(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 January 2020 (16.01.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/012267 A1

(51) International Patent Classification:
B21D 37/04 (2006.01) *B25J 13/00* (2006.01)
B21D 37/14 (2006.01) *B21D 28/04* (2006.01)
B25J 11/00 (2006.01) *B23Q 41/02* (2006.01)

(21) International Application Number:
PCT/IB2019/055051

(22) International Filing Date:
17 June 2019 (17.06.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/696,721 11 July 2018 (11.07.2018) US
62/820,528 19 March 2019 (19.03.2019) US

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(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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

(54) Title: BENT TUBE AUTOMATION TOOLING

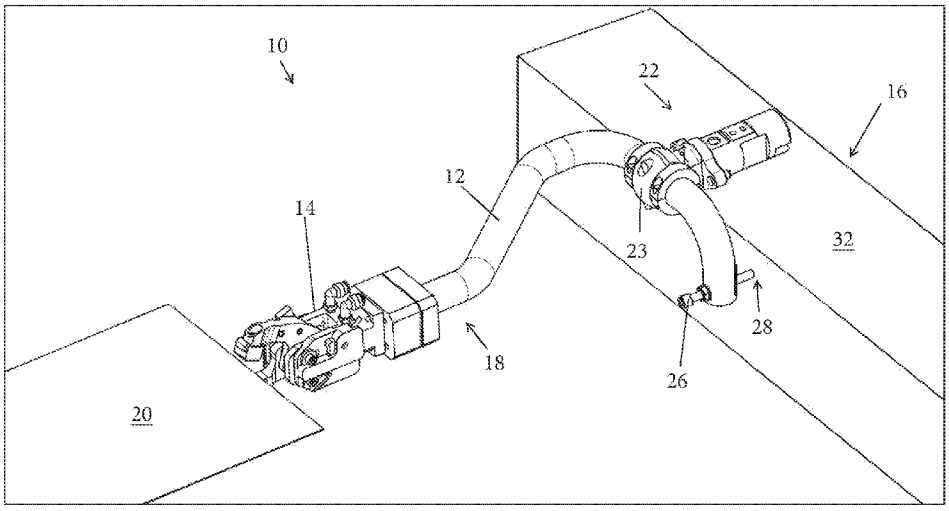

FIG. 1

(57) Abstract: A bent tubing automation tooling apparatus having a body component made of a rigid piece of material to connect an automation tooling machine to a work-piece manipulating implement, allowing for precision tooling with decreased parts and decreased setup, service, and tuning time to prepare the automation tooling machine for production. The body component may be a single monolithic body that is selectively movable between an operational position and an access position to provide for safer servicing of the automation tooling machine and components by allowing a technician to service the equipment from a safety zone instead of entering a dangerous area of the machine. The bent tubing apparatus provides fine tuning and quick adjustments to positional characteristics of the apparatus to increase precision of the automation tooling process while decreasing service time of the automation tooling machine and components.

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HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, 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, ST, 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))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

BENT TUBE AUTOMATION TOOLING

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority of U.S. provisional applications Ser. No. 62/696,721 filed Jul. 11, 2018 and Ser. No. 62/820,528 filed Mar. 19, 2019, which are hereby incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

[0002] The present invention is directed to an attachment apparatus for use in automation tooling, specifically a bent tube apparatus for automation build-up between a transfer implement and an automation tooling machine.

BACKGROUND OF THE INVENTION

[0003] Automation tooling requires precision movement of work-pieces between specific locations and different machines. Automation tooling increases overall product quality due to the high level of precision attained through modern tools and machines available in the industry. The automation tooling industry requires skilled technicians and engineers to ensure that the tools, machines, systems, and software are setup, calibrated, tuned, and functioning properly and precisely to produce quality end products.

[0004] A key part in automation tooling is the build-up, or the structure, connecting an automation tooling machine to a work-piece manipulating implement, in order to move the work-piece as required for the job. The build-up is a critical component of the process and requires fine-tuning and service to provide the required precision needed in the automation tooling industry. The build-up is made up of any number of precision parts, assembled in many variations and positions, to allow an automation tooling machine to deliver a work-piece to a precise location within a workspace. The work-piece handling build-up typically includes a configured element that forms an elongated arm or arms that extend toward and contact the work-piece. The elongated arm or arms selectively hold and move the work-piece into and away from the work space, such as for example to move a work piece into equipment for stamping, cutting, coining or other forming equipment.

[0005] During operation of work-piece handling build-ups it is not uncommon for operation to be interrupted in order to address a problem or other issue with the work-piece in the work space or with the forming equipment. In many such situations the build-up must be moved to gain access to the work-piece or work space. In such cases the build-up must be partially disassembled or adjusted to gain access to the work-piece or work space. The build-up must then be subsequently re-built or

adjusted back into its operating condition, which is a time consuming process which requires particular positional tolerances to be recreated in order to handle the work-piece in the originally specified manner. In other situations the build-up may be left in position, but workers must then reach around the build-up to access the work-piece or work space and service the problem.

SUMMARY OF THE INVENTION

[0006] The present invention provides an automation tooling build-up that is configured in a specified manner in order to handle and move work-pieces relative to a workspace. The build-up includes a material handling region that may be selectively moved out of a specified operational position to an access position, and a registry device that is set at a registry position to relocate the material handling region to the specified operational position when moved back from the access position. With the preferred automation tooling build-up the material handling region may be moved out of the operational position in order to access or service the work-piece or work space, and then returned to the original specified operational position without having to undertake build-up adjustment or recalibration of the automation tooling build-up. Preferably, the material handling region of the build-up is moved between the operational position and access position by pivoting the material handling region or by lateral sliding of the material handling region.

[0007] Preferably, according to one form of the present invention, an automation tooling build up is a bent tubing automation tooling build-up having a single body component made of a continuous rigid piece of material to connect an automation tooling machine to a piece of work-piece manipulating equipment or implement, allowing for precision tooling with decreased parts and decreased setup, service, and tuning time required to prepare the automation tooling machine for production. The pivoting function of the present invention provides for safer servicing of the automation tooling machine and components by allowing a technician to service the equipment from a safety zone instead of climbing into a dangerous area or work zone of the machine. The single body bent tubing apparatus of the present invention provides fine tuning and quick adjustments to positional characteristics of the apparatus to increase precision of the automation tooling process while decreasing service time of the automation tooling machine and components. Optionally, the bent tube apparatus is configurable to support more than one body component to support large work-pieces or to support more than one work-piece.

[0008] In one aspect of the present invention, the bent tube apparatus for automation tooling build-up to connect a work-piece maneuvering implement to an automation tooling machine is provided

to precisely position, manipulate, and maneuver a work-piece within a workspace in proximity to the tooling machine. The bent tube apparatus includes a continuous rigid elongate body defining the build-up for the tooling process. The bent tube apparatus is configured to robustly connect to the automation tooling machine on at least one portion of the elongate body and configured to support a work-piece maneuvering region or implement at a distal end of the elongate body at a location apart from the tooling machine. Preferably, the elongate body includes at least one bend that enables the elongate body to accurately and precisely accommodate the work-piece within the workspace envelope in proximity to the tooling machine and to allow the bent tube apparatus to effectively manipulate the work-piece. Alternatively, the elongated body may be made up of multiple connected sections of tubing that are coupled together in a specified configuration and may be maintained for repeated use in that configuration or alternatively assembled into different configurations for alternative applications.

[0009] In one aspect, the bent tube apparatus is releasably coupled to the automation tooling machine with a securing device, such as a primary clamp. The securing device is configured to mate with a mount on the automation tooling machine at one end and to couple to the elongate body on the opposing end. The releasable securing device allows for an operator or technician to quickly install a bent tube apparatus, or to remove and replace one bent tube apparatus with another, each configured for a specific automation tooling operation. The securing device machine-side mount may be one of various forms, including commercially available mounts or a custom mount system.

[0010] In another aspect of the present invention, the bent tube apparatus is pivotally coupled to the automation tooling machine with a pivotable securing device, such as a primary clamp. The pivotable securing device is able to be loosened by a technician such that the technician can pivot the bent tube apparatus from a working orientation to a service orientation. The service orientation providing the technician access to the tooling build-up to perform maintenance on the build-up or to remove and replace the build-up with a different bent tube apparatus without having to enter a dangerous area within the tooling machine to do so. After the technician has completed their task, the bent tube apparatus is returned to the working orientation and the securing device is tightened to secure the bent tube apparatus in the working orientation.

[0011] In another aspect, the bent tube apparatus is fixedly coupled to the automation tooling machine, such as with a transfer rail mount. The transfer rail mount allows an operator to loosen and remove the bent tube apparatus and to replace it with a different tube for a different task or

operation. The fixed coupling of the bent tube apparatus and the automation tooling machine provides a simple, low-maintenance, and cost effective work piece manipulation implement.

[0012] In one aspect, the bent tube apparatus includes a retaining system configured to retain the elongate body from moving from side to side relative to the securing device. In one aspect, the retaining system includes at least one tube clamp positioned abutting the securing device. The retaining system ensures that during movement of the bent tube apparatus from a working orientation to a service orientation, and back, that the bent tube apparatus returns to the precise defined location required for the tooling procedure without shifting laterally relative to the tooling machine. The at least one tube clamp of the retaining device is operable to be loosened from and tightened onto the elongate body to allow a technician to change or reposition the elongate body from side to side to fine tune the precision of the apparatus relative to the required position of the work-piece.

[0013] In one aspect, the distal end of the elongate body is configured to couple with a detachable work piece manipulating implement or head. The manipulating implement may be a variety or commercially available work-piece manipulating systems, such as suction cups, magnets, clamping devices, shovels, or the like. The manipulating implements are detachable such that a technician can quickly remove one implement and replace it with another for a different operation.

[0014] In another aspect, the distal end of the elongate body includes an integral work-piece manipulating implement, such that the distal end of the elongate body includes a notch or slot disposed through or in the elongate body material defining a specific type of manipulating element. The work-piece manipulating implement may be defined by a variety of shapes, such as a shovel. Integral notches and slots reduce weight of the build-up and decrease the amount of parts to be configured for the tooling production being performed, thereby decreasing possible sources of vibration, reducing stress in the system, decreasing energy used, and increasing speed of tooling processes.

[0015] In one aspect of the present invention, the bent tube apparatus includes an adjusting element or set-stop disposed at a portion of the elongate body at a location proximate to the automation tooling machine, such as near a transfer rail of the machine. The adjusting element is configured to adjust at least one position characteristic of the bent tube apparatus to precisely position the bent tube apparatus as required relative to the automation tooling machine.

[0016] In one aspect, the adjusting element is a threaded bolt threaded into a threaded insert that is disposed within the elongate body. The threaded bolt passes into and through the elongate body and contacts a proximate location on the automation tooling machine to provide a physical contact interaction between the threaded bolt and the tooling machine. The threaded bolt is turned clockwise or counter-clockwise to adjust the position characteristic of the bent tube apparatus relative to the tooling machine. The interaction between the threaded bolt and the tooling machine provides a set-stop position wherein the bent tube apparatus can be returned to a desired working orientation that has been set by the technician after the technician has finished a task, such as performing maintenance on the material handling implement. The set-stop position enables the return of the bent tube apparatus to a precise location after it has been moved between the working orientation and a service orientation without additional adjustment or time needed to reposition the bent tube apparatus. In this aspect, after the technician has completed their task, the bent tube apparatus can be returned to the working orientation where the adjusting element of the bent tube apparatus contacts a portion of the tooling machine at the set-stop position and the bent tube apparatus is back in the working orientation. The threaded insert may be a rivet type threaded insert, a nylon plug type threaded insert, or similar threaded element disposed in the elongate body. Optionally, the adjusting element includes a pivotable contact head configured to provide optimal contact between the adjusting element and the tooling machine.

[0017] In another aspect, the adjusting element is disposed in at least one of the releasable clamps of the retaining system, such that no hole is required through the elongate body and no additional material is required beyond the section of the elongate body that is secured to the automation tooling machine. Optionally, the adjusting element includes a pivotable contact head configured to provide optimal contact between the adjusting element and the tooling machine.

[0018] According to another form of the present invention, a bent tube apparatus is configured to support more than one elongate body, wherein each elongate body is configured to support a work-piece manipulating implement. Each elongate body is independently adjustable relative to a securing device. Each of the multiple elongate bodies are provided for manipulating one work-piece or may cooperate to manipulate a single larger work-piece.

[0019] According to another form of the present invention, a continuous rigid elongate body of the bent tube apparatus is formed from a single elongate member of material, such as steel or aluminum, which is bent based on volumetric data from a three-dimensional model. A software

program may be used to model an elongated body to perform a specific process, wherein the software program outputs the data of the model to a material bending machine that then bends the elongate member to the specification of the model.

[0020] Therefore, the present invention provides a bent tubing automation tooling build-up apparatus for connecting a work-piece maneuvering implement to an automation tooling machine to precisely maneuver and manipulate a work-piece within a workspace envelope while utilizing a minimal number of parts. Limiting the number of parts decreases weight, increases precision, decreases setup, service, maintenance, and tuning time, decreases costs, increases productivity, and provides additional benefits as compared to traditional automation tooling build-ups. The single precision-bent, machined, or milled elongate body provides a versatile connection type between an automation tooling machine and the work-piece to be manipulated.

[0021] These and other objects, advantages, purposes and features of this invention will become apparent upon review of the following specification in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1 is a perspective view of an embodiment of a bent tubing apparatus embodying the invention for attachment between an automation tooling system, such as a transfer rail, and a workpiece manipulating implement;

[0023] FIG. 2 is a perspective view of an embodiment of a bent tubing apparatus coupled to an attachment clamp configured to mount to a transfer rail;

[0024] FIGS. 3A-3D are perspective views of the bent tubing apparatus including various alternative types of workpiece manipulating implements with different work piece handling configurations, such as shovels, notches, or mounts for a workpiece manipulating device, for lifting or transferring a work piece and embodying the invention;

[0025] FIGS. 4A-4B are a perspective view and a side view illustrating a rotation of the bent tube apparatus from a working orientation or operational position to a non-working orientation or access orientation shown in phantom, such as out of a working area to an adjustment and manipulation area for safely adjusting or servicing the bent tube apparatus;

[0026] FIGS. 5A-5B are perspective views of an embodiment of the bent tubing apparatus having more than one work piece handling arm for supporting larger work pieces or more than one work piece;

[0027] FIG. 6 is a perspective view of another embodiment of the bent tubing apparatus having more than one work piece handling arm for supporting larger work pieces or more than one work piece.

[0028] FIG. 7 is a perspective view of a bent tubing apparatus configured to mount directly to a transfer rail.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0029] Referring now to the drawings and the illustrative embodiments depicted therein, an automation tooling build-up apparatus is defined by an elongated rigid body that is configured to provide precision support or manipulation functionality between a work-piece and an automation tooling machine, such as a transfer press machine. The elongated body may be formed from a precision bent or shaped single piece of material, thereby minimizing the required number of parts or members required to form the build-up. Minimizing the number of build-up parts reduces the need for time-consuming and imprecise adjustment of the tooling system and increases production throughput. The elongated body may be mechanically formed using a software controlled machine to shape the elongated body based on information from a three-dimensional model.

[0030] According to one form of the present invention, a bent tubing automation tooling or build-up apparatus 10 having a continuous elongated rigid body 12 is configured to provide precision support between a part or work-piece and an automation tooling machine 16, such as a transfer machine (FIG. 1). The elongated body 12 is formed as a precision bent single continuous or monolithic piece of material to enable precision maneuvering of a work-piece 20 using a tooling or transfer machine 16 without the need for time-consuming and imprecise adjustment of multi-piece build-up tooling systems. The elongated rigid body 12 includes a work piece manipulating implement 14 disposed at a distal end 18 of the elongated body 12 to support or grip the work-piece 20. The bent tubing apparatus 10 is configured such that the work-piece 20 and the tubing apparatus 10 are maneuverable proximate the tooling machine 16 without contacting, clashing, or impeding clearance with other proximate parts of the tooling machine 16. As illustrated in FIGS. 1-3D, the manipulating element 14 may by coupled to or disposed in the elongated body 12 and may be selected from any type of machine tooling implement configured to maneuver or manipulate a work piece 20, such as suction cups, magnets, clamping devices, shovels, or the like. Alternatively elongated body may be made up of connected components or pieces that are locked into a rigid

configuration or joined by welding or other joining processes, but preferably once made up in the desired configuration is used and maintained in a set configuration.

[0031] The elongated body 12 may be composed of a rigid, resilient material that is capable of being precision bent, machined, or milled, such as steel, stainless steel, aluminum, plastic, or the like. The elongated body 12 may be produced off-site to a required specification and installed onto an automation tooling machine 16, greatly simplifying changeover procedures and reducing the time required for a technician to reconfigure the build-up for a new tooling configuration. Optionally, a software-controlled forming machine may form the elongated body 12 based on three-dimensional volumetric information as provided by the software that controls the forming machine. Preferably, elongated body 12 is a single continuous or monolithic body, but alternatively may be made up of multiple components or elements and then fixed into a rigid configuration.

[0032] In one embodiment, a machine securing device 22, such as a releasable primary clamp or an adaptor for coupling with a receiver, is coupled to a portion of the elongated body 12 to provide a robust connection between the tooling machine 16 and the tubing apparatus 10. In addition, the tubing apparatus 10 may include features such as a releasable and pivotable clamp 23 disposed with the securing device 22 and configured to allow safe maintenance of the tubing apparatus 10, releasable retaining clamps 24 configured to retain the tubing apparatus 10 at a desired location relative to the pivotable clamp 23, position adjustment systems 26 provided to fine-tune at least one position characteristic of the tubing apparatus 10, or a position return set registry or set-stop 28 provided to return the tubing apparatus 10 to a pre-determined position if it has been pivoted at the pivotable clamp 23. Thus, the bent tubing automation tooling apparatus 10 greatly simplifies the setup and changing of an automation build-up from one operation configuration to the next configuration, while also providing increased safety to a technician by allowing the technician to maintain or remove the build-up from a safe location relative to the automation tooling machine.

[0033] In another embodiment, as illustrated in FIGS. 3A-3D, the manipulating element 14 is disposed within the elongated body 12 at the distal end 18. The manipulating element 14 disposed within the distal end 18 may be defined as a slot or notch 30 cut or machined into the distal end 18. Various shapes of slots or notches 30 may be utilized to perform differing operations, shapes such as: a slot to lift and tilt the work-piece 20 as shown in FIG. 3A; a bottom shovel to support a work-piece 20 from below as shown in FIG. 3B; a notch through one side of the distal end 18 to lift and tilt the work-piece 20 while limiting lateral movement of the work-piece 20 as shown in FIG. 3C; a

shovel with varying side wall heights to support a work-piece from below while limiting lateral movement of the work-piece 20 as shown in FIG. 3D. It will be appreciated that other notch and slot shapes are configurable to support and maneuver a work-piece 20.

[0034] In one embodiment, as illustrated in FIGS. 4A-4B, the tubing apparatus 10 is pivotally coupled to a transfer rail 32 of the automation tooling machine 16 such that an operator or technician may pivot the tubing apparatus 10 from a potentially dangerous working orientation or position 34 to a service orientation or position 36 to allow for safer access to service the build-up tooling of the automation tooling machine 16. The tubing apparatus 10 is pivotable after a pivotable clamp 23 of the securing device 22 is loosened, such that the tubing apparatus 10 is freely pivotable about the axis passing through the axial center of the pivotable clamp 23. A retaining system defined by the releasable retaining clamps 24 is provided to retain the position of the elongated body 12 from sliding laterally or side to side relative to the pivotable clamp 23 while allowing the tubing apparatus 10 to pivot about the axial axis of the pivotable clamp 23. Rotational adjustment of the tubing apparatus 10 is provided by the pivotable clamp 23, such that the elongated body 12 is rotatable at the pivotable clamp 23 while the clamp 23 is loosened. The technician can set the rotational position of the elongated body 12 relative to the pivotable clamp 23 by tightening the clamp 23. Positional adjustment of the tubing apparatus 10 is provided by the releasable retaining clamps 24, such that the elongated body 12 is slideable through the releasable retaining clamps 24 while the clamps 24 are loosened. The technician can set the position of the elongated body 12 relative to the releasable retaining clamps 24 by tightening the clamps 24.

[0035] The elongated body 12 may be moved between the operational or working position 34 and an access or service position 36 by releasing the pivotable clamp 23 and one of retaining clamps 24 while maintaining the clamped state of the other retaining clamp 24. In this released adjustment position elongated body 12 is laterally slidable through pivotable clamp 23 with the released retaining clamp 24 sliding along the lateral length of elongated body 12 until an access position is achieved that provides sufficient desired clearance between the elongated body 12 and the work space or forming equipment. After service is completed elongated body is slid back through pivotable clamp 23 until the clamped retaining clamp 24 is contacted and released retaining clamp 24 is slid back to the original clamping position. Both pivotable clamp 23 and the released retaining clamp 24 are tightened into a clamped condition while an adjustment system 26 or a position return set registry 28 maintains registry with transfer rail 32 and proper positioning of elongated body 12.

[0036] In one embodiment, the position adjustment system 26 is disposed on the tubing apparatus 10 proximate the automation tooling machine 16. The position adjustment system 26 is operable to fine tune a position characteristic of the tubing apparatus 10, such as the rotation of the apparatus 10 about the pivotable clamping axis defined previously. In the illustrated embodiment of FIGS. 4A-4B, the position adjustment system 26 is a threaded bolt 38 threading into a threaded insert 40 disposed in a portion of the elongate body 12, the threaded bolt 38 passing through the opposite wall of the elongated body 12. The position adjustment system is adjustable by turning the threaded bolt 38 clockwise or counter-clockwise to adjust the position characteristic of the tubing apparatus 10 as desired. Optionally, the position adjustment system 26 includes a jam nut 42 disposed on the threaded bolt 38 to ensure the threaded bolt 38 does not loosen during operation of the automation tooling machine 16. The threaded insert 40 may be any form of fixed or fixable threaded insert, such as a press fit insert, a machinable nylon plug, tapping and threading the elongated body 12, or the like. In an alternative embodiment, as illustrated in FIG. 5A, the position adjustment system 26 is disposed on at least one of a releasable retaining clamp 24.

[0037] In one embodiment, the position adjustment system 26 is configured to provide a set registry or position set-stop 28, such that when the tubing apparatus 10 is pivoted between the working orientation 34 and the service orientation 36, the technician simply pivots the tubing apparatus 10 back to the working orientation 34 and the set-stop 28 makes contact with a portion of the automation tooling machine 16, such as the transfer rail 32, thus returning the tubing apparatus 10 to the desired working orientation 10 without measurement or adjustment. The set registry 28 is defined by a point of contact between the position adjustment system 26 and the automation tooling machine 16. Set-stop 28 maintains the relative position or calibration of tubing apparatus 10 relative to transfer rail 32 by maintaining the registry between set-stop 28 and transfer rail 32. Optionally, not shown, the position adjustment system 26 includes a pivoting contact head configured to pivot about the distal end of the threaded bolt 38 until it contacts the transfer rail 32 and continues to pivot until the contacting portion of the contact head is uniformly in contact with the transfer rail 32 ensuring that the position adjustment system 26 is in stable contact with the transfer rail 32 at the set-stop 28.

[0038] In another form of the present invention, a tubing apparatus 10a is configured to include more than one manipulating implement 14, as illustrated in FIGS. 5A-6. The tubing apparatus 10a is configurable to support at least two continuous elongated rigid bodies 12a, 12b, each configured to

provide precision support between a part or work-piece manipulating implement 14 and an automation tooling machine 16, such as a transfer machine. Each of the elongated bodies 12a, 12b are adjustable independent of the other within the pivotable clamp 23 and the releasable retaining clamps 24. In one embodiment, a piece of round stock 44 is inserted between proximal ends of elongated bodies 12a, 12b to provide optimal clamping strength beneath the pivotable clamp 23 and the releasable retaining clamps 24 to prevent crushing or pinching at the proximal ends of elongated bodies 12a and 12b. In another embodiment, as illustrated in FIG. 6, proximal ends of elongated bodies 12a, 12b are disposed into the releasable retaining clamps 24 perpendicular to the transfer rail 32, and the retaining clamps 24 are coupled to the securing device 22 with a piece of round stock 46 axially inserted through the retaining clamps 24 and the pivotable clamp 23. The elongated bodies 12a, 12b are independently releasable and pivotable at their respective retaining clamps 24, such that one of elongated bodies 12a, 12b may be moved out of or into the work zone independent of the other. Optionally, the elongated bodies 12a, 12b may be pivoted together about pivotable clamp 23 to be moved out of or into the work zone.

[0039] In another form of the present invention, as illustrated in FIG. 7, an elongated body 48 is fixedly coupled at a proximal end 50 to a transfer rail mount 52. The elongated body 48 is configured to rigidly attach to the transfer rail 32 to provide a simple and cost effective precision support between a part or work-piece manipulating implement 14 and an automation tooling machine 16, such as a transfer machine. The elongated body 48 is not pivotally coupled to the automation tooling machine 16.

[0040] In one form of the present invention, a continuous rigid elongate body 12 of the bent tube apparatus 10 is formed from a single member of material, such as steel or aluminum, which is bent, shaped, or formed based on three-dimensional volumetric data, such as from a software based model. A software program may be used to model an elongated body to perform a specific process, whereby the software program outputs the data of the model to a material bending machine that then bends the elongate member to the specification of the model.

[0041] Optionally, not shown, wiring for sensors and air lines for pneumatic clamping devices can be run through an interior of the elongate tubing 12 to prevent it from snagging, pinching, or damaging of the wiring or airlines during operation of the automation tooling machine 16.

[0042] Accordingly, the automation tooling build-up apparatus of the present invention provides a single body component made of a continuous rigid piece of material to connect to an automation

tooling machine and to support a work-piece or a work-piece manipulating implement, allowing for precision automation tooling with decreased parts and decreased setup, service, and tuning time required to prepare the automation tooling machine for production. The build-up includes a material handling region that may be selectively moved out of a specified operational or working position to an access or service position. A registry device that is set at a registry position may be included to relocate the material handling region to the specified operational position when the build-up apparatus is moved between the operational position and the access position. The selectively movable function provides for safer servicing of the automation tooling machine and components by allowing a technician to service the equipment from a safety zone instead of climbing into a dangerous area or work zone of the machine. Optionally, the bent tube apparatus is configurable to support more than one body component to support large work-pieces or to support more than one work-piece. The single body component may be formed with the aid of a three-dimensional volumetric data, such as with a three-dimensional modeling software.

[0043] Changes and modifications in the specifically described embodiments can be carried out without departing from the principles of the present invention which is intended to be limited only by the scope of the appended claims, as interpreted according to the principles of patent law including the doctrine of equivalents.

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A bent tube apparatus for automation build-up between a work piece to be manipulated and an automation tooling machine, comprising:

a continuous rigid elongate body configured to position a work piece at a location apart from the automation tooling machine;

said continuous rigid elongate body removably coupled at a proximal end to the automation tooling machine.

2. The bent tube apparatus of claim 1, wherein said continuous rigid elongate body further comprises at least one bend to accurately accommodate the work piece within a movement envelope available proximate to the automation tooling machine.

3. The bent tube apparatus of claim 2, further comprising a work piece maneuvering implement disposed at a distal end of said continuous rigid elongate body opposite of the automation tooling machine, said work piece maneuvering implement configured to manipulate the work piece.

4. The bent tube apparatus of claim 1, wherein a portion of said elongate body is configured to releasably couple to a securing device, said securing device is configured to couple to the automation tooling machine.

5. The bent tube apparatus of claim 1, wherein a portion of said elongate body is configured to pivotally couple to a securing device, said securing device is configured to couple to the automation tooling machine.

6. The bent tube apparatus of claim 5, further comprising a retaining system configured to retain a portion of said elongate body proximate to said securing device, such that said bent tube apparatus is operable to be serviced at a service position that is safe for a technician to perform adjustments and then returned to a working position to perform a function without moving side to side proximate the securing device.

7. The bent tube apparatus of claim 6, wherein said retaining system comprises at least one clamp releasably coupled to said elongate body.

8. The bent tube apparatus of claim 3, wherein said work piece maneuvering implement is disposed at a distal end of said elongate body and is configured to couple with a detachable work piece manipulating head configured to perform a function, such that the detachable head may be quickly interchanged with another detachable head configured to perform a different function.

9. The bent tube apparatus of claim 3, wherein said work piece maneuvering implement is integrally disposed in a distal end of said elongate body and configured to manipulate the work piece directly with at least a portion of said elongate body, such that no additional apparatus is necessary to manipulate the work piece.

10. The bent tube apparatus of claim 1, further comprising an adjusting element disposed at a portion of said elongate body, wherein said adjusting element is configured to adjust at least one position characteristic of said bent tube apparatus, said adjusting element is further configured to define a set position of said bent tube apparatus relative to the automation tooling machine, such that when said bent tube apparatus is moved between a working position and a service position it is automatically returnable to a desired set position.

11. The bent tube apparatus of claim 10, further comprising a pivotable contact head disposed at a distal end of said adjusting element and configured to securely seat the distal end of said adjusting element to a portion of the automation tooling machine.

12. The bent tube apparatus of claim 6, further comprising an adjusting element disposed at a portion of said retaining system, wherein said adjusting element is configured to adjust at least one position characteristic of said bent tube apparatus, said adjusting element is further configured to define a set position of the bent tube apparatus relative to the automation tooling machine, such that when the bent tube apparatus is moved between a working position and a service position it is automatically returned to a desired set position.

13. A bent tube apparatus for automation build-up between a work piece to be acted upon and an automation tooling machine, comprising:

at least one rigid elongate body configured to position a work piece maneuvering implement at a precise location apart from the automation tooling machine;

a pivot clamp selectively coupled to said elongate body and configured to be mounted to the automation tooling machine, said pivot clamp operable to provide selective pivoting of said elongate body relative to said pivot clamp; and

an adjustable contact registry element coupled with said elongate body to provide a contact surface selectively adjustable relative to said elongate body and operable to provide a contact with a surface on the automation tooling machine;

wherein said adjustable contact registry element is operable to be adjusted to a selected position and provide a set registry location with the automated tooling machine when said elongate body is pivoted relative to said pivot clamp.

14. The bent tube apparatus of claim 13, wherein said rigid elongate body comprises a substantially continuous, monolithic body.

15. An automation tooling build-up apparatus, comprising:

at least one rigid elongate body configured to position a work piece at a working location apart from an automation tooling machine;

a pivotable clamp selectively coupled to a proximal end of said elongate body and configured to be mounted to the automation tooling machine, said pivotable clamp operable to selectively pivot said elongate body relative to the automation tooling machine; and

an adjustable contact registry element coupled with said elongate body to provide a contact surface selectively adjustable relative to said elongate body and operable to provide a contact with a surface on the automation tooling machine;

wherein said adjustable contact registry element is operable to be adjusted to a selected position and provide a set registry location in cooperation with the automated tooling machine when said elongate body is pivoted relative to said pivotable clamp.

16. The bent tube apparatus of claim 15, wherein said rigid elongate body comprises a substantially continuous, monolithic body.

17. A method for manipulating a work piece, said method comprising:

coupling a bent tube tooling build-up apparatus to an automation tooling machine;

adjusting said bent tube apparatus to a working position relative to the automation tooling machine by adjusting a pivotable clamp selectively coupled between the automation tooling machine and a proximal end of said bent tube apparatus; and

manipulating the work piece by operating the automation tooling machine while said bent tube apparatus is in the working position.

18. The method for manipulating a work piece of claim 17, further including servicing said bent tube tooling build-up apparatus by pivoting said bent tube apparatus at said pivotable clamp out of the working position to a service position, servicing said bent tube apparatus, and pivoting said bent tube apparatus at said pivotable clamp back to the working position.

19. A method for manipulating a work piece, said method comprising:

coupling a bent tube tooling build-up apparatus to an automation tooling machine;

adjusting said bent tube apparatus to a working position relative to the automation tooling machine by adjusting a pivotable clamp selectively coupled between the automation tooling machine and a proximal end of said bent tube apparatus;

providing a set registry position between the automated tooling machine and said bent tube apparatus;

selectively adjusting the set registry position by adjusting an adjustable contact registry element coupled with said bent tube apparatus, said adjustable contact registry element operable to provide a selectively adjustable contact with a surface on the automation tooling machine; and

manipulating the work piece by operating the automation tooling machine while said bent tube apparatus is in the working position.

20. The method for manipulating a work piece of claim 19, further including servicing said bent tube tooling build-up apparatus by pivoting said bent tube apparatus at said pivotable clamp out of the working position to a service position, servicing said bent tube apparatus, and pivoting said bent tube apparatus at said pivotable clamp back to the working position.

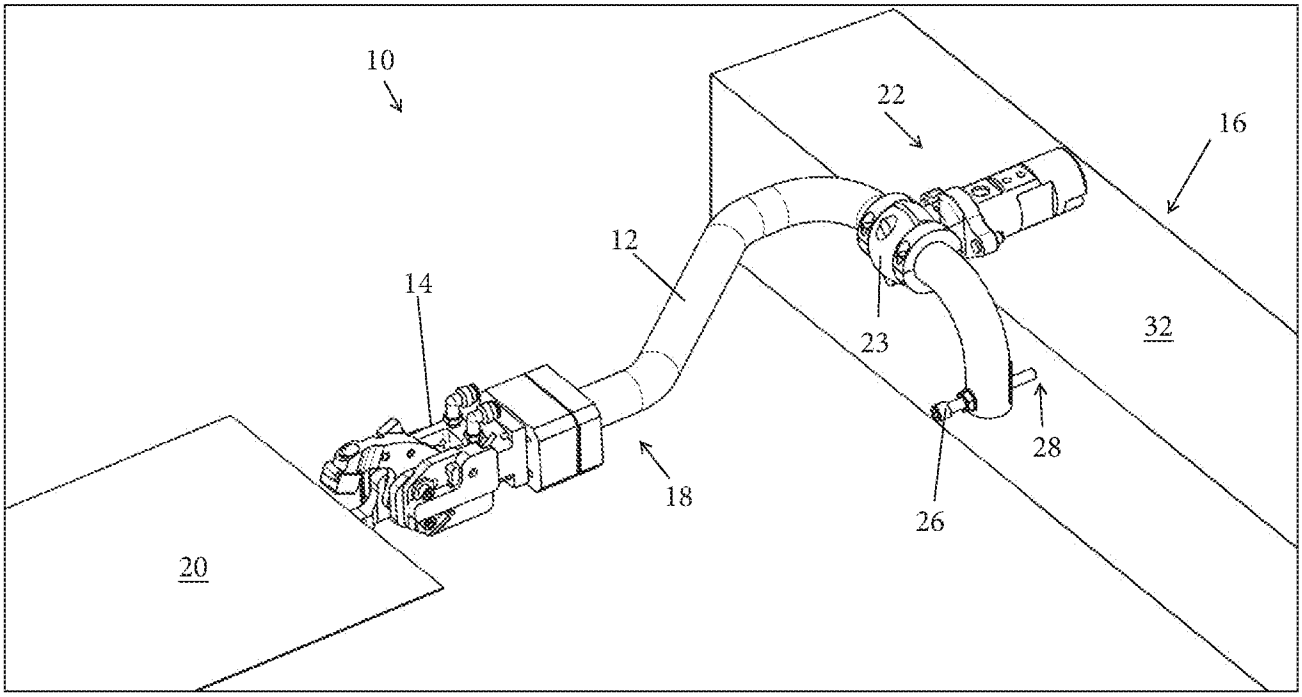

FIG. 1

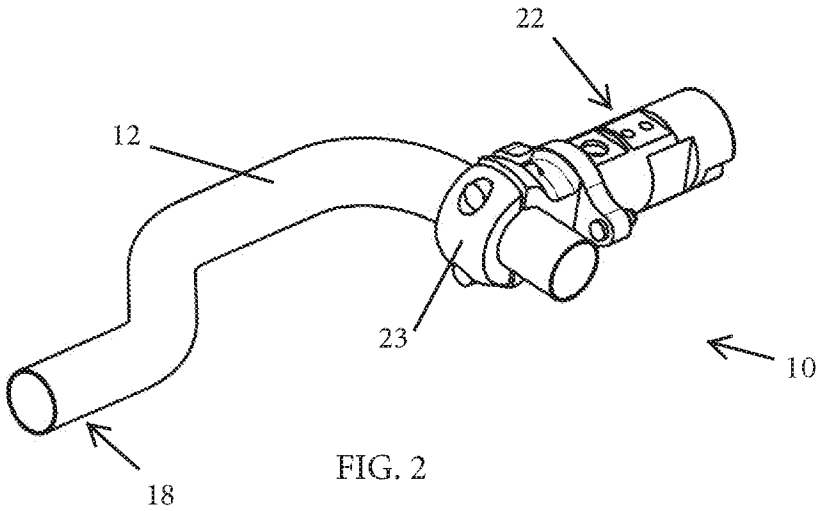

FIG. 2

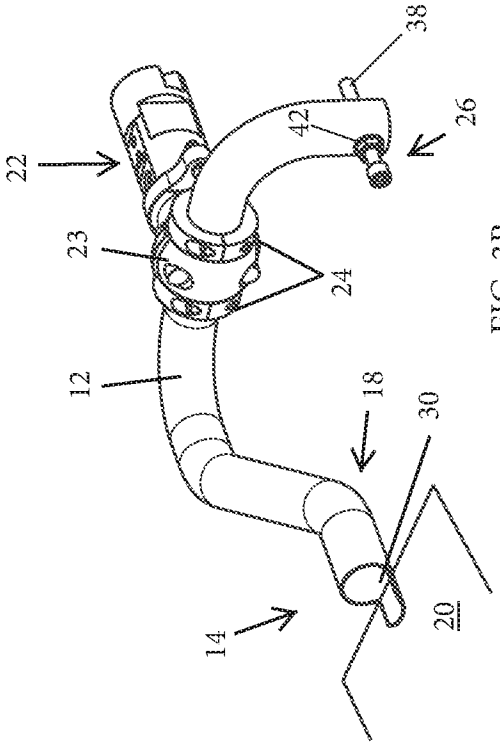

FIG. 3B

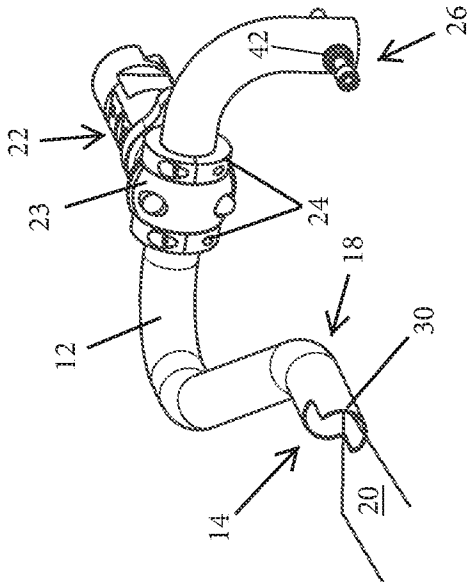

FIG. 3D

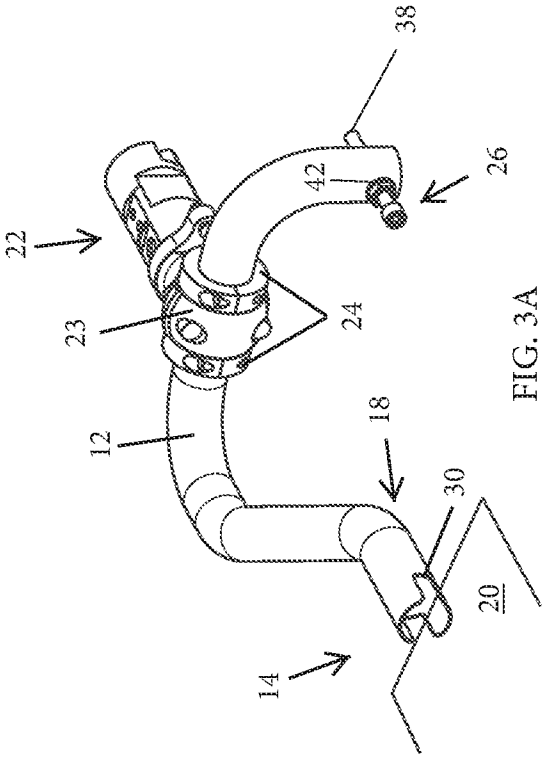

FIG. 3A

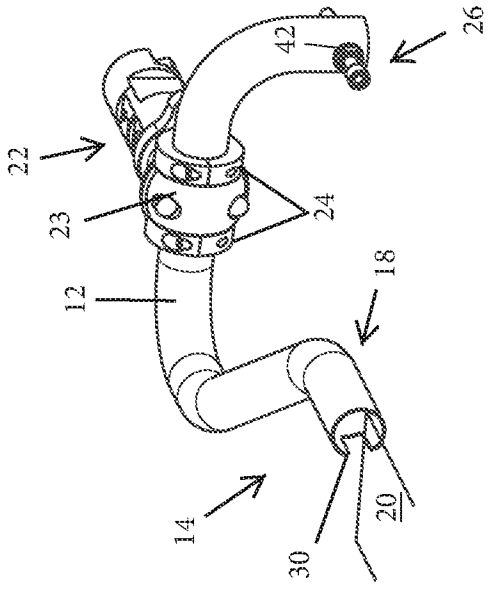

FIG. 3C

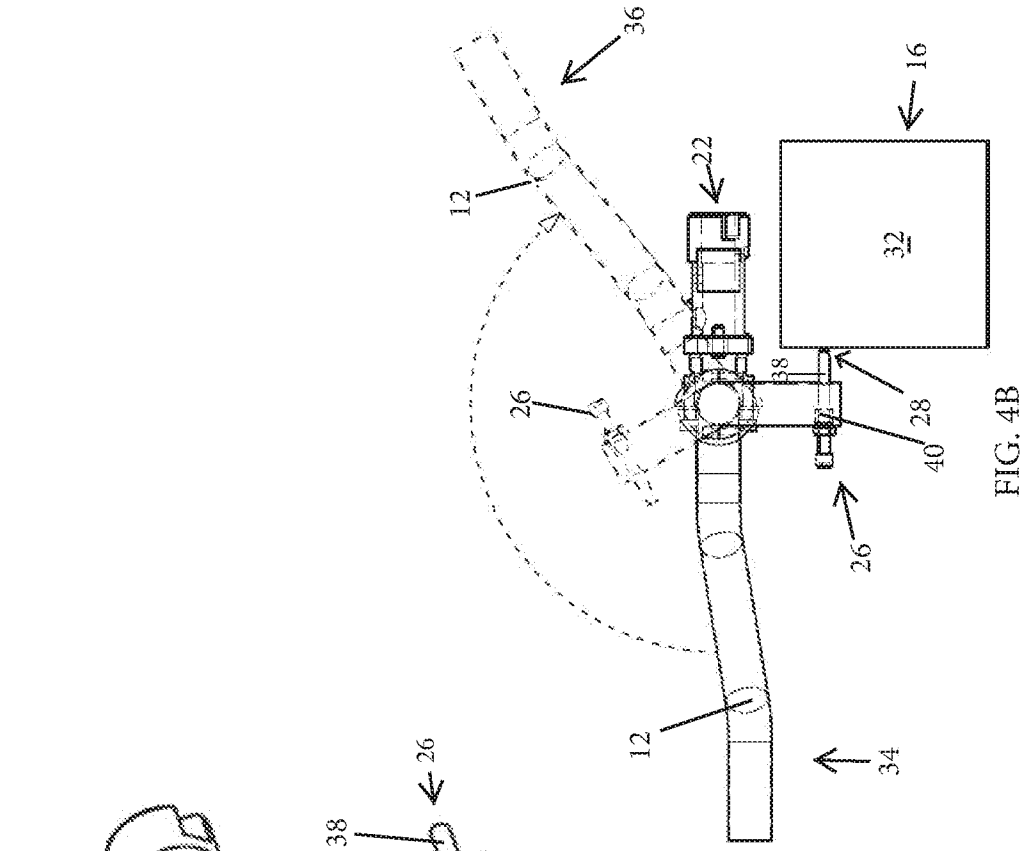
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FIG. 4B

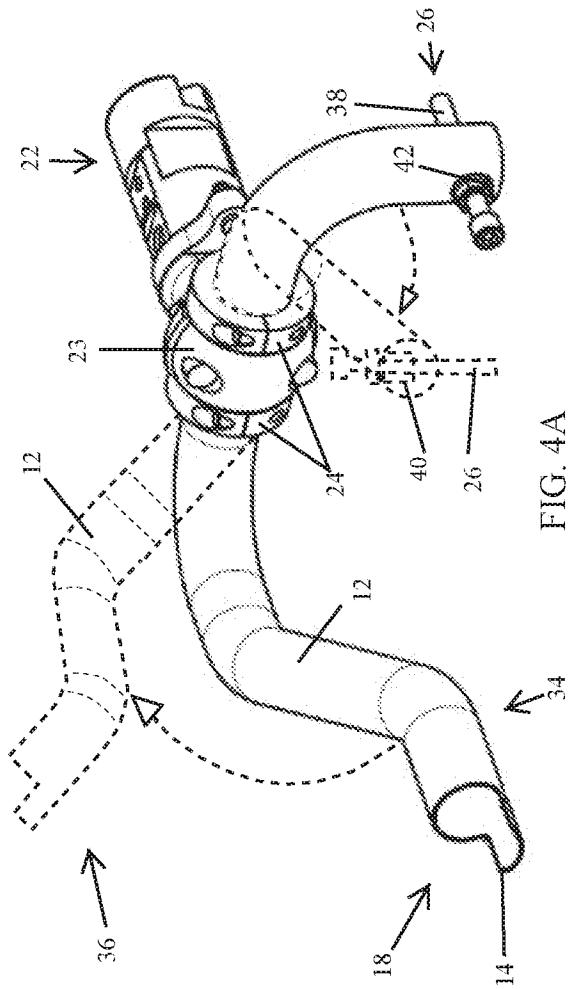
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FIG. 4A

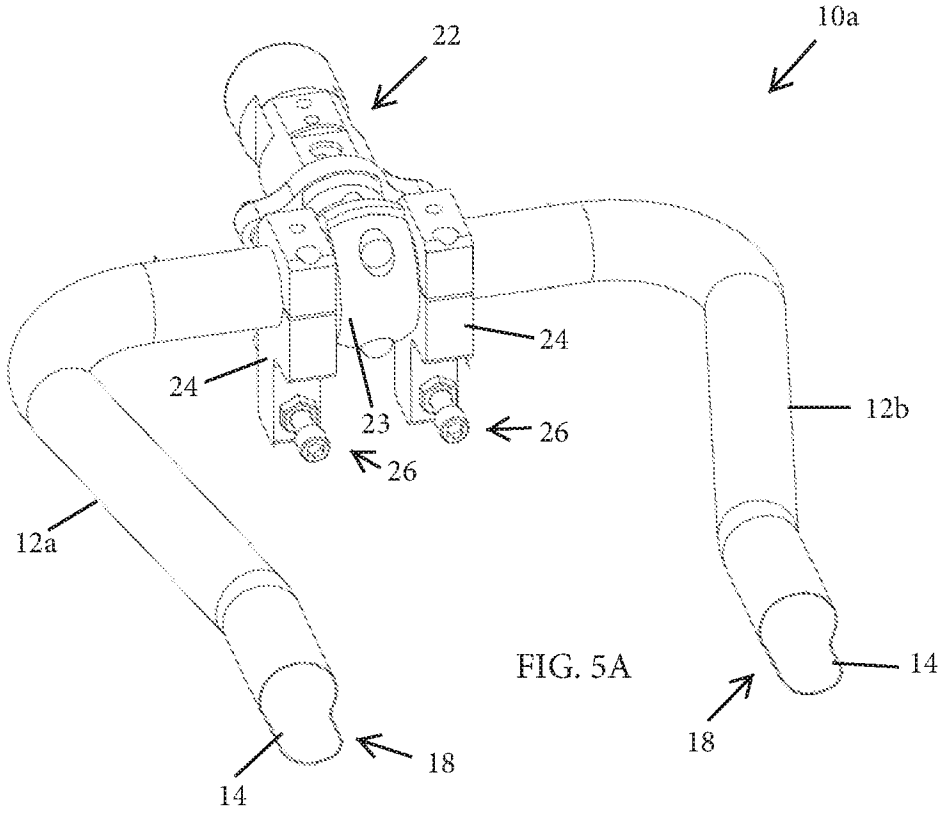

FIG. 5A

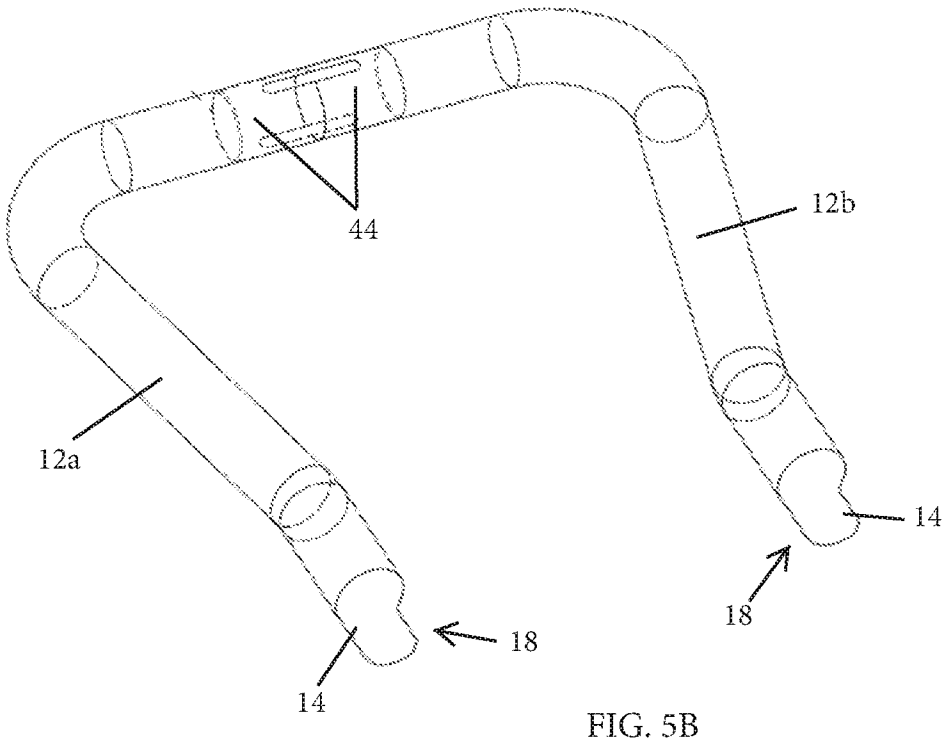

FIG. 5B

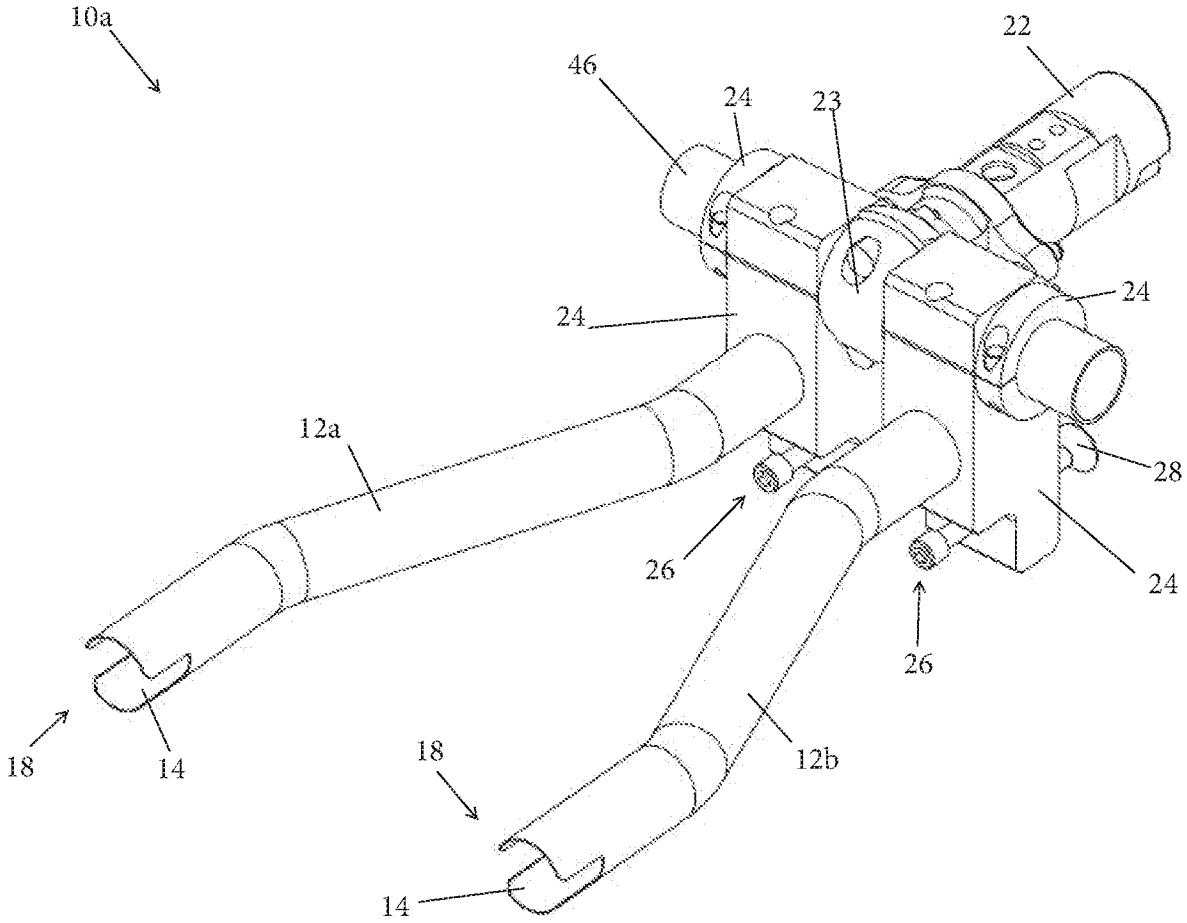

FIG. 6

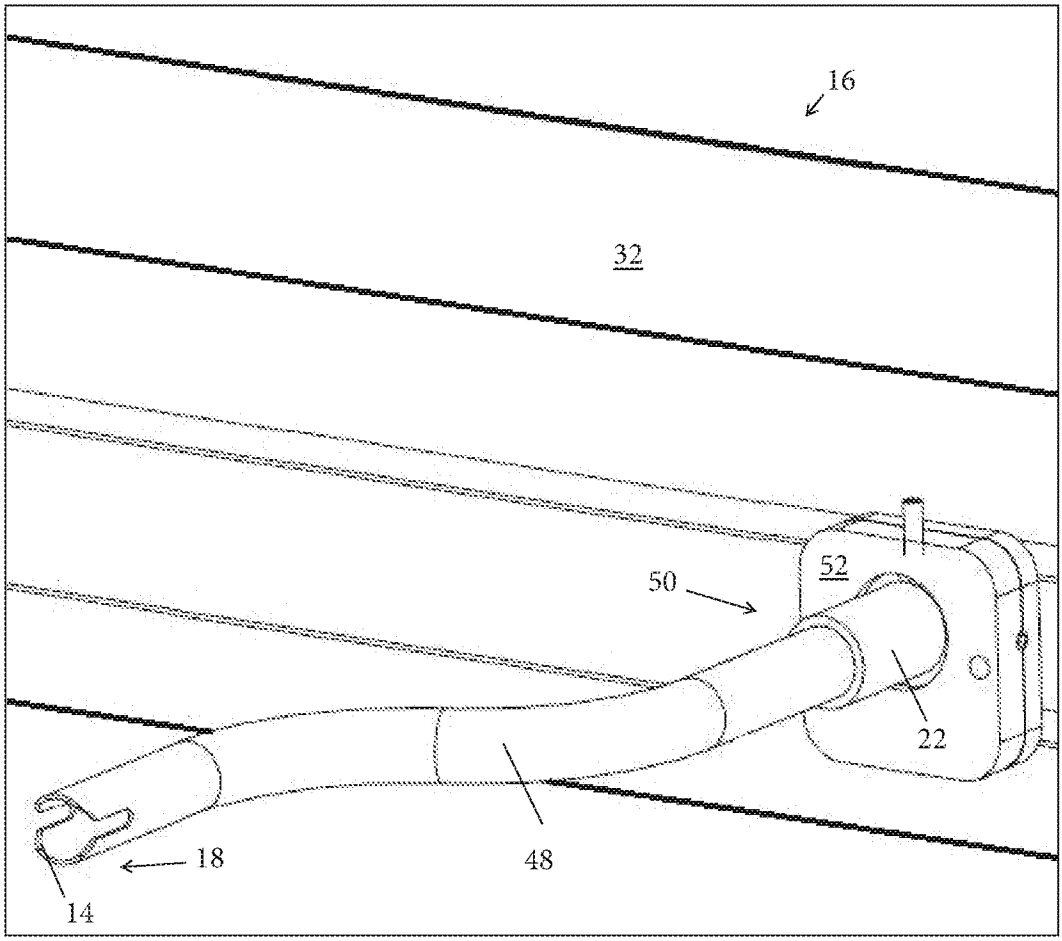

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 19/55051

A. CLASSIFICATION OF SUBJECT MATTER

IPC - B21D 37/04, B21D 37/14, B25J 11/00, B25J 13/00, B21D 28/04, B23Q 41/02 (2019.01)

CPC - B21D 37/04, B21D 37/14, B21D 5/02, B25J 11/00, B25J 13/00, Y10S 901/02, B21D 5/0281, B21D 28/04, B21D 43/00, B21D 43/26, B23D 33/10, B23Q 3/18, B21D 7/06, B21D 7/00, B21D 43/105, B21D 43/006, B23Q 41/02, B23Q 7/00, B25J 17/00, B25J 9/04, B66C 23/00, F16D 1/06, B25J 9/02, B66C 3/00

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)
See Search History document

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 6,116,845 A (Wright et al.) 12 September 2000 (12.09.2000), entire document, especially Fig. 1, 2, 3, 6, 9; col 2, ln 35-40; col 2, ln 56-63; col 2, ln 64 to col 3, ln 12; col 3, ln 13-26; col 3, ln 27-47; col 2, ln 41-48;	1-7, 9, 17-18 ---------- 8, 10-16, 19-20
Y	US 2014/0270909 A1 (UNIVER S.p.A.) 18 September 2014 (18.09.2014), entire document, especially Fig. 3; para[0002]; para[0040]; para[0039]; para[0037]; para[0038];	10-16, 19-20
Y	US 2006/0228205 A1 (Trachet et al.) 12 October 2006 (12.10.2006), entire document, especially Fig. 1; para[0016]; para[0018];	8
A	US 3,431,759 A (Kidera et al.) 11 March 1969 (11.03.1969), entire document	1-20
A	US 7,749,163 B2 (Mulac et al.) 06 July 2010 (06.07.2010), entire document	1-20
A	US 2001/0004431 A1 (Crorey et al.) 21 June 2001 (21.06.2001), entire document	1-20
A	WO 2004/103652 A2 (AMG SOC et al.) 02 December 2004 (02.12.2004), entire document	1-20
A	US 2012/0263519 A1 (Kotula et al.) 18 October 2012 (18.10.2012), entire document	1-20
A	US 2018/0003337 A1 (UNIVER S.P.A.) 04 January 2018 (04.01.2018), entire document	1-20
A	US 6,249,985 B1 (Piko et al.) 26 June 2001 (26.06.2001), entire document	1-20
A	US 4,775,135 A (Leibinger et al.) 04 October 1988 (04.10.1988), entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"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	Date of mailing of the international search report
12 November 2019	26 NOV 2019
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Lee Young Telephone No. PCT Helpdesk: 571-272-4300