



(43) International Publication Date
20 March 2014 (20.03.2014)

- (51) International Patent Classification:
B23P 19/06 (2006.01) *B25B 23/04* (2006.01)
B23Q 7/08 (2006.01)
- (21) International Application Number:
PCT/US2013/059232
- (22) International Filing Date:
11 September 2013 (11.09.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
13/618,254 14 September 2012 (14.09.2012) US
- (71) Applicant: **HONDA MOTOR CO., LTD.** [JP/JP]; 1-1, 2-chome, Minami-Aoyama, Minato-ku, Tokyo, 107-8556 (JP).
- (72) Inventors; and
- (71) Applicants (for US only): **NEUMEIER, Samuel, J.** [US/US]; Honda Patents & Technologies North America LLC, 21001 State Route 739, Raymond, OH 43067 (US). **JOHNSON, Ryan, M.** [US/US]; Honda Patents & Technologies North America LLC, 21001 State Route 739, Raymond, OH 43067 (US). **DUKEHART, Joseph, E.** [US/US]; Honda Patents & Technologies North America LLC, 21001 State Route 739, Raymond, OH 43067 (US). **EHEMANN, Kurt** [US/US]; Honda Patents & Technologies North America LLC, 21001 State Route 739, Raymond, OH 43067 (US). **EVERS, Chris** [US/US]; Honda Patents & Technologies North America LLC, 21001 State Route 739, Raymond, OH 43067 (US).

(74) Agents: **BODI, Robert, F.** et al.; Pearne & Gordon LLP, 1801 East 9th Street, Suite 1200, Cleveland, OH 44114 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: HIGH SPEED BOLT DISPENSER

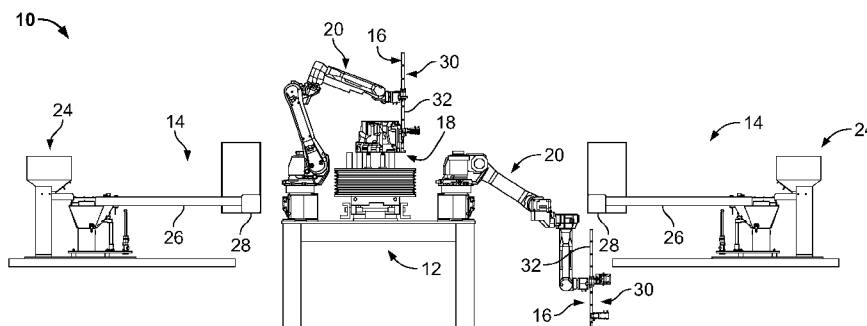


FIG. 1

(57) Abstract: A method and a system for dispensing bolts are provided. The system includes a dispensing cartridge including a dispensing tube and a dispensing section. The dispensing tube includes a first end, a second end, and a passage provided between the first end and the second end. The passage is configured to store a plurality of bolts to be supplied to the dispensing tube through the first end such that the bolts are moved through the passage. The dispensing section is located near the second end of the dispensing tube and is configured to dispense the bolts one at a time from the second end.

HIGH SPEED BOLT DISPENSER

BACKGROUND

[0001] The present disclosure relates to methods and an apparatus for dispensing bolts and, more particularly, methods and systems for dispensing bolts into apertures formed on a work piece.

[0002] One manner of manufacturing a product in mass is through the use of an assembly line in which a work piece is moved through a number of stations and a specific set of components are mounted onto the work piece at each station. Such a manner of manufacturing involves moving the components from a feeder to the work piece at each station. While a single trip from the feeder to the work piece by an automated apparatus such as a robot may be sufficient to carry and mount one type of component on the work piece, it may not be possible to carry and mount a variety of components in a single trip, and thus using conventional manufacturing techniques, multiple trips may be necessary. For example, it may be difficult or impossible to configure the robot to carry and mount bolts or screws of different sizes or shapes onto the work piece efficiently in a single trip.

[0003] Thus, there is a need for a method and an apparatus allowing components of different sizes and shapes to be carried and mounted onto the work piece in a more efficient manner.

SUMMARY

[0004] In one example aspect, a system for dispensing bolts is provided. The system includes a dispensing cartridge including a dispensing tube and a dispensing section. The dispensing tube includes a first end, a second end, and a passage provided between the first end and the second end. The passage is configured to store a plurality of bolts to be supplied to the dispensing tube through the first end such that the bolts are moved through the passage. The dispensing section is located near the second end of the dispensing tube and is configured to dispense the bolts one at a time from the second end.

[0005] In another example aspect, a method of dispensing bolts into apertures formed on a work piece is provided. The method includes a step of providing a dispensing cartridge including a dispensing tube and a dispensing section. The dispensing section is

configured to control opening and closing of an end of the dispensing section. The method further includes a step of filling the dispensing tube with a plurality of bolts by stacking the bolts on top of one another. The method further includes a step of dispensing the bolts one at a time from the dispensing tube into apertures formed on a work piece using the dispensing section.

[0006] In yet another example aspect, a method of dispensing bolts into apertures formed on a work piece is provided. The method includes a step of providing a first dispensing cartridge and a second dispensing cartridge. Each of the first dispensing cartridge and the second dispensing cartridge includes a dispensing tube and a dispensing section configured to control opening and closing of an end of the dispensing tube. The method further includes a step of filling the dispensing tube of the first dispensing cartridge with bolts. The method further includes a step of dispensing the bolts one at a time from the dispensing tube of the first dispensing cartridge into apertures formed on a work piece using the dispensing section of the first dispensing cartridge. The method further includes a step of filling the dispensing tube of the second dispensing cartridge with bolts.

[0007] In yet another example aspect, a method of dispensing bolts into apertures formed on a work piece is provided. The method includes a step of providing a dispensing cartridge including a dispensing tube and a dispensing section, the dispensing section configured to control opening and closing of an end of the dispensing tube. The method further includes a step of filling the dispensing tube with a plurality of bolts including a first bolt and a second bolt, the first bolt and the second bolt shaped differently from one another. The method further includes a step of dispensing the first bolt and the second bolt one at a time from the dispensing tube into apertures formed on a work piece using the dispensing section.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] These and other aspects are better understood when the following detailed description is read with reference to the accompanying drawings, in which:

[0009] **FIG. 1** is a side view of an example embodiment of a system for dispensing and mounting bolts onto a work piece;

[0010] FIG. 2 is a top view of the example system in FIG. 1 with bolt loading stations, a conveying device, a holding device and robotic arms;

[0011] FIG. 3 is a perspective view of an example embodiment of the robotic arm transporting example embodiments of a dispensing cartridge around the work piece in order to dispense and mount bolts;

[0012] FIG. 4A is a close-up, isolated view of the dispensing cartridge held by a gripper;

[0013] FIG. 4B is a cross-sectional view of the dispensing cartridge storing the bolts and including a dispensing section with a first member and a second member therein with the second member engaging a bolt;

[0014] FIG. 4C is a cross-sectional view of the dispensing cartridge storing the bolts and including the dispensing section with a first member and a second member therein with the first member engaging a bolt;

[0015] FIG. 4D is a close-up, phantom view of a gripping section on the dispensing cartridge and digits of a gripper that engage the gripping section;

[0016] FIG. 5A is an isolated perspective view of a dispensing tube in the dispensing cartridge;

[0017] FIG. 5B is an isolated perspective view of the first member in the dispensing cartridge;

[0018] FIG. 5C is an isolated perspective view of the second member in the dispensing cartridge;

[0019] FIG. 6 is a top view of an example embodiment of the work piece including a variety of apertures into which bolts are dispensed; and

[0020] FIG. 7 is a schematic diagram of a controller for operating the system.

DETAILED DESCRIPTION

[0021] Examples will now be described more fully hereinafter with reference to the accompanying drawings in which example embodiments are shown. Whenever possible, the same reference numerals are used throughout the drawings to refer to the same or like parts. However, aspects may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

[0022] Referring now to **FIGS. 1 and 2**, an example embodiment of a system **10** is illustrated transporting bolts between a holding device **12** and one or more bolt loading stations **14** for dispensing bolts **16** onto a work piece **18** that is secured to the holding device **12**. The term “bolt” in the present disclosure should be construed to include any type of fastener that includes a head and a cylinder that extends from the head and may or may not be externally threaded, among others.

[0023] In the example embodiment of **FIGS. 1-2**, the holding device **12** is provided with two robotic arms **20** each of which transports bolts **16** to the holding device **12** from the bolt loading stations **14** located laterally thereof. A different type of arrangement can also be contemplated and, for example, the number or arrangement of the robotic arms **20**, the holding device **12** or the bolt loading stations **14** may vary. The holding device **12** may be embodied to include a chuck, a lathe or the like and may be mounted on a conveying device **22** (e.g., a conveyor, a rail or the like) by way of which the holding device **12** can be moved along an assembly line. The conveying device **22** may allow the holding device **12** to stop at discrete locations along the conveying device **22** and be brought in proximity with each bolt loading station **14** such that the work piece **18** secured by the holding device **12** may be worked on by a variety of apparatuses on the assembly line. Moreover, in this example embodiment, the system **10** further includes one or more robotic arms **20** which are configured in the example embodiment to move with the holding device **12** along the conveying device **22**, although the robotic arms **20** may instead be mounted at fixed locations relative to the bolt loading stations **14**. The robotic arm **20** may be embodied with members connected by one or more joints that allow for movement with various degrees of freedom similar to a human arm as conventionally known in the art.

[0024] As shown in **FIGS. 1-2**, the bolt loading stations **14** may supply the bolts **16** that are to be assembled to the work piece **18**. The bolt loading stations **14** may be provided at various positions surrounding a holding device **12** that has come to a stop (e.g., one on a lateral side of the conveying device **22**, one on each lateral side of the conveying device **22**, two or more bolt loading stations **14** on a lateral side of the conveying device **22**, two or more bolt loading stations **14** on each lateral side of the conveying device **22**, etc.). Each bolt loading station **14** may include one or more bolt feeders **24** with each bolt feeder

24 supplying bolts **16** having a given set of dimensions such as a fixed diameter, length or the like. Each bolt feeder **24** may include a track **26** which leads to a hopper **28** from which the bolts **16** are fed to a dispensing cartridge **30** as will be described below.

[0025] As shown in the embodiment of **FIG. 1**, the system **10** further includes a dispensing cartridge **30** with a dispensing tube **32** that is loaded or filled with bolts **16**. The dispensing cartridge **30** is transported by the robotic arm **20** between the bolt loading station **14** and the holding device **12**. As shown in **FIG. 4B-4C**, the dispensing tube **32** functions as a container for the bolts **16** and includes a first end **32a**, a second end **32b** and a passage **32c** provided between the two ends **32a**, **32b**. Although the dispensing tube **32** is shown in a transparent fashion in **FIGS. 1** and **4B-4C** in order to indicate the presence of bolts **16** inside the dispensing tube **32**, the dispensing tube **32** need not be transparent. The dispensing cartridge **30** is filled with bolts **16** after the robotic arm **20** positions the first end **32a** under the hopper **28** of one of the bolt feeders **24** and the bolts **16** are fed to the dispensing cartridge **30** and are dropped into the passage **32c** through to the second end **32b**. The bolts **16** may be stored inside the dispensing tube **32** by vertically stacking the bolts **16** on top of one another in the passage **32c** such that the head of a bolt supports another bolt, as shown in **FIG. 4B-4C**.

[0026] As shown in **FIGS. 2-3**, the bolt loading station **14** may include a dock **34** provided with one or more first grippers **36a** that can grasp the dispensing cartridge **30** such that the dispensing cartridge **30** can be temporarily secured to the bolt loading station **14**. In **FIG. 3**, only the dock **34** of the bolt loading station **14** is shown for clarity of illustration and a dispensing cartridge **30** is shown temporarily secured to the dock **34**. As shown in **FIGS. 3-4A**, an end of the robotic arm **20** may also include a second gripper **36b** that is similar to the first gripper **36a** provided on the dock **34** of the bolt loading station **14**. The dispensing cartridge **30** may include a first gripping section **38a** and a second gripping section **38b** that are configured to be engaged or grasped by the first gripper **36a** of the dock **34** and the second gripper **36b** of the robotic arm **20** respectively.

[0027] As shown in the embodiment of **FIGS. 3-4A**, the grippers **36a** and **36b** are similar in structure and include a cylindrically shaped main body **40** and two digits **42** that protrude from one of the bases of the main body **40**. As shown in **FIGS. 4A** and **4D**, the

digits **42** are configured to move radially inward and outward about the base and thereby engage and disengage the first gripping section **38a** (or **38b**) of the dispensing cartridge **30**. The movement of the digits **42** may be controlled pneumatically. As shown in the embodiment of **FIG. 4D**, each digit **42** is substantially box-shaped and includes a recessed section **42a** which is shaped to mate with a projecting section **39** of the first gripping section **38a** (or **38b**) when the digits **42** grasp or engage the first gripping section **38a** (or **38b**).

[0028] As shown in **FIGS. 4A-4C**, the bolts **16** stored inside the passage **32c** of the dispensing tube **32** may be dispensed from the dispensing cartridge **30** using a dispensing section **44** that is located near the second end **32b** and controls the opening and closing of the dispensing cartridge **30** at the second end **32b**. In this embodiment, the dispensing section **44** is an elongate, box-shaped component that extends in a radially outward direction from the dispensing tube **32**.

[0029] As shown in **FIGS. 4B-4C** and **5A-5C**, the dispensing section **44** may include a first member **46** and a second member **48** that are oriented to extend at least partially into the passage **32c** of the dispensing cartridge **30** through apertures **32d**, **32e** formed near the second end **32b** of the dispensing tube **32**. The dispensing section **44** may include a mechanism by way of which each of the first member **46** and the second member **48** can alternate between a retracted position and an extended position. The mechanism may be operatively connected to gas lines **50** (shown in **FIG. 4A**) originating from the second gripping section **38b** and may be pneumatically controlled by gas originating from the second gripper **36b**. Also, the first member **46** includes a first distal **46a** end and the second member **48** includes a second distal end **48a**. In the extended position, the distal end **46a** or **48a** of either member **46** or **48** is positioned and oriented to extend sufficiently into the passage **32c** of the dispensing tube **32** such that a part of the bolt **16** (e.g., the head) is caught by the distal end **46a** or **48a** and is prevented from passing through. In the retracted position, the member **46** or **48** may be substantially retracted into a housing **44a** of the dispensing section **44** and may allow a bolt **16** to pass by the member **46** or **48**.

[0030] As shown in **FIG. 4B**, the second distal end **48a** of the second member **48** may extend into the passage **32c** at a location nearer the second end **32b** of the dispensing tube **32** and engage a bolt **16** nearest the second end **32b** in the extended position. The first

distal end **46a** of the first member **46** may engage a bolt **16** that is second to nearest the second end **32b** of the dispensing tube **32** in the extended position.

[0031] As shown in **FIGS. 4B-4C**, the first member **46** may be in the extended position when the second member **48** is in the retracted position and the first member **46** may be in the retracted position when the second member **48** is in the extended position. When the first member **46** is in the extended position and the second member **48** is the retracted position, the bolt **16** that is nearest the second end **32b** of the dispensing tube **32** is the bolt **16** held and engaged by the first distal end **46a** of the first member **46** because the bolt **16** that was nearest the second end **32b** and was engaged by the second distal end **48a** of the second member **48** has been released from the dispensing cartridge **30**. As the first member **46** switches to the retracted position while the second member **48** moves to the extended position, the bolt **16** that was being held by the first distal end **46a** of the first member **46** moves down but is caught and engaged by the second distal end **48a** of the second member **48**.

[0032] While the distal ends **46a**, **48a** may take on a variety of shapes, the distal ends **46a**, **48a** include a concavely semi-cylindrical indent **46b** or **48b** as shown in **FIG. 5B** and **5C**. In the extended position of the members **46** or **48**, the radius of curvature of the indent **46b** or **48b** is dimensioned to block and prevent the head of the bolt **16** from passing through while the cylinder of the bolt **16** can extend past through the indent **46b** or **48b**. As shown in the second member **48** in **FIG. 5C**, the indent **48b** may also include an upper tapered section **48c** that funnels the bolt **16** into the indent **48b** and reduces the possibility of the cylinder of a bolt **16** not entering the indent **48b**. As further shown in the second member **48** in **FIG. 4B-4C**, the member **48** may also include a magnet **52** adjacent the indent **48b** to immobilize or keep the bolt **16** substantially still as the dispensing cartridge **30** is moved around the work piece **18** and the robotic arm **20** aligns the bolt **16** to be dispensed into an aperture.

[0033] As shown in **FIG. 3**, the first gripper **36a** on the dock **34** is configured to simply grasp the first gripping section **38a** whereas the second gripper **36b** on the robotic arm **20** is configured to operatively control as well as grip the dispensing cartridge **30**. Although the dock **34** may be stationary, the dock **34** may include a horizontally movable

slide mechanism **35** such that the grippers **36a** may be moved so that the first end **32a** of the dispensing tube **32** can be positioned under any of the hoppers **28** in order to fill the dispensing tube **32** with a bolt **16** having the required dimensions.

[0034] The dispensing section **44** of the dispensing cartridge **30** may be controlled pneumatically as shown in **FIG. 4D**. Each digit **42** of the second gripper **36b** of the robotic arm **20** may include a first gas channel **54** each of which is configured to establish gas communication with a second gas channel **56** in the second gripping section **38b** once the second gripper **36b** grasps the second gripping section **38b**. As shown in **FIG. 4A**, the gas lines **50** run between the second gripping section **38b** grasped by the second gripper **36b** on the robotic arm **20** and the dispensing section **44** of the dispensing cartridge **30** that allow the first and second members **46**, **48** to alternately extend into the passage **32c**. There may be additional gas lines **50** running from the second gripper **36b** to the robotic arm **20**. Using the above configuration, the digits **42** of the gripper **36b** may be pneumatically controlled by one solenoid and while movement of the members **46**, **48** of the dispensing section **44** may be pneumatically controlled by another solenoid. Alternatively, electrical control could be utilized to generate movements of the first and second members **46**, **48** in other embodiments.

[0035] Moreover, the dock **34** may include an emptying gripper **36c** as shown in **FIG. 2** for emptying the dispensing cartridge **30**. After the robotic arm **20** transports the dispensing cartridge **30** to the emptying gripper **36c**, the slide mechanism **35** (shown in **FIG. 3**) can move the second end **32b** of the dispensing tube **32** over a trash bin **37** so that a dispensing tube **32** in which the bolts **16** are stacked in an incorrect order may be emptied into the trash bin **37**. In this case, the emptying gripper **36c** is configured with gas channels and to engage the second gripping section **38b** so that gas communication is established with the dispensing section **44** similarly as between the second gripper **36b** and the second gripping section **38b** so that the emptying gripper **36c** can pneumatically control the dispensing section **44** and empty the dispensing tube **32** into the trash bin **37**.

[0036] In an example operation, the dispensing of the bolts **16** onto the work piece **18** by system **10** may occur as described in the following. The holding device **12** which transports the work piece **18** is brought to a stop next to one of the bolt loading

stations **14** by the conveying device **22**, as shown in **FIGS. 1-2**. One or more dispensing cartridges **30** are provided at the dock **34** of the bolt loading station **14** with the grippers **36a** of the dock **34** grasping the first gripping sections **38a** of the dispensing cartridges **30**. The robotic arm **20** next to the holding device **12** can pick up the dispensing cartridges **30** by grasping the second gripping section **38b** with the second gripper **36b** at which point the first gripper **36a** of the dock **34** releases the dispensing cartridge **30**. Thereafter, the robotic arm **20** moves the dispensing cartridge **30** around the work piece **18** and dispenses the bolts **16** at apertures formed at different parts of the work piece **18**. The dispensing of the bolts **16** is controlled pneumatically by the robotic arm **20** through the gas channels **54** and **56** and the gas lines **50** (shown in **FIG. 4A**) so that the members **46** and **48** (shown in **FIGS. 4B-4C** and **5B-5C**) alternate between the extended position and the retracted position and release the bolts **16** one at a time into each aperture. The bolts **16** are moved and dispensed through the dispensing tube **32** entirely by way of gravity in this example. The robotic arm **20** may be configured with features such that the dispensing tube **32** being properly aligned about an aperture prior to dispensing a bolt **16**. The order of apertures followed by the robotic arm **20** is predetermined and the bolts **16** are stacked inside the dispensing tube **32** in accordance with such an order at the bolt loading station **14** so that bolts of appropriate lengths are inserted in the proper apertures, as determined in advance or otherwise by computer command. It may also be possible for an assembly line worker to manipulate the dispensing cartridge **30** that is held by a device similar to the robotic arm **20** about the work piece **18**.

[0037] As shown in **FIG. 6**, an example embodiment of the work piece **18** is shown to include a group of apertures **19a**, **19b**, **19c** and **19d** with each group capable of accommodating a particular bolt **16** of a given configuration. The different groups of apertures **19a**, **19b**, **19c** and **19d** are schematically distinguished from one another in **FIG. 6** using “x”, “+” and the like. The robotic arm **20** may be configured to move about the groups **19a**, **19b**, **19c** and **19d** in a first order that is programmable from a computer and to move about the apertures within a group in a second order that is programmable from the computer. The group of apertures **19a** and the group of apertures **19b** may be configured to accommodate bolts that are shaped differently from one another. For example, the bolts **16** may have lengths that are different from one another but have the same first diameter.

Alternatively, the bolts **16** may differ in that the heads accommodate different types of screw drives (e.g., slot, Phillips, hex or the like). Similarly, the group of apertures **19c** and the group of apertures **19d** may be configured to accommodate bolts that have lengths different from one another but have the same second diameter. Accordingly, a first dispensing cartridge **30** may be filled with bolts **16** to be dispensed into groups of apertures **19a** and **19b** while a second dispensing cartridge **30** may be filled with bolts **16** to be dispensed into groups of apertures **19c** and **19d**. Thus, by providing two dispensing cartridges **30** in accordance with the first order and the second order by which the robotic arm **20** will move, bolts **16** of different lengths can be dispensed into the apertures of the work piece **18** in an efficient manner.

[0038] After the dispensing cartridge **30** has dispensed all of the bolts **16** in the passage **32c** of the dispensing tube **32**, the robotic arm **20** may obtain another dispensing cartridge **30** filled with bolts arranged in a variety of ways. In a first method, the robotic arm **20** returns the empty dispensing cartridge **30** back to the dock **34** where the second gripper **36b** of the robotic arm **20** releases the dispensing cartridge **30** which is grasped by the first gripper **36a** of the dock **34**. The robotic arm **20** then grasps another dispensing cartridge **30** from another first gripper **36a** on the dock **34** that was previously filled. The filling of the dispensing cartridge **30** may occur while the robotic arm **20** transports another dispensing cartridge **30** around the work piece **18**. The dispensing cartridge **30** is filled through the slide mechanism **35** of the dock **34** which moves the first end **32a** of the dispensing tube **32** under the hoppers **28** according to an order by which the robotic arm **20** will subsequently dispense the bolts **16** onto the work piece **18**. As a result, the bolts **16** in the dispensing tube **32** are not necessarily equal in length, but may vary in length and type based on the desired need and desired installation order. Moreover, a dock **34** equipped with multiple grippers **36a** and the slide mechanism **35** allows the dispensing of bolts **16** from a first dispensing cartridge **30** and the filling of bolts **16** into a second dispensing cartridge **30** to occur simultaneously at least during some duration of time.

[0039] In a second alternative method, the robotic arm **20** may transport a dispensing cartridge **30** under the hoppers **28** according to a desired order by which the robotic arm **20** will subsequently dispense the bolts **16** onto the work piece **18**. In this case,

there may be no need to provide the dock **34** with a slide mechanism **35** for filling the dispensing cartridge **30** with bolts. The dispensing cartridge **30** transported by the robotic arm **20** may be the same dispensing cartridge **30** that was previously transported around the work piece **18**.

[0040] After the bolts **16** are inserted into appropriate apertures, the bolts **16** can be fastened about the work piece **18** by another device such as a robotic arm with a screw driving capability, or they can be fastened manually, if desired.

[0041] As shown in **FIG. 7**, the system **10** may include a control unit **58** (e.g., a computer) executing one or more programs to coordinate the operations of the robotic arms **20**, the bolt loading stations **14**, the conveying device **22** and other parts of the system **10**. Based on information about the apertures formed on a work piece **18** and the desired order by which the robotic arms **20** will approach the apertures, the controller **58** may operate the bolt loading stations **14** according to its programming so that the dispensing cartridges **30** are filled in accordance with the desired order.

[0042] The system **10** is particularly adaptable because it allows bolts **16** of varying lengths to be carried from the bolt loading station **14** to the work piece **18** in a single trip. It is possible to provide at the dock **34** a second type of dispensing cartridge **30** with a passage **32c** that has a diameter different from a first type of dispensing cartridge **30** so that bolts **16** of different types, such as with different diameters, lengths, pitches, and/or compositions, can be dispensed onto the work piece **18** by configuring the robotic arm **20** to grasp the second type of dispensing cartridge **30**. As such, the inner diameter of the first type of dispensing cartridge **30** may be different from that of the second type of dispensing cartridge **30** so as to accommodate bolts of different dimensions (e.g., diameters) while the outer dimensions of the dispensing cartridges **30**, including those of the gripping sections **38a**, **38b**, may remain the same. Alternatively, dispensing tubes **32** with smaller inner diameters may also be configured with smaller outer diameters thereby making the dispensing cartridge **30** more compact and increasing the ability of the dispensing cartridge **30** to access tight spaces near the apertures on the work piece **18**. Even for these configurations, only the inner dimensions of the gripping section **38a**, **38b** would change and

their outer dimensions would remain the same such that a gripper **36b** with the same dimensions could be used.

[0043] Accordingly, these bolts **16** of different types can be provided and possibly assembled to the work piece **18** in a single stop thereby making the assembly of bolts **16** more efficient. Moreover, the size and geometry of the dispensing cartridge **30** is reduced such that the second end **32b** of the dispensing tube **32** can approach the work piece **18** from a variety of angles and despite certain spatial restrictions.

[0044] It will be apparent to those skilled in the art that various modifications and variations can be made without departing from the spirit and scope of the claimed invention.

CLAIMS

What is claimed is:

1. A system for dispensing bolts, the system comprising:
a dispensing cartridge including a dispensing tube and a dispensing section, the dispensing tube including a first end, a second end, and a passage provided between the first end and the second end, the passage configured to store a plurality of bolts to be supplied to the dispensing tube through the first end such that the bolts are moved through the passage, the dispensing section located near the second end of the dispensing tube and being configured to dispense bolts one at a time from the second end.
2. The system of claim 1, the bolts stacked on top of one another in the passage, and the bolts moved through the passage by way of gravity.
3. The system of any of claims 1-2, the bolts not being of equal length.
4. The system of any of claims 1-3, further including a bolt loading station with a plurality of bolt feeders each of which configured to supply bolts to the first end of the dispensing cartridge, each bolt feeder configured to supply a bolt with a given set of dimensions.
5. The system of claim 4, the bolt loading station including a dock on which the dispensing cartridge can be secured, the dock including a gripper configured to engage a gripping section of the dispensing cartridge, the dock configured to be moved along a rail such that the first end of the dispensing cartridge can be positioned about any of the bolt feeders in order to fill the dispensing cartridge with bolts.
6. The system of any of claims 1-5, the dispensing section further including a first member and a second member, each of the first member and the second member configured to move between an extended position and a retracted position, the first member and the second member including a first distal end and a second distal end respectively, the first member oriented such that the first distal end extends into the passage in the extended position of the first member, the second member oriented such that the second distal end extends into the passage in the extended position of

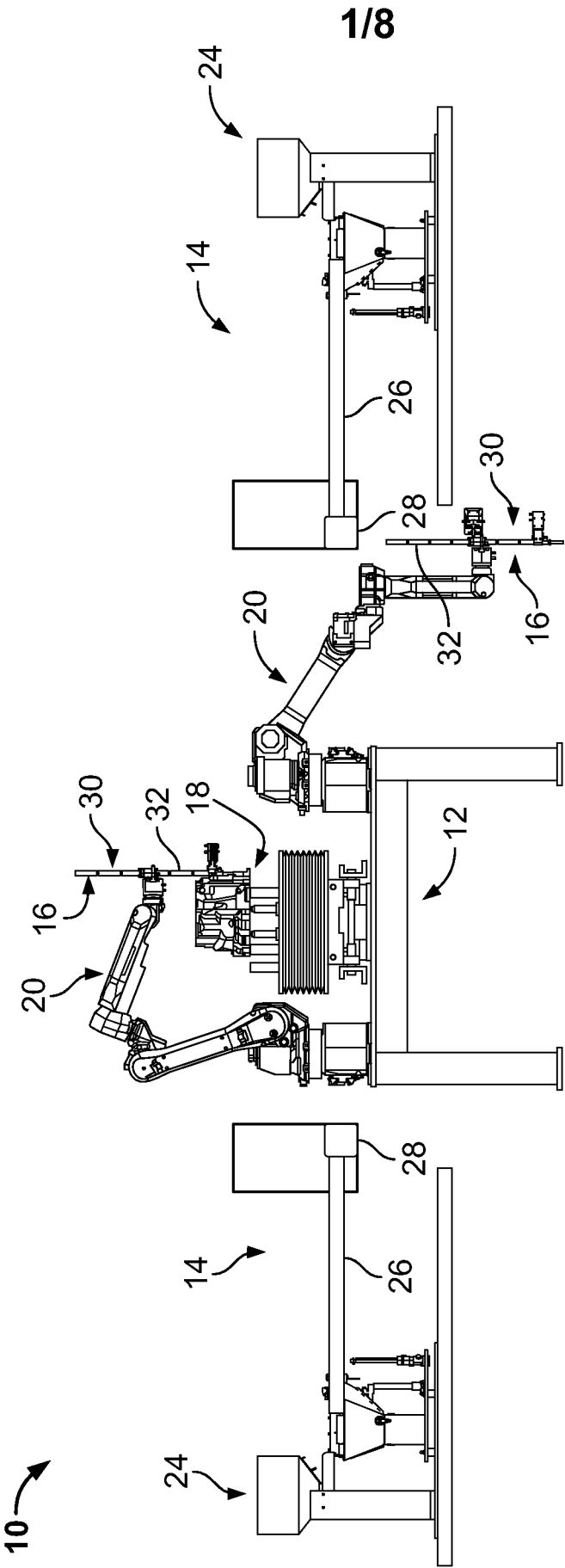
the second member, the second distal end configured to extend into the passage at a location nearer the second end than the first distal end such that the second distal end is configured to engage a bolt nearest the second end in the extended position and the first distal end is configured to engage a bolt that is second to nearest the second end in the extended position.

7. The system of claim 6, the first member being in the extended position when the second member is in the retracted position, the second member being in the extended position when the first member is in the retracted position.
8. The system of claim 6 or 7, each of the first distal end and the second distal end including a concavely semi-cylindrical indent and dimensioned to catch a bolt head in the extended position.
9. The system of claim 8, the indent of the second distal end including an upper tapered portion configured to funnel a bolt into the indent, and the second distal end including a magnet adjacent the indent.
10. The system of any of claims 1-9, further including a robotic arm configured to transport the dispensing cartridge about a work piece secured by a holding device.
11. The system of claim 10, the robotic arm including a gripper, the dispensing cartridge further including a gripping section configured to be engaged by the gripper.
12. The system of claim 11, the robot arm further including first gas lines configured to allow gas communication to the gripper, and thereby allow the gripper to be pneumatically controlled; and the dispensing cartridge further including second gas lines configured to allow gas communication to the dispensing section, and thereby allow the dispensing section to be pneumatically controlled.
13. The system of claim 12, the gripper including digits configured to contact the gripping section, the digits including a first gas channel, and the gripping section including a second gas channel, wherein the second gas channel is configured to establish gas communication with the first gas channel when the gripping section is gripped by the digits, and wherein the second gas lines run from the gripping section to the dispensing section to allow gas communication between the gripping section and the dispensing section.

14. The system of any of claims 1-13, wherein the dispensing section protrudes from the dispensing tube in a direction that is radial with respect to the dispensing tube.
15. A method of dispensing bolts into apertures formed on a work piece, the method including steps of:
 - providing a dispensing cartridge including a dispensing tube and a dispensing section, the dispensing section configured to control opening and closing of an end of the dispensing tube;
 - filling the dispensing tube with a plurality of bolts by stacking the bolts on top of one another; and
 - dispensing the bolts one at a time from the dispensing tube into apertures formed on a work piece using the dispensing section.
16. The method of claim 15, wherein the bolts inside the dispensing tube are not of equal length.
17. The method of any of claims 15-16, further including a step of transporting the dispensing cartridge using a robotic arm between a bolt loading station where the step of filling the dispensing tube occurs and a holding device where the step of dispensing the bolts occurs, wherein the work piece is secured to the holding device.
18. The method of claim 17, wherein the bolts are stacked inside the dispensing tube according to an order of apertures by which the robotic arm is configured to transport the dispensing cartridge.
19. The method of claim 18, further including the step of emptying the dispensing cartridge in case the bolts are stacked in an incorrect order.
20. The method of any of claims 15-19, further including a step of fastening the bolts to the apertures.
21. The method of any of claims 15-20, wherein the bolts are dispensed into the apertures by way of gravity.
22. A method of dispensing bolts into apertures formed on a work piece, the method including steps of:
 - providing a first dispensing cartridge and a second dispensing cartridge, each of the first dispensing cartridge and the second dispensing cartridge including a

- dispensing tube and a dispensing section configured to control opening and closing of an end of the dispensing tube;
- filling the dispensing tube of the first dispensing cartridge with bolts;
- filling the dispensing tube of the second dispensing cartridge with bolts;
- selecting the first dispensing cartridge using a robot; and
- using the robot for dispensing the bolts one at a time from the end of the dispensing tube of the first dispensing cartridge into apertures formed on a work piece using the dispensing section of the first dispensing cartridge.
23. The method of claim 22, wherein the step of dispensing the first dispensing cartridge and the step of filling the dispensing tube of the second dispensing cartridge occur at least in part simultaneously.
24. The method of any of claims 22-23, wherein the bolts in the first dispensing cartridge are different in diameter from the bolts in the second dispensing cartridge.
25. The method of any of claims 22-24, further comprising the steps of:
- selecting the second dispensing cartridge using the robot; and
- dispensing the bolts one at a time from the end of the dispensing tube of the second dispensing cartridge into apertures formed on the work piece or another work piece using the dispensing section of the second dispensing cartridge.
26. A method of dispensing bolts into apertures formed on a work piece, the method including steps of:
- providing a dispensing cartridge including a dispensing tube and a dispensing section, the dispensing section configured to control opening and closing of an end of the dispensing tube;
- filling the dispensing tube with a plurality of bolts including a first bolt and a second bolt, the first bolt and the second bolt shaped differently from one another; and
- dispensing the first bolt and the second bolt one at a time from the dispensing tube into apertures formed on a work piece using the dispensing section.
27. The method of claim 26, wherein the first bolt and the second bolt have different lengths.

28. The method of any of claims 26-27, wherein the bolts are dispensed into the apertures by way of gravity.



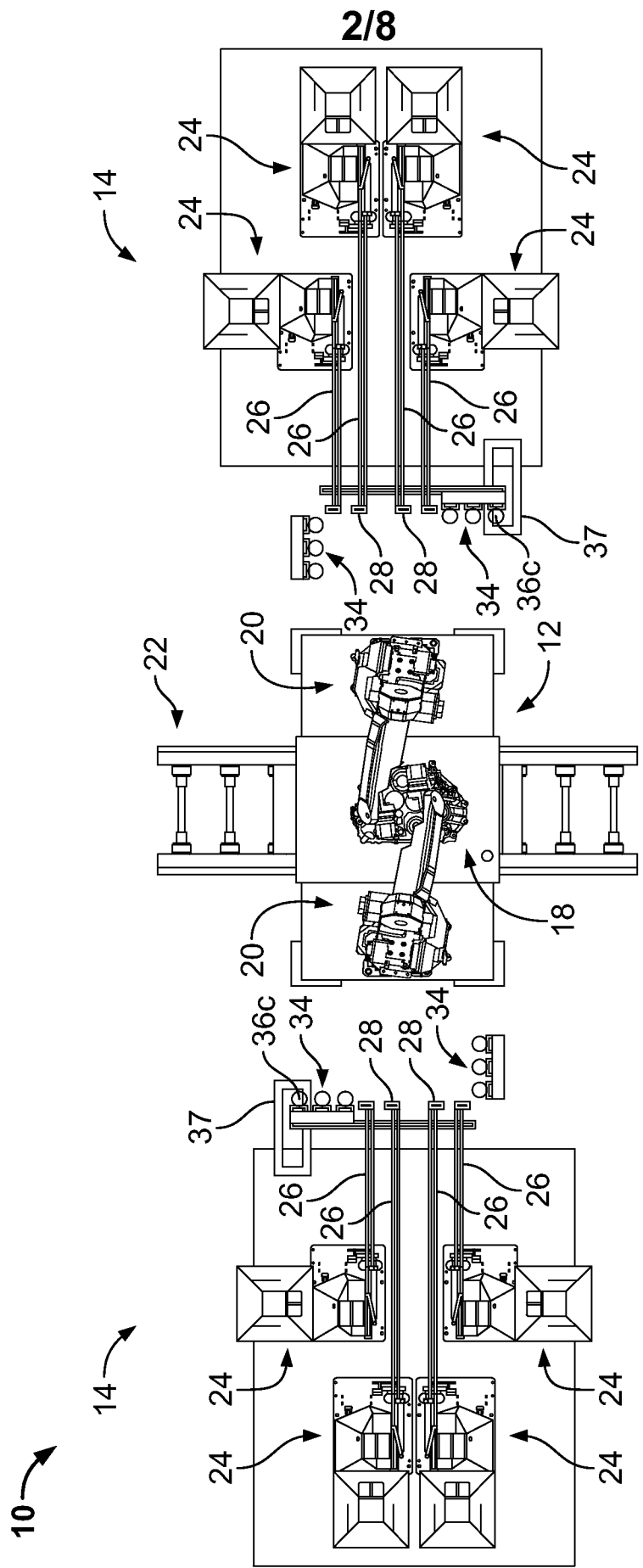


FIG. 2

3/8

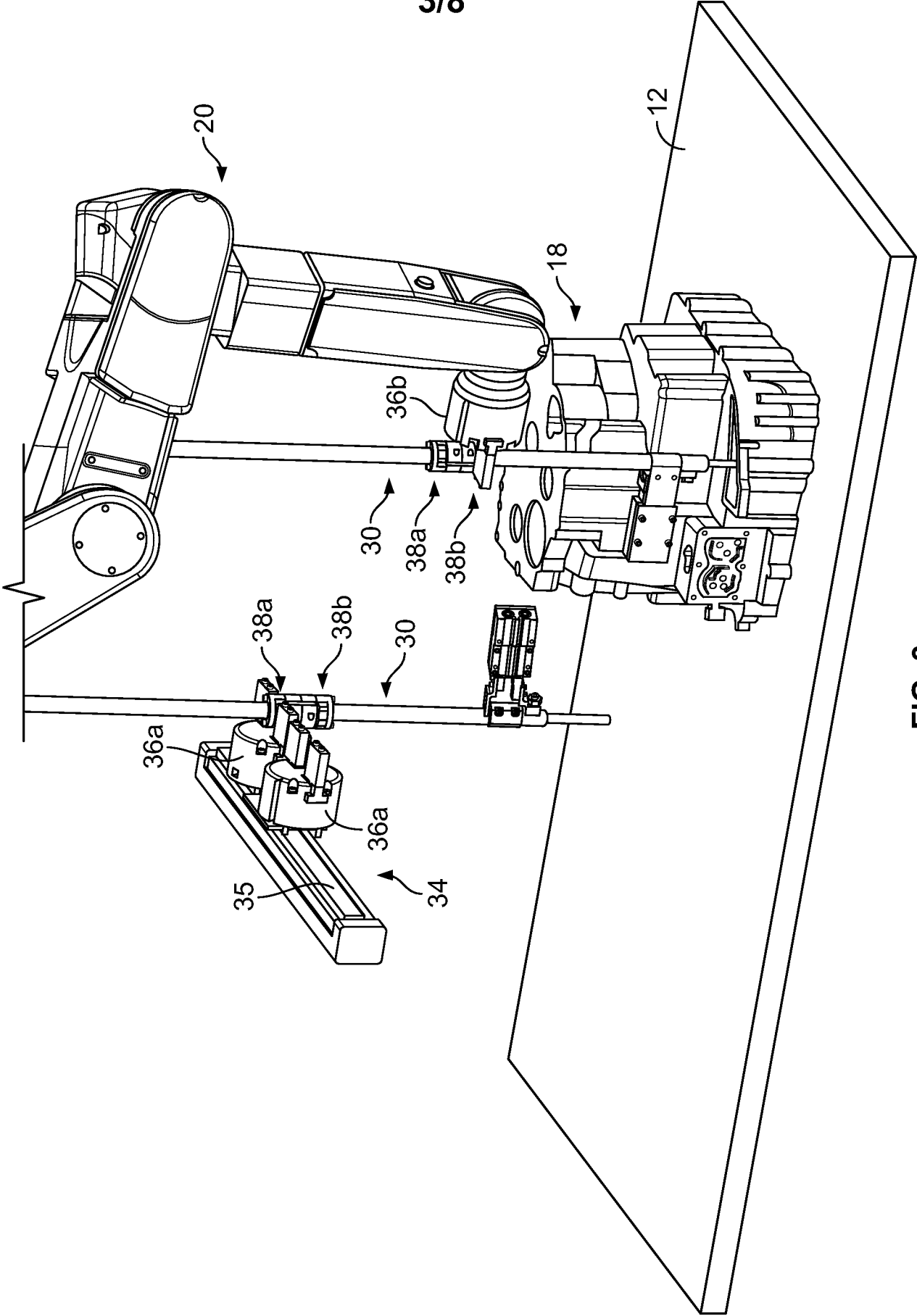


FIG. 3

4/8

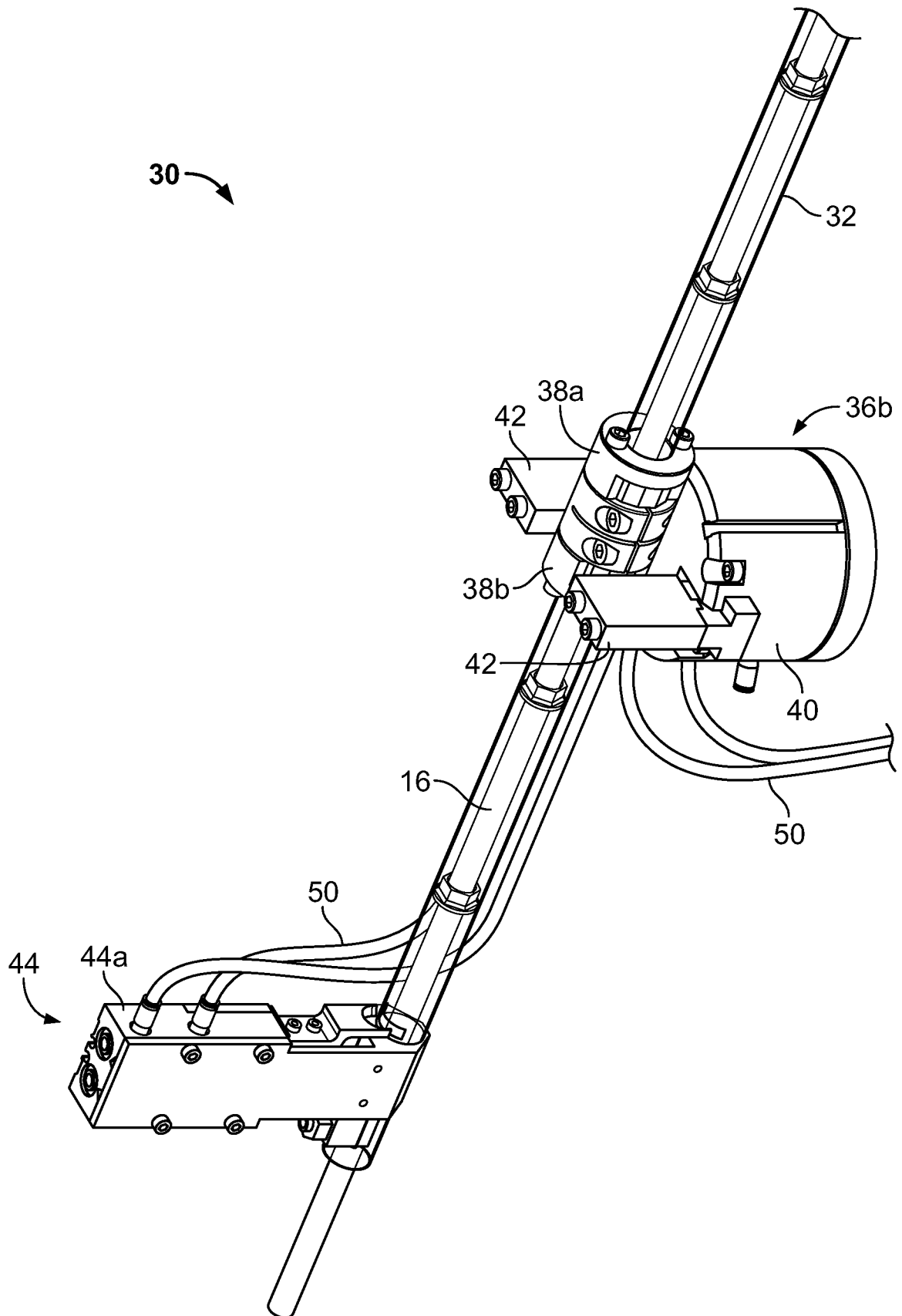


FIG. 4A

5/8

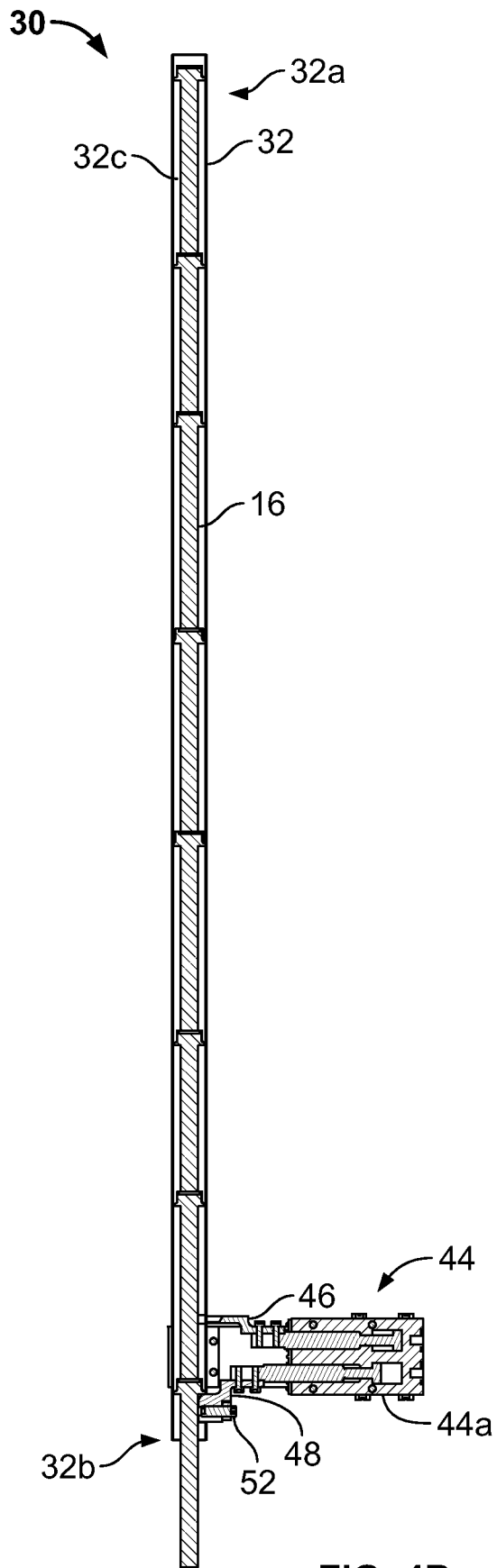


FIG. 4B

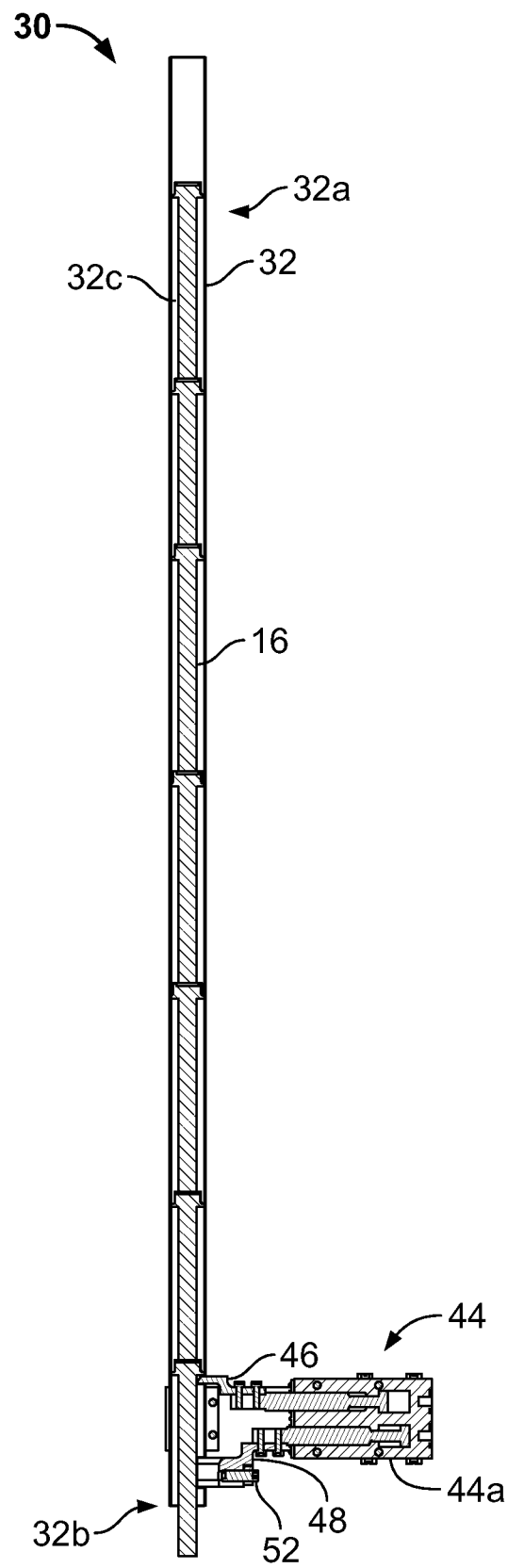


FIG. 4C

6/8

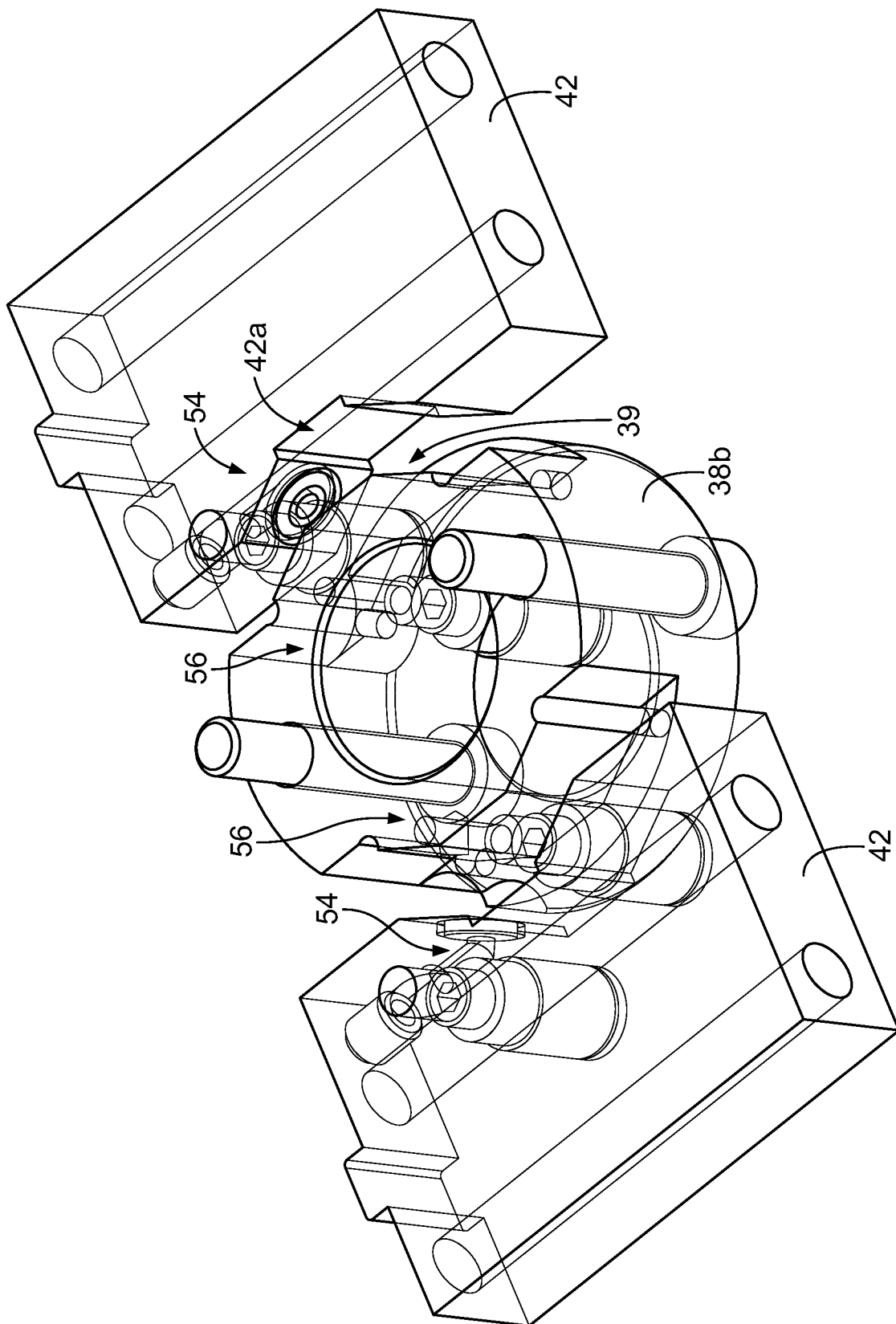
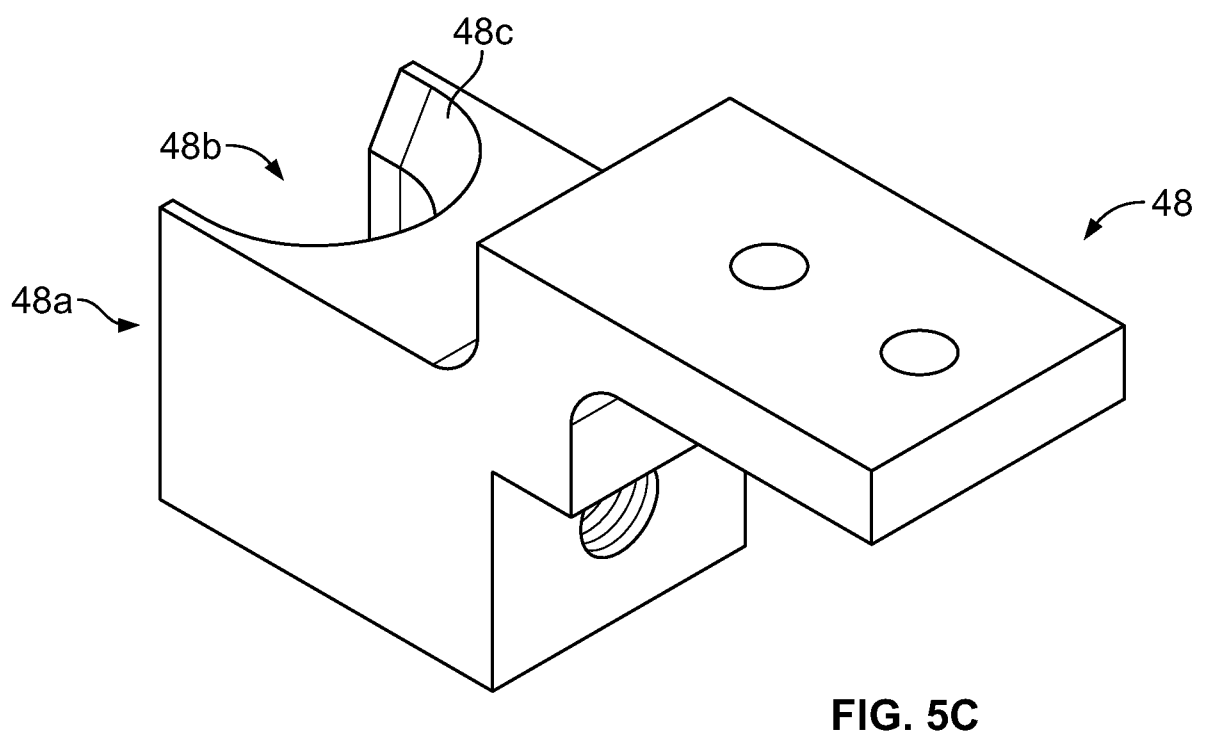
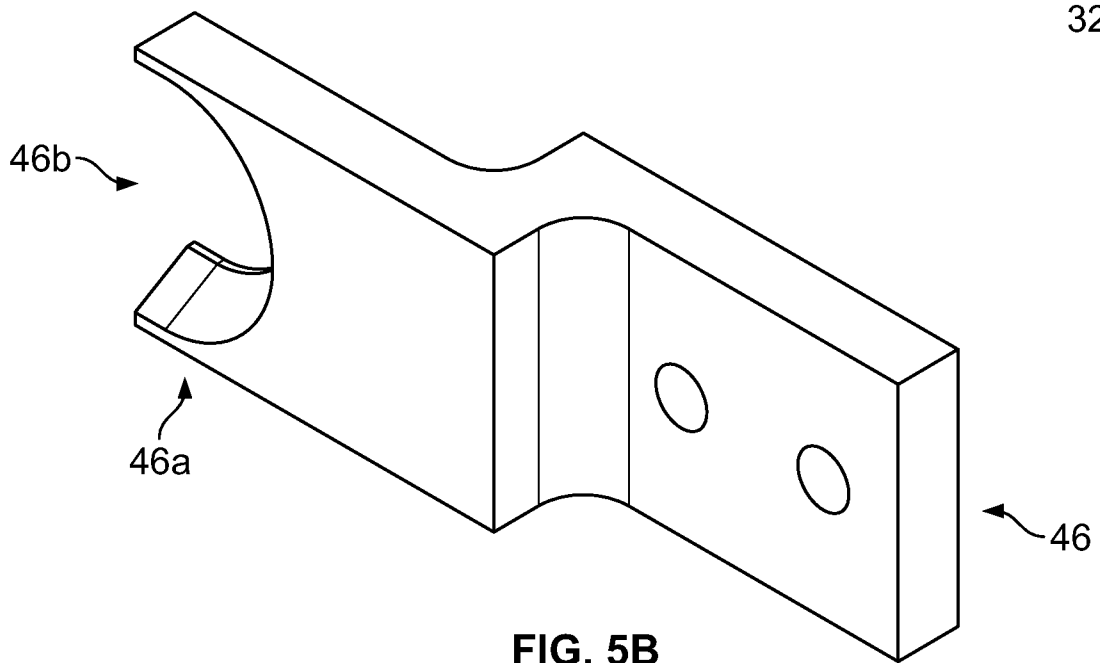
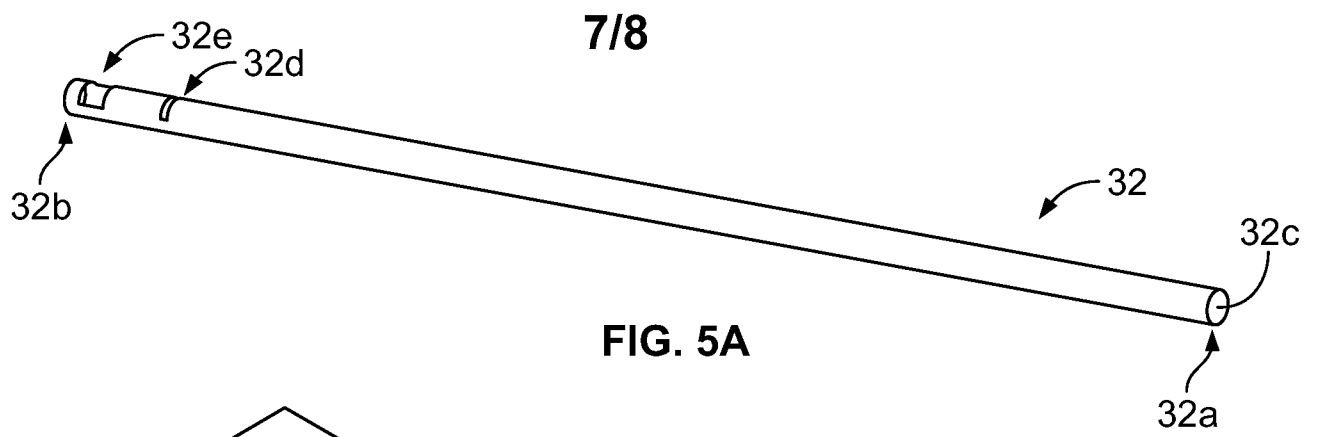


FIG. 4D



8/8

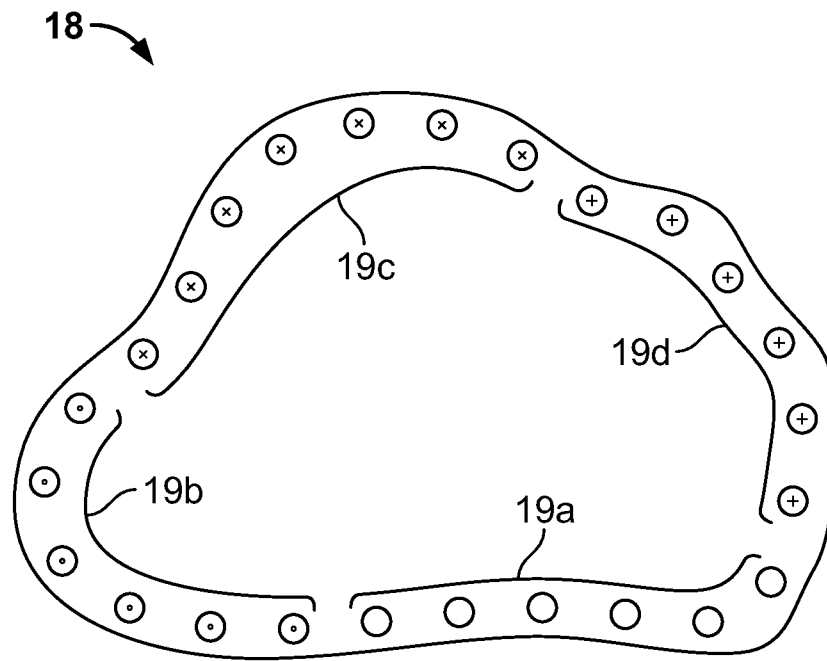


FIG. 6

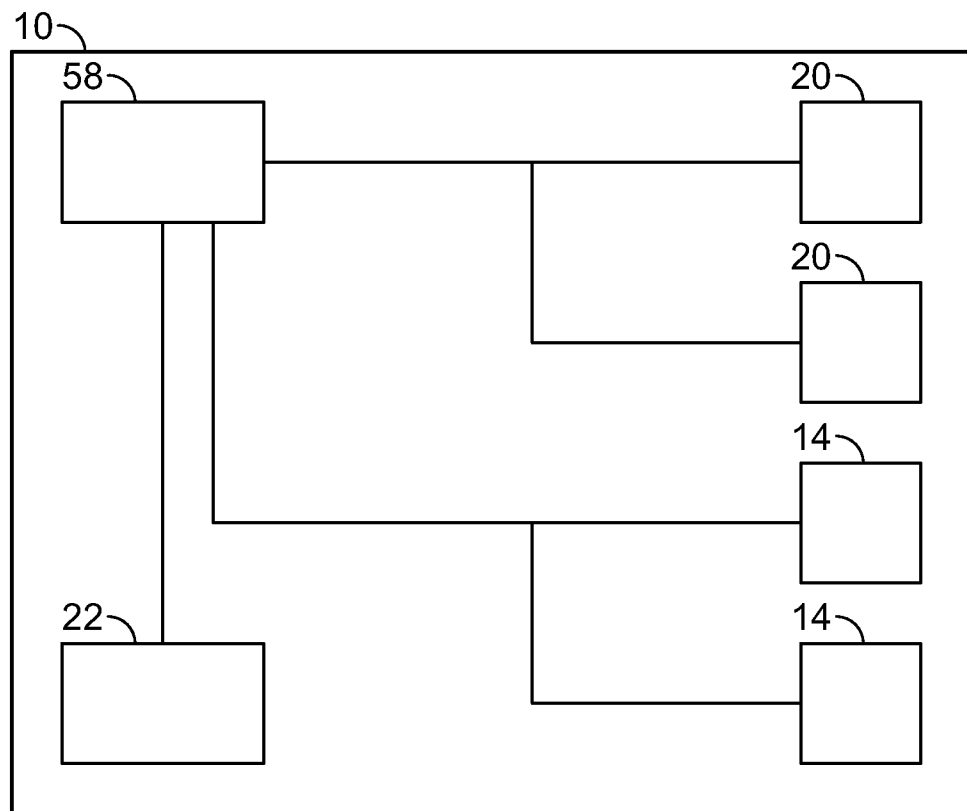


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/059232**A. CLASSIFICATION OF SUBJECT MATTER****B23P 19/06(2006.01)i, B23Q 7/08(2006.01)i, B25B 23/04(2006.01)i**

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)

B23P 19/06; B07C 5/06; B23P 19/00; B25B 23/04; B23Q 7/08

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: dispenser, feeder, bolt, fastener, robot, cartridge and magazine

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2005-246558 A (HONDA MOTOR CO., LTD.) 15 September 2005 See abstract, paragraphs [0005]–[0012], [0024] and figures 1, 5–7.	1–3, 15–19, 26–28
A		22–24
A	WO 2011-059966 A1 (ILLINOIS TOOL WORKS INC.) 19 May 2011 See abstract, page 7, line 5 – page 8, line 18 and figures 3A–3C.	1–3, 15–19, 22–24 , 26–28
A	EP 2384850 A1 (PIAS SALES CO., LTD.) 09 November 2011 See abstract, paragraph [0022] and figure 3.	1–3, 15–19, 22–24 , 26–28
A	JP 11-033844 A (HONDA MOTOR CO., LTD.) 09 February 1999 See abstract, paragraphs [0013]–[0017] and figure 1.	1–3, 15–19, 22–24 , 26–28
A	JP 11-033500 A (MITSUBISHI MOTORS CORP.) 09 February 1999 See abstract, paragraphs [0010]–[0020] and figure 3.	1–3, 15–19, 22–24 , 26–28



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19 December 2013 (19.12.2013)

Date of mailing of the international search report

19 December 2013 (19.12.2013)

Name and mailing address of the ISA/KR


 Korean Intellectual Property Office
 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City,
 302-701, Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

KIM, Jin Ho

Telephone No. +82-42-481-8699



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/059232

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2005-246558 A	15/09/2005	None	
WO 2011-059966 A1	19/05/2011	AU 2010-226914 A1 EP 2498953 A1	26/05/2011 19/09/2012
EP 2384850 A1	09/11/2011	BR PI1102439 A2 CN 102233512 A EP 2384850 B1 JP 04995302 B2 JP 2011-235362 A KR 10-2011-0123216 A TW 201206653 A US 2011-0297724 A1	06/11/2012 09/11/2011 19/12/2012 08/08/2012 24/11/2011 14/11/2011 16/02/2012 08/12/2011
JP 11-033844A	09/02/1999	None	
JP 11-033500A	09/02/1999	JP 3360571 B2	24/12/2002

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/US2013/059232**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 5, 7, 9, 11-14
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 5, 7, 9, 11-14 are unclear, because they refer to multiple dependent claims which do not comply with PCT Rule 6.4(a).
3. ☒ Claims Nos.: 4, 6, 8, 10, 20, 21, 25
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.