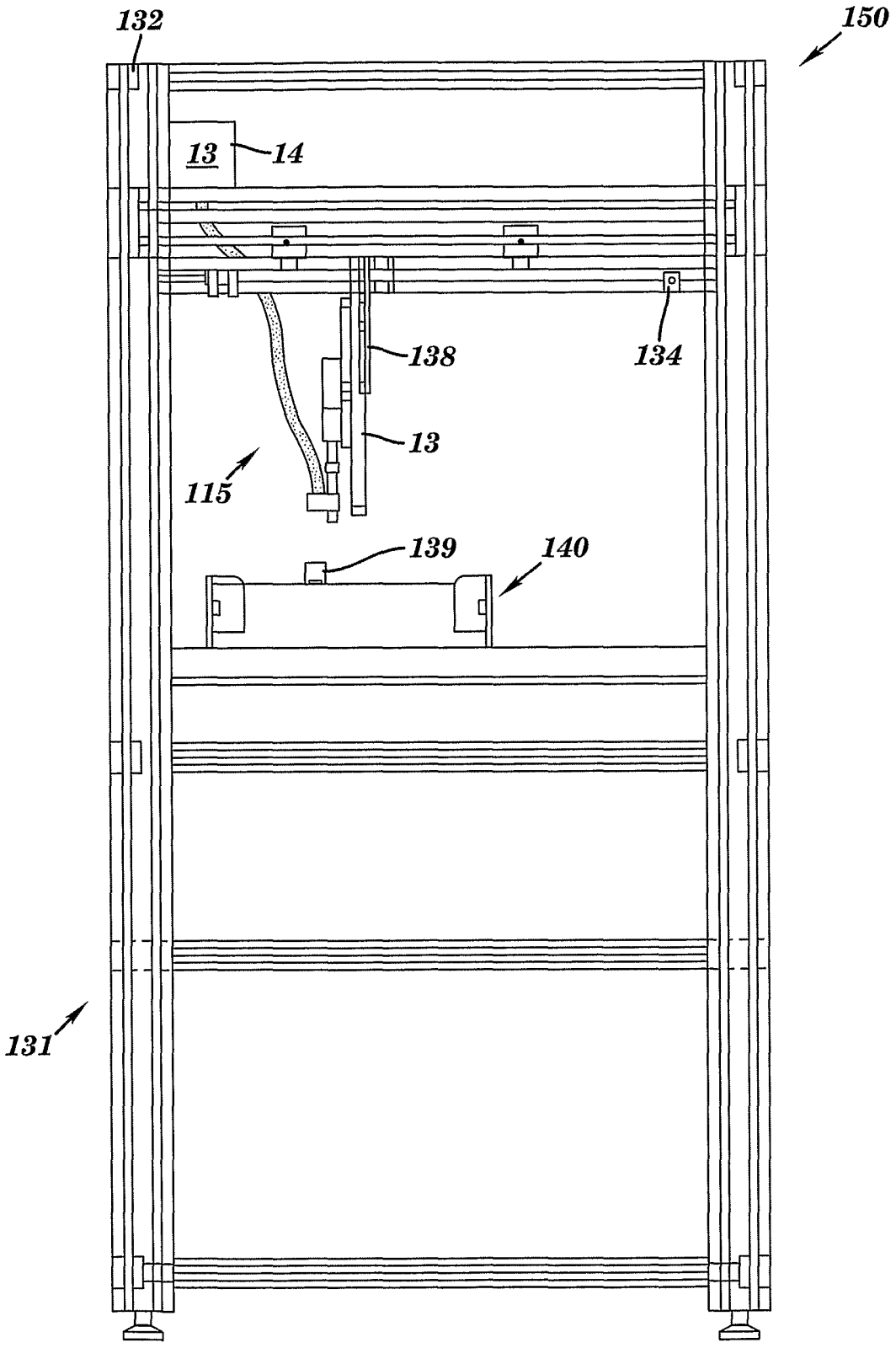

FIG. 11

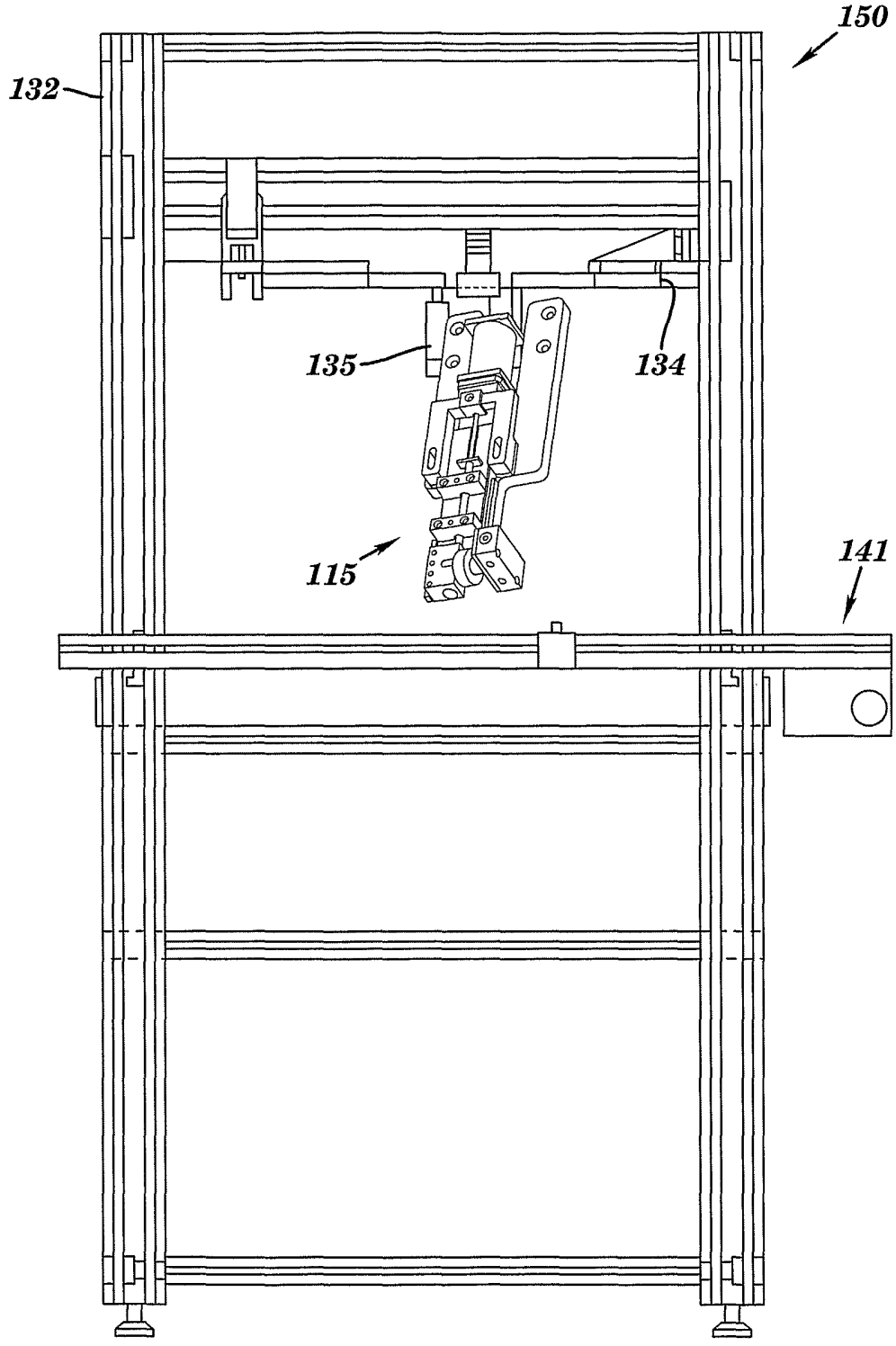

FIG. 12