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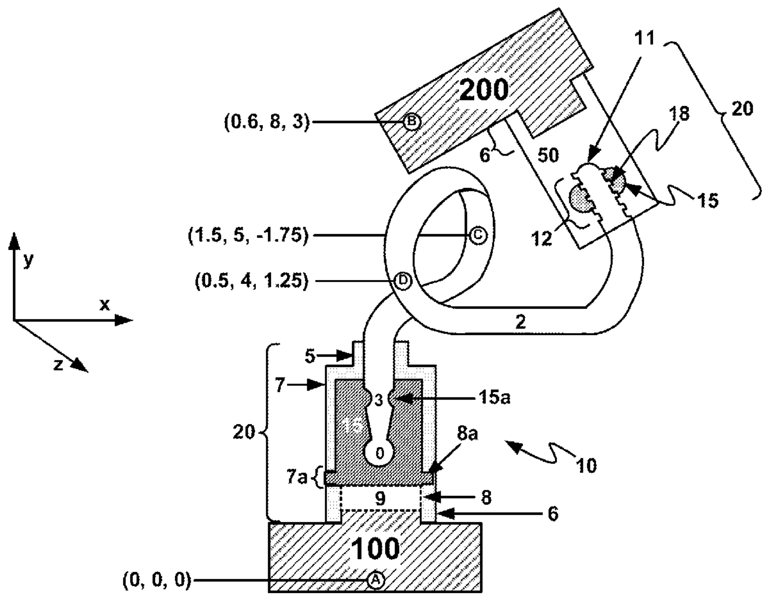
(54) Title: POSABLE TOY LINKAGE

FIG. 15



(57) Abstract: A linkage that couples a plurality of Lego blocks or Lego-like blocks is posable and configured to provide a plurality of three-dimensional orientations for the plurality of blocks it interconnects.

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POSABLE TOY LINKAGE

RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Patent Application Serial Number 14/474,276, filed on September 1, 2014 and claims the benefit of U.S. Provisional Patent Application Serial Number 62/211,822, filed August 30, 2015, priority to each of the aforementioned applications is hereby claimed and the disclosures of each of which are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0001] Disclosed are embodiments of the invention that relate to, among other things, building block linkage and joint systems and methods.

BACKGROUND

[0002] Linkages for toy building blocks, such as those made by LEGO®, Duplo®, Mega Bloks, Built to Rule, K'nex, Kre-O, and others, provide limited degrees of movement and positioning in the three dimensional plane for the blocks they connect. Flexible plastic cables, string, plastic rods, and plastic tubes have been used to connect building blocks, as illustrated and described in U.S. Patent Nos. 5,433,549, 5,733,168, 6,000,984, 6,213,839, 6,461,215, 6,676,474, 6,843,700, and PCT/DK1991/000373. Other prior art systems are Lego® Technic Sets 5118, 7471, 8002, 8074, 8412, 8437, 8440, 8444, 8445, 8457, 8479, 8482, 8483, 8485, 8828, 8836, 8839, 8856, and 9748.

[0003] As shown in **Fig. 1A**, an end P1 is connected to a bendable plastic rod P2 via neck P3. Front end P1, rod P2, and neck P3 are shaped to be received in a complementary slot P11-P13 of the receiver block P10. Thus, a plastic rod P2 with necks P3 and ends P1 disposed on either terminus of the rod P2 is used to tether blocks to which receiver block P10 may couple, provided the necks P3 and ends P1 are capable of receipt in the receiver block slots P11-P13. In an alternative arrangement shown by **Fig. 1B**, a receiver block P10 is comprised of a jaw P5, a mouth P6, and a tooth P7 that engages a recess/neck P3 in a plastic rod P2 received within block P10. In this arrangement, the prior art receiver block P10 relies on plastic-on-plastic coupling between tooth P7 and recess P3 to maintain rod P2 in the block P10, e.g., a crimping connection.

[0004] All of these linkage systems suffer disadvantages in terms of the reduction in strength from repeated use and/or exposure to heat, weakness when loaded in a direction perpendicular to their cross-section, and/or lack of ability to be bent in any number of conformations while also substantially maintaining a conformation in three-dimensional space, e.g., wilting or buckling in response to loads.

SUMMARY OF THE INVENTION

[0005] By having posability, a linkage may have an unlimited range of displacement in three-dimensional space and be able to hold its conformation in loaded and/or unloaded configurations. Such a linkage may serve as a universal joint for building blocks.

[0006] The posable linkage may be coupled to a building block using one or more of the following: the building block apertures themselves, a combination of the building block apertures and intermediary components within the building block, and/or a socket or adaptor disposed within the building block either alone or in combination with other features of the building block.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figures 1A-1B illustrate the prior art and have been previously described.

[0008] Figures 2 and 15 illustrate exemplary embodiments of exemplary inventive building block linkage systems.

[0009] Figures 3A-D, 4A-G, 5, 6A-B, 7A-C, 8-10, 11A-C, 12A-B, 13, 16A-D, 17A-D, and 18A-D illustrate other exemplary embodiments of blocks and linkages used in forms of an exemplary inventive building block systems and assembly methods.

[0010] Figures 14A-D illustrate other exemplary embodiments of adaptors for exemplary blocks and linkages used in other forms of an exemplary inventive building block systems and assembly methods.

[0011] In the drawings like characters of reference indicate corresponding parts in the different figures. The drawing figures, elements and other depictions should be understood as being interchangeable and may be combined in any like manner in accordance with the disclosures and objectives recited herein, and as disclosed in U.S. Patent Application Serial Number 14/474,276 and U.S. Provisional Patent Application Serial Number 62/211,822.

DETAILED DESCRIPTION

[0012] With respect to **Fig. 2**, an exemplary linkage 2 may be configured to fit within an opening 5 of a receiving exemplary building block 10 (hereinafter referred to as block or brick 10, which may be a Lego-like brick). An exemplary brick 10 may be made of plastic, rubber, or metal, but preferably PLA or ABS plastic. An exemplary brick 10 may be prismatic, cubic, spherical, conical, pyramidal, or any other form of polyhedron in shape. When assembled, the head 1 and tail 0 of an exemplary linkage 2 may be located within a cavity 9 of exemplary block 10. In an exemplary embodiment, head 1 of an exemplary linkage 2 need not enter the exit 6 of exemplary block 10. The opening 5 and exit 6 of an exemplary block 10 may also serve as adaptors for connecting exemplary block 10 to other building blocks. For example, in an exemplary Lego® block 10 opening 5 may be sized to fit within the exit 6 of another exemplary building block (not shown). Conversely, an exit 6 of an exemplary Lego® block 10 may be sized to fit about an opening 5 of another exemplary building block. According to these embodiments, the engagement between an exemplary linkage 2 and exemplary block 10 may be considered a joint 20.

[0013] In one embodiment, an exemplary linkage 2 is made of a metal and is flexible yet posable. An example of posability may be that an exemplary linkage 2 can be bent into any conformation, without any limit on degrees of freedom of movement, and substantially maintain that conformation in three-dimensional space. As another example of posability, an exemplary linkage 2 may be configured to dispose at least two blocks 10, which are adapted to receive an exemplary linkage 2, in different positions in three-dimensional space and substantially maintain those positions over time without the need for any other movable parts but the linkage 2. Accordingly, an exemplary linkage 2 may be the exclusive means of positioning exemplary building blocks which it interconnects. As such, an exemplary linkage 2 may allow exemplary building blocks to be translated, rotated, and/or held in positions with respect to one another in three-dimensional space. Further alternatively, an exemplary linkage 2 may couple a plurality of different block systems together, e.g., a Lego® block to a K'nex piece.

[0014] In another embodiment, an exemplary linkage 2 may have one or more of the following exemplary characteristics: (i) a wire-like shape; (ii) made out of one or more of the following and/or their combinations and/or galvanized variants: aluminum, copper, iron, or brass; (iii) dimensioned so that it can be received within an opening 5 and/or an exit 6 of an exemplary block 10; (iv) dimensioned so that it can be received within fabric, flexible plastic, or elastomer tubing (see **Figs. 16A-D**); (v) dimensioned so that its diameter is within the range of diameters between those of opening 5 and those of exit 6 of an exemplary block 10; (vi) a diameter of approximately 0.123 inches to approximately 0.193 inches; (vii) be approximately 5- to approximately 14-gauge wire; or (viii) be an armature wire. In an exemplary embodiment, an exemplary linkage 2 is about 0.12574 inches in diameter and is made from a flexible aluminum armature wire. While an exemplary linkage 2 may preferably be circular in cross-section, any number of cross-sections of an exemplary linkage 2 may be contemplated depending on the exemplary brick with which it couples.

[0015] For example, an exemplary linkage 2 may be configured so that it and/or its head 1 or tail 0 may friction-fit within an exemplary block 10 opening 5, exit 6, and/or other such aperture as described herein, provided the exemplary block 10 material creating the cross-section of such opening 5, exit 6, and/or other such aperture does not go beyond its modulus of resilience (e.g., the cross-section may be the same as or smaller than the cross-section of an exemplary linkage 2, head 1, and/or tail 0). Where multiple cross-sections are involved, an average cross-section may be used to determine the applicable modulus of resilience. An average cross-section of an exemplary linkage 2 may be the cross-section at one end of linkage 2 to the point on linkage 2 just before where the cross-section remains substantially un-changed along the length of linkage 2.

[0016] An exemplary linkage 2 may be included in and made out of any other material or combination of materials that results in properties equivalent to those achieved by structures with one or more of the foregoing characteristics and posabilities. For example, a metal wire may be included within an elastomer tube so that the combination of the two, which together form an exemplary linkage 2, may have the flexibility and posability of the underlying metal wire (for example the illustrative embodiments and related disclosures of **Figs. 16A-D** and **17A-D**). Those skilled in the material arts may be able to identify other materials of which a single exemplary linkage 2 can be made to achieve one or more of the foregoing requirements of the metal linkage 2 embodiments, such as, polymers and plastics, provided the final composition has posability.

[0017] An exemplary linkage 2 may have a plurality of orientations in three-dimensional space in which it may position blocks coupled thereto. In the illustrative embodiment of **Fig. 2**, any number of different points in three-dimensional space, identified by Cartesian coordinates (x, y, z), may be found about the length of a single exemplary linkage 2. For example, point “A” on an exemplary linkage 2 has exemplary coordinates (0, 0, 0), meaning that this portion of exemplary linkage 2 may serve as an origin position or point of comparison. Point “B”, which has coordinates (-1, 1, -1), may suggest that this part of linkage 2 is located in a plane behind and above Point “A” in three-dimensional space.

Point “C”, which has coordinates (1.5, -0.5, 1), may suggest that this part of an exemplary linkage 2 is in a plane ahead of and under point “A.” Thus, an exemplary linkage 2 may be configured so that the positioning of the blocks coupled thereto in the three-dimensional space is substantially maintained. Because of its flexibility, an exemplary linkage 2 may also be configured so that its parts have different positions in three-dimensional space as bricks are displaced from one position to another. Further orientation arrangements capable with an exemplary linkage 2 may also be understood with reference to **Figs. 11C**, **15**, **17B-D**, and their related, interrelated, and interchangeable disclosures.

[0018] With reference to **Figs. 3A-D**, head 1 may be considered the portion of an exemplary linkage 2 that may be used to join an exemplary linkage 2 to exemplary bricks 10, although tail 0 may have the same or similar purpose for the same or different bricks 10. Thus, head 1 has no restrictive beginning point, but may comprise one end of an exemplary linkage 2. Likewise, tail 0 has no restrictive beginning point, but may comprise the other end of an exemplary linkage 2 opposite head 1. An exemplary linkage 2 may be shown in **Fig. 3A** as having a head 1 comprised of a conical or spherical terminus 11 and one or more threads or windings 12. While shaped in this fashion, terminus 11 may be flat, concave, or any other surface. In another exemplary embodiment illustrated by **Figs. 3B** and **3C**, an exemplary linkage 2 may have a head 1 comprised of bumps or curved recesses 3 about the linkage’s circumference and/or perimeter. In yet another exemplary embodiment illustrated by **Fig. 3D**, an exemplary linkage 2 may have a head 1 comprised of one or more discs 3a separated by one or more recesses 3. Such contours may be made by 3D printing, laser machining, laser sintering, CNC machining, lathes, molding, extrusions, taps, and/or dies.

[0019] The illustrative embodiment of **Fig. 4A**, an exemplary linkage 2 may have a head 1 comprised of round surfaces 3. An exemplary linkage 2 in **Fig. 4A** may be received within exemplary brick 10 through opening 5. In this illustrative embodiment, exemplary brick 10 may be hollow inside so that it may have a cavity 9 with inner surface 8 and an outer surface 7. Disposed within cavity 9 of exemplary brick 10 may be an exemplary socket 15. An exemplary socket 15 may be such that it does not inhibit the use of opening 5 or exit 6 to allow exemplary brick 10 to combine with other building blocks.

[0020] As shown in **Fig. 4A**, an exemplary socket 15 may comprise a channel 16 into which an exemplary linkage 2 may be received. Channel 16 may be sized and shaped to complement head 1 of linkage 2 when received within an exemplary socket 15. Alternatively, channel 16 may be sized and shaped so that head 1 of linkage 2 friction-fits within an exemplary socket 15. For example, as shown in **Fig. 4B**, when inserted into exemplary brick 10 containing an exemplary socket 15, spherical surfaces 3 compress walls of cylindrical channel 16 while walls of channel 16 press against spherical surfaces 3. In this manner, channel 16 may be molded so that compression surfaces 15a hold or brace the head 1 of linkage 2 so as to maintain its reception in an exemplary socket 15 and thereby retention in exemplary brick 10. According to another exemplary embodiment, channel 16 may be sized and shaped for bracing an exemplary linkage 2 but allow passage of other exemplary building blocks known to those skilled in the art, e.g., as may be illustrated in **Figs. 5** and **14D**.

[0021] With reference to the illustrative embodiment of **Fig. 4C**, another exemplary socket 15 within exemplary brick 10 may have a contoured channel 16 having one or more grips 17 for gripping or bracing an exemplary linkage 2, which may have a head 1 comprising disks 3a and recesses 3. An exemplary contoured channel 16 may have the same characteristics, such as being complementary to the shape of head 1 or be slightly smaller to create a friction-fit by way of compression surfaces 15a, or channel 16 may not be complementary to linkage 2 and/or head 1 so as to create more gripping, hugging, and/or bracing surfaces within channel 16.

[0022] As illustrated in the exemplary embodiment depicted in **Fig. 4D**, an exemplary joint 20 may comprise an exemplary linkage 2 with a head 1 comprised of alternating discs 3a separated by recesses 3 braced by grips 17 in an exemplary socket 15. The elasticity of grips 17 may allow them to permit entry of head 1 of linkage 2 when inserted into the socket 15 while substantially resisting departure of head 1 from an exemplary socket 15 if linkage 2 experiences forces tending to displace it from an exemplary socket 15, e.g., tension forces. In an alternative embodiment illustrated with respect to **Figs. 4F** and **4G**, grips 17 may be modified to allow easier displacement from an exemplary socket 15 (e.g., sloped grips 17a) and/or discs 3a may be modified to allow head 1 of an exemplary linkage 2 to more easily displace from gripping socket (e.g., bowl discs 3b).

[0023] Further illustrated in the illustrative embodiment of **Fig. 4F** may be an exemplary socket 15 having wings 15a. Exemplary wings 15a may be configured to be received within an exemplary crevice 8a within exemplary brick 10. While wings 15a may be shown as single extensions from the circumference of a circular socket 15, they may also be shaped to spiral about the outer surface of an exemplary socket 15 so that when met with complementary spiral crevice 8a, such a socket 15 may be screwed into exemplary brick 10.

Accordingly, an exemplary interaction between crevice 8a and wings 15a may further increase the bracing capability of an exemplary socket 15 in an exemplary joint 20.

[0024] With respect to a through-hole crevice 8a, reception of an exemplary socket 15 within an exemplary brick 10 with such a through-hole 7a, such as may be illustrated with respect to **Fig. 4E**, may possess the added advantage of being released from exemplary brick 10 by inserting a pin or pencil point into through-hole 7a to depress wing 15 located in the through-hole crevice 8a. In so doing, an exemplary socket 15 may be released from cavity 9.

[0025] With reference to the illustrative embodiment of **Fig. 5**, an exemplary linkage 2 may be comprised of a head 1 for reception within a channel 16 as well as intermediary ribs 3c/3d extending from its own surface structures, which may be the same as or different from those on head 1 and proximal or distal to the same, for reception in a separate channel 16a of a separate socket 15 in a separate exemplary brick 10. A first exemplary brick 10_1 may be coupled to head 1 of an exemplary linkage 2 by way of an exemplary socket 15 such that linkage 2 does not pass from exemplary brick 10_1 opening 5 to exit 6 via channel 16. Grooves 3c and extensions 3d may also friction fit a second exemplary brick 10_2 by way of a second through-socket 15_1 whose through channel 16a allows full passage of an exemplary linkage 2 from opening 5 to exit 6 of the exemplary brick 10_2. Alternatively, one or more exemplary bricks 10_3 may comprise channels 16b that slidingly or frictionally engage the non-contoured surface of an exemplary linkage 2. Alternatively, exemplary bricks 10_3 may also slidingly or frictionally engage both contoured and non-contoured surfaces of an exemplary linkage 2. While exemplary brick 10_3 may be illustrated as a small exemplary brick, e.g., a 1x1 Lego® plate, exemplary brick 10_3 may be any size and shape with a channel 16b through its surfaces.

[0026] An exemplary multi-surface linkage 2 may be able to interact with numerous exemplary bricks 10_n (where *n* is any integer) to provide building points for other exemplary blocks, e.g., exemplary building blocks 100, on its posable surface. In other words, exemplary bricks 10_2 may be anchored by surface structures intermediary of linkage 2's head 1 and tail 0, e.g., exemplary block 10_3. While such exemplary bricks have been shown having a through socket 15_1 other forms of exemplary bricks 10_2 and 10_3, with and without an exemplary socket 15 that permit full passage of an exemplary linkage 2 there through, are also suitable. Thus, an exemplary linkage 2 may act as the foundation for building numerous block structures on its flexible surfaces and may serve as a universal scaffolding for exemplary building block assemblies 100.

[0027] With reference to the illustrative embodiments of **Figs. 6A-B**, an exemplary brick 10 may contain an exemplary socket 15 comprising a channel 16 having spiral threads 18 for complementary screw-threads 12 corresponding to head 1, tail 0, and/or terminus 11 of an exemplary screw linkage 2. As illustrated in these illustrative embodiments and may be used in others, an exemplary socket 15 may possess rounded surfaces 15c to reduce material usage and cost of fabrication. Alternatively, rounded surface 15c may take the form of a funnel-like structure adjacent an opening 5 or exit 6 to facilitate reception of an exemplary linkage 2 within the channel 16. An exemplary socket 15 may also be porous or sponge-like in material composition.

[0028] As illustrated in **Fig. 6B**, threads 18 may be complementary to such screw threads 12 to allow for a robust connection between screw linkage 2 and exemplary screw socket 15. Alternatively, an exemplary screw linkage 2 with threads 12 may be used with sockets 15 without threads 18 and rely on the modulus of resilience of an exemplary socket 15 to brace such screw linkage 2 threads. One advantage of using an exemplary screw socket 15 in the aforementioned embodiments may be to establish a greater amount of surface contacts between screw linkage 2 and its thread surfaces 12 and an exemplary socket 15. For an exemplary linkage 2 with a screw head 1 with threads 12 and a recess 3 distal of the threads 12, one may provide an exemplary socket 15 having a grip 17 proximal to the entry of the channel 16 and screw threads 18 distal from the entry so that the exemplary screw linkage 2 may both screw into an exemplary socket 15 and be restrained from movement by grip 17.

[0029] As illustrated in **Fig. 7A**, an exemplary brick 10 may be solid except for opening 5 in which a channel 16 with threaded wall 18 may be found and an exit 6 for receipt of an adjoining exemplary brick 10. Exemplary screw linkage 2 may then screw into exemplary brick 10 as shown in **Fig. 7B**. According to the illustrative embodiment of **Fig. 7B**, an exemplary screw linkage 2 may be received within screw channel 16 and screwed into threaded wall 18 using its threads 12 extending from the head 1 and/or tail 0 of screw linkage 2. For example, screw channel 16 may be located adjacent to threads 18 found on opening 5 and/or exit 6. In an exemplary embodiment, exemplary brick 10 with screw channel 16 may be capable of assembly to other bricks (not shown) using the geometries of opening 5 and exit 6 even though it may have a screw channel 16 embedded therein or threads 18 on the inside of opening 5 and/or exit 6. This is the same for the other embodiments having a screw channel 16 in a socket 15. Screw channel 16 may be made by boring out an exemplary brick 10 and using a tap and die to create the threads 18 of the channel for an exemplary screw linkage 2. Alternatively, a lathe may be utilized. Further alternatively, exemplary brick 10 containing a screw channel may be made using 3D printing technologies known to those skilled in the art. The extension of threads beyond screw channel 16 to opening 5 and/or exit 6 may be provided for in any of the other disclosed embodiments involving screw linkages 2.

[0030] Other exemplary screw bricks 10 may be illustrated by way of **Figs. 7C** and **Figs. 8-10**. In the illustrative embodiment of **Fig. 8**, an exemplary screw brick 10 may have a plurality of screw channels 16 of various sizes, threading, and orientations. As illustrated, exemplary screw brick 10 of **Fig. 8** may comprise one type of screw channel 16p and 16q, and another type of screw channel 16r in various sides of exemplary brick 10. While exemplary brick 10 may be illustrated as rectilinear, there is no requirement that exemplary brick 10 need be so. When an exemplary brick 10 may comprise one or more screw channel 16s about a spherical surface, such an exemplary brick 10 may allow for multiple screw linkages 2 disposed in various planes in three-dimensional space at one time, e.g., **Fig. 9**. An exemplary brick 10 may have one or more angled screw channels 16s/16t within its surfaces, including in corners or on other points of the exemplary brick 10 surface. In other exemplary embodiments, a plurality of screw channels 16 may be disposed on an exemplary brick 10 so that they are both oriented with respect to one another and exemplary brick 10 at non-orthogonal positions.

[0031] An illustrative exemplary hybrid block 50 may be composed using 3D printing or other formation methods known to those skilled in the art. As illustrated in **Fig. 10**, an exemplary hybrid building block 50 may comprise an exemplary socket 15 located in a cavity 9 between a screw channel 18 and opening 5. Accordingly, such an exemplary hybrid block 50 may allow an exemplary screw linkage 2 having threads 12 and recesses 3 about its length to have a plurality of coupling regions within exemplary block 50. In the illustrative embodiment of **Fig. 10**, an exemplary linkage 2 may screw into exemplary block 50 while also being gripped by grips 17 of an exemplary socket 15. As illustrated, an exemplary socket 15 may act as a diaphragm or friction washer for an exemplary building block system joint 20. Any variety and order of linkage recesses 3, threads 12, and surfaces 3a-g, as described elsewhere, may be used up and down an exemplary linkage 2. As such, exemplary hybrid block 50 may have numerous sockets 15 and receiving cavities 9, with and without contours, e.g., threads 18, and in any order to accommodate a particular exemplary linkage 2 and/or add to retention of such linkage 2.

[0032] With reference to the illustrative embodiments of **Figs. 11A-C**, an exemplary clamshell-type brick 30 (hereinafter referred to as "brick 30") may comprise a plurality of exemplary brick portions, for example, 10a and10b, with inner surfaces 8a and 8b, respectively, coupled via flexible portion 31. According to other illustrative embodiments, flexible portion 31 may be configured to allow exemplary brick 30 to open and close like a clam shell so that, when closed, substantially no gaps exist in one or more of outer surface 7, inner surfaces 8a and 8b, opening 5, or exit 6. An exemplary clam brick 30 may contain a groove 34 in outer surface 7 of its halves 10a/b for receiving a brace 35 therein. As illustrated in **Fig. 11C**, a brace 35, which may preferably be made of an elastomer, such as rubber, is shown as being wrapped tightly about exemplary brick 30 while an exemplary linkage 2 is free to move outside of exemplary brick 30.

[0033] As another exemplary embodiment of the posability and universal orientation of an exemplary linkage 2 may be further illustrated in **Fig. 11C**. As illustrated in **Fig. 11C**, an exemplary linkage 2 may exit an exemplary brick 30 at point "A." An exemplary linkage 2 may be undulated at point "B" so that it enters point (0.5, 0.5, -0.5), which means that as this part of linkage 2 ascends and proceeds to the right, it also goes behind point "A." Point "C," at coordinates (1, 2, -0.75), illustrates that an exemplary linkage 2 may be further bent behind point "B" while gravitating upwardly and further ahead of point "A" in the horizontal plane. Further illustrating the universal positioning of an exemplary linkage 2, point "D" located at the terminus 11 of tail 0 (which is shown with spiraling threads 12 thereon) may have coordinates (-2, 4, 1) thereby showing that the tail 0 of an exemplary linkage 2 may be bent behind its origin point and brought forward of the origin, even though it began with bending behind the origin (as in points "B" and "C"). As described, an exemplary linkage 2 would be configured to maintain bricks coupled to either of its ends in this configuration in three-dimensional space. Alternatively, an exemplary linkage 2, by virtue of its flexibility, may be configured to change these illustrated coordinates when displacing bricks coupled to its ends.

[0034] With reference to **Figs. 12A-B** and **Fig. 13**, an exemplary porous brick 60 may be one possessing multiple cavities/apertures in its construction. With respect to the exemplary porous brick 60 illustrated in **Fig. 12A**, such exemplary brick 60 may have one or more openings 5 extending from its outer surface 7, a first cavity 9 leading to one or more exits 6 and additional cavities 9a, and one or more inner surfaces 8 which may have one or more crevices 8a. In an exemplary embodiment, exemplary porous brick 60 may be an Erling Lego-like brick.

[0035] In another embodiment in accordance with the illustrative features of **Fig. 12B**, an exemplary porous brick 60 may receive within its inner surface 8 an exemplary socket 15 adapted to fit within one of its cavities 9 so as to close off exit 6. An exemplary socket 15 may have one or more wings 15a configured to be received within a crevice 8a in one of the cavities 9 of exemplary porous brick 60. An exemplary fitting of an exemplary socket 15 within exemplary porous brick 60 may provide a channel 16 through opening 5 for reception of an exemplary linkage 2 therein. An exemplary channel 16 may be a contoured channel 16 which may contain one or more grips 17. While a contoured channel 16 may be shown, any other channels 16 (e.g., screw channels) may be contemplated as well as contoured openings 5 and/or exits 6 of such exemplary bricks 60 as per other embodiments.

[0036] With reference to **Fig. 13**, an exemplary porous brick 60 alone or in combination with an exemplary socket 15 may be connected to an exemplary brick assembly 100 in which its cavity 9 where an exemplary linkage 2 may be received is closed off by surrounding exemplary bricks in the exemplary brick assembly 100. Exemplary brick assembly 100 may be comprised of one or more bricks compatible with exemplary porous brick 60 and receptive to its attachment and/or connection. As shown in the illustrative embodiment of **Fig. 13**, an exemplary linkage 2 may be received through opening 5 of exemplary porous brick 60, which houses an exemplary socket 15 within its cavity 9, and is juxtaposed by exemplary brick assembly 100 such that an exemplary socket 15 is substantially confined within exemplary porous brick 60.

[0037] In the illustrative embodiments of **Figs. 14A**, **14B**, **14C** and **14D**, yet other mechanisms of linkage systems may be disclosed. For example, **Fig. 14A** shows an exemplary brick 70 with a passage 5/6 through its thickness for reception of parts much larger in diameter than exemplary linkage 2. Such exemplary bricks 70 may be found in Lego® Technic sets or other non-Lego® building block systems, e.g., K’nex. Exemplary bricks 70 may have surface contours 7a, e.g., an indentation in surface 7, that surround or are adjacent to their passages 5/6.

[0038] As illustrated in **Fig. 14B**, an exemplary linkage 2 with a tail 0 may be placed within the cavity 9 of the exemplary brick 70 connected by passage 5/6. An adaptor socket 19 may possess an exemplary channel 16 configured as other disclosed channels of sockets

15. An exemplary adaptor socket 19 may possess one or more anchors 19a substantially complementary to surface contours 7a of exemplary brick 70. Exemplary anchors 19a may take the form of lips, rims, or pegs, but may be any other structures that may serve to hold adaptor socket 19 within exemplary brick 70, either on surface contours 7a of exemplary brick 70 or crevices 8a in exemplary brick 70 (see **Fig. 14C**). Exemplary surface contours 7a and crevices 8a may be utilized within exemplary brick 70 to allow for friction fitting of adaptor socket 19 within the exemplary brick 70 cavity 9.

[0039] In an exemplary adapted brick 70 system illustrated by **Fig. 14C**, an exemplary linkage 2 may have its tail 0 within channel 16 of adaptor socket 19. One or more crevices 8a within cavity 9 of exemplary brick 70 may receive one or more adaptor surface contours 19b. Adaptor socket 19 may have a solid portion that resists further displacement of an exemplary linkage 2 into channel 16. Alternatively, channel 16 of adaptor socket 19 may allow for complete passage of an exemplary linkage 2 there through, as illustrated by **Fig. 14D**.

[0040] An example of an exemplary linkage 2 posability may be illustrated in **Fig. 15**. According to this illustrative embodiment, **Fig. 15** may show the positioning of exemplary blocks 10 and 50 in three-dimensional space. As shown by the coordinates of points “A” and “B” of exemplary blocks 10 and 50, respectively, an exemplary linkage 2 may position the exemplary blocks and their adjoining assemblies 100 and 200, respectively, in different positions in three-dimensional space. These exemplary blocks may be further moved with respect to one another by virtue of the flexibility of an exemplary linkage 2. Exemplary linkage 2 may be disposed in various parts of three-dimensional space, as may be illustrated by **Fig. 15**, with reference to the coordinates of points “C” and “D” on sections of an exemplary linkage 2. According to this illustrative embodiment, the posability of an exemplary linkage 2 may substantially maintain the parts of an exemplary linkage 2 in their illustrated conformation, e.g., coordinates “C” and “D.” Further, the posability of an exemplary linkage 2 may substantially maintain exemplary blocks 10 and 50 (or other exemplary blocks 30/40/60/70) and their respective adjoining assemblies 100 and 200, respectively, at their coordinates “A” and “B,” respectively, over a span of time.

[0041] Those skilled in the art may understand various other methods and ways to secure an exemplary linkage 2 to an exemplary brick 10/30/40/50/60/70 using other techniques. Exemplary bricks 10/30/40/50/60/70 that may open or “lock” an exemplary head 1 of an exemplary linkage 2 may take various forms and variations, depending on the needs of the construction. They may involve exemplary bricks 10/30/40/50/60/70 with doors, clasps, or other moveable parts that allow an exemplary head 1 of an exemplary linkage 2 to enter and then resist exiting the exemplary brick 10/30/40/50/60/70. For all exemplary embodiments, whether illustrated, described, or understood from combination from the disclosures herein, exemplary bricks 10/30/40/50/60/70, brace 35, and/or sockets 15/19 may be printed using 3D printers known to those skilled in the art, and disclosed in U.S. Patent Application No. 14/474,276. In an exemplary embodiment, an exemplary socket 15 may be 3D printed within exemplary brick 10 while exemplary brick 10 is being formed. Alternatively, exemplary brick 10 may be 3D printed and socket 15 may be simultaneously 3D printed within exemplary brick 10 (e.g., an exemplary hybrid brick 50). 3D printing fabrication of an exemplary brick 10 and socket 15 subsystem may be particularly suited for mass production of such constructs and reduce the need for physical assembly of the two structures post-fabrication.

[0042] In an exemplary embodiment, an exemplary posable linkage 2 may be fabricated to comply with the June 2010 United States Consumer Product Safety Commission Laboratory Test Manual for Toy Testing, which is incorporated herein by reference in its entirety. In one embodiment, exemplary posable linkage 2 will satisfy one or more of subsections of section 9.2 and all of section 18, in particular, section 9.2.4 Sharp Point Test, 9.2.5 Sharp Edge Test, and 9.3.6 Flexure Test of the June 2010 United States Consumer Product Safety Commission Laboratory Test Manual for Toy Testing.

[0043] As further illustrated in the exemplary embodiments of **Figs. 16A-D**, an exemplary linkage 2 may contain a component 2A of diameter D_M and a coating or cover 2B of thickness T_C. The cover or coating 2B may be one or more of the covers, coatings, and/or tubings described herein and may be removable or permanently attached to component 2A. Component 2A may be made of a flexible metal. Alternatively, component 2A may be made of any other material or combination of materials that in conjunction with coating 2B has posability. An exemplar linkage 2 comprised of component 2A and coating 2B may have a diameter D, although an exemplary linkage 2 without a coating 2B may have the same or similar diameter D.

[0044] An exemplary coating 2B may be an elastomer selected from the group comprising poly-isoprenes (e.g., rubber, natural rubber), polyethylenes, polystyrenes, polyurethane, buna-N, butyl, SBR, neoprene, silicone, polybutadiene, and other flexible elastomers known to those skilled in the art. Preferably, an exemplary elastomer may be colored to match one or more exemplary bricks 10/30-70 to which an exemplary posable linkage 2 may couple and/or interconnect. Additionally, coating 2B may have structures formed on it to allow connection between the outer-most surface of linkage 2 and other Lego-like bricks. Those skilled in the art would understand the use of plasticizers to improve flexibility and ductility of an exemplary coating 2B.

[0045] In an exemplary embodiment, an exemplary linkage 2 may be particularly dimensioned to friction-fit within the circular opening 5 used on Erling Lego blocks 60, and others with such opening (block 10/30/40/50/70), and still be maneuvered and posed in three-dimensional space while substantially maintaining their conformation, e.g., have posability. According to such an exemplary embodiment, an exemplary linkage 2 may have a D_M of about 0.0625 inches and a T_C of about 0.03125 inches. In another exemplary embodiment, an exemplary linkage 2 may have sufficient size to friction-fit within the cylindrical opening 5 used in Lego® Technic block systems and/or Lego® Erling blocks, and still be maneuvered and posed in three-dimensional space while substantially maintaining their conformation, e.g., have posability. According to such an exemplary embodiment, an exemplary linkage 2 may have a D_M of about 0.0125 inches and a T_C of about 0.00074 inches. In yet another exemplary embodiment, as may be further discussed with respect to **Fig. 16D**, an exemplary linkage 2 may have a coating 2B with a T_C that is of such size and elasticity so as to deflect when entering an opening 5 and/or 6 of an exemplary building block, such as block 10/30-70, and yet exert a force against the inner surfaces 8 of the opening 5/6 of that block that is no greater than the modulus of resilience of the structure making up the opening 5 and/or 6 of the block 10/30-70, see **Fig. 16D**. In one exemplary embodiment as illustrated by **Fig. 16A**, a posable linkage 2 with a D of approximately 0.1257 inches may have a 907A or 907C aluminum armature wire component 2A having a D_M of approximately 0.06285 inch and which may be coated with an elastomer 2B substantially about its length having a T_C of approximately 0.031925 inches. More particularly, such an elastomer 2B may be a type of rubber.

[0046] In a first embodiment, $2*T_C + D_M$ may be the diameter of an exemplary opening 5/6 in a Lego-like block. In a second embodiment, $2*T_C + D_M$ is slightly greater than the diameter of an exemplary opening 5/6 in a Lego-like block. In a third embodiment, $2*T_C + D_M$ is equal to the diameter of the cylindrical opening 5 in an Erling Lego block 60. In a fifth embodiment, $2*T_C + D_M$ is equal to or slightly greater than the diameter of the circular opening 5 in an Erling Lego block 60. Where $2*T_C + D_M$ is greater than the diameter of the aperture into which linkage 2 head 1 or tail 0 is inserted, an exemplary linkage 2 with such T_C and D_M may utilize its elastomeric qualities or take advantage of the modulus of resilience of the exemplary block opening 5/6. An elastomeric coating 2B may be utilized due to its ability to deform in response to contact forces and thereby allow a user to insert a linkage 2 comprising a component 2A with such a coating into a Lego-like block opening while maintaining friction-like contact, reduced wear on the block opening, non-contact with metal, and/or minimal manufacturing costs. Further and alternatively, an elastomeric coating 2B may allow linkage 2 to have a D greater than the diameter of block opening 5 and/or 6 because such a coating 2B can deform while being inserted into the same.

[0047] According to an exemplary embodiment as illustrated in **Fig. 16B**, an exemplary linkage 2 may comprise a component 2A of length L_M and a coating 2B of length L_C. In an exemplary embodiment, L_C is about the same length as an exemplary metal component 2A. In another exemplary embodiment, L_C is between about 85-95% of the length of metal component 2A so that the coating covers all but a length of the ends of the metal component 2A that are sufficient to couple the linkage 2 of this exemplary embodiment in an exemplary block 10/30-70, e.g., L_T. In yet another exemplary embodiment, L_C is whatever length necessary to leave about 0.090-0.150 inches of the end of a metal component 2A exposed on either side or both sides of linkage 2, e.g., an $L_T = 0.090\text{-}0.150$. In another exemplary embodiment, coating 2B may envelop metal component 2A on all sides, as may be shown in **Fig. 16C** by an exemplary face coating 2C. In another exemplary embodiment, where a Lego brick 10/50/60/70 is used for receiving an exemplary linkage 2 of length L_C, the length L_C may be no greater than about 110-115% the length of L_M so that the linkage does not interfere with other structures trying to fit within Lego brick 10 (e.g., other Lego bricks 10, other exemplary linkages 2). In an exemplary embodiment where L_T is the length of component 2A on which contours 3a-e, and 3g may be found, such contours 3a-d, and 3g may be disposed such that enough contours 3a-e, and 3g can frictionally engage opening 5/6 of an exemplary block 10/30-70 or the exemplary opening 16 of an exemplary socket 15. L_C may be a function of L_M, T_C, D_M, D, L_T, and combinations thereof. In this context, "function of" refers to any known mathematical operation or series of operations involving one or more of L_M, T_C, D_M, D, L_T, and operations involving the same.

[0048] In an exemplary embodiment all lengths L_M and L_C may be based on the number of studs and/or Lego Drawing Units ("LDU") of exemplary Lego blocks 10, e.g., two stud lengths, three stud lengths, four stud lengths, etc., as would be understood by a person of ordinary skill in the art. In an exemplary embodiment, length L_C and/or L_M may be between about 4 and about 8 LDU in length as measured from the forward-most end of the linkage 2. In this exemplary embodiment, length L_C and/or L_M may avoid interference between linkage 2 and other structures traveling through an exemplary block 10. In yet another exemplary embodiment, length L_C and/or L_M may be between about 2 and about 16 LDUs in length as measured from the forward-most end of an exemplary linkage 2, e.g., section 2C/D or the head/tail 1/0 made up of only component 2A. In still other exemplary embodiments, length L_C and/or L_M may have the same LDU lengths as the smallest and/or longest Lego blocks known to those skilled in the art. L_T may be a length of metal component 2A sufficient to allow for a UNF Fine Thread #0, 7 threads, 0.010 inch chamfer and a 0.0125 inch thread relief zone between coating 2B and the most proximal thread 12.

[0049] In an alternative embodiment, as illustrated by **Fig. 16B**, an exemplary posable linkage 2 may comprise a component 2A of length L_M with contoured ends 3a-d/g and/or thread ends 12 and terminus 11 opposite head/tail 1/0. In this illustrative embodiment, a coating 2B may substantially cover a metal component 2A over a distance L_C and leave exposed a length L_T for contouring 3 or threading 12. Where L_M is a length of component 2A with threading, the types of thread ends 12 and lengths (L_M, L_C, and L_T) that may be used for an exemplary linkage 2 may be shown in Table 1 (the value of L_T and the threading type/number of threads may correspond to one or more of the length and/or threading of channel 16, 16a-b and channel threads 18 of an exemplary brick or block 10/30-70 and/or the length and threading of channels and threads in socket 15/15$_1$, including the spacing and length of use of socket structures 15a, 17, and/or 17a):

[0050] **TABLE 1**

Exemplary Illustrative Embodiments	L_M	L_C	L_T	Threading Type/number of threads
I	0.625 inches	0.400 inches	0.100 inches	UNF #0
II	1.250 inches	1.000 inches	0.100 inches	UNF #0
III	2.500 inches	2.200 inches	0.100 inches	UNF #0
IV	1.000 inches	0.700 inches	0.150 inches	8 threads
V	4.000 inches	3.750 inches	0.120 inches	7 threads
VI	8.000 inches	6.000 inches	0.550 inches	12 threads
VII	1.250 inches	0.700 inches	0.250 inches	10 threads

VIII	0.500 inches	0.300 inches	0.100 inches	6 threads
IX	3.000 inches	2.500 inches	0.250 inches	UNF #0
X	2/3 inches	1/3 inches	1/6 inches	UNF #0

[0051] In the illustrative exemplary embodiments of **Figs. 16B-C**, an exemplary linkage 2 may have threaded sections 12 that are further from the axis of the linkage 2, e.g., they are located outside the diameter of component 2A, with or without coating 2B. While threaded sections 12 may be illustrated in **Fig. 16B**, contoured sections 3a-e/g may also be used in place, or used as per the illustrative embodiment of **Fig. 16C**, such that one or more of their individual heights or the average height of all such contours, extend beyond the non-threaded/non-contoured diameter of component 2A, D_{MnT}. In an exemplary embodiment, a threaded section 12 may have a height H_T that makes the threaded section 12 have the same or slightly larger D compared to the central cross-section of linkage 2 (e.g., linkage 2 with and without coating 2B). In an exemplary embodiment, the height of threaded section 12, H_T, may be about 0.0625 inches from an axis running perpendicular to the cross-section of linkage 2. In an exemplary embodiment, threaded sections 12 may result from thread rolling or other such cold rolling machining processes as are known to those skilled in the art. In an exemplary embodiment, the ratio of ($H_T + D_{MnT}$) to D is between about 0.80 to about 1.64. In an alternative exemplary embodiment, the ratio of H_T to D_{MnT} is between about 0.05 to about 0.20. Where an exemplary linkage 2 has a plurality of contours 3a-e/g, D_{MnT} may be calculated by taking the average cross-section as previously described, and H_T may be calculated by taking the average of the peaks and troughs of each of the plurality of contours 3a-e/g as compared to the D_{MnT}, where all peaks and troughs above D_{MnT} to have positive values and all peaks and troughs below D_{MnT} to have negative values.

[0052] In the illustrative exemplary embodiment of **Fig. 16C**, an exemplary linkage 2 of diameter D may have a coating 2B over substantially its entire length L_M so that L_C may represent the operative length of linkage 2. Those skilled in the art may appreciate that **Fig. 16C** may illustrate embodiments of an exemplary linkage 2 having a metal component 2A covered in a flexible tube 2B. Alternatively, **Fig. 16C** may illustrate various surface features of an exemplary linkage 2, but it should be understood any of the illustrated features may be found in isolation of other features or over different distances, depths, and have different shapes, angles, dimensions, configurations, and properties. For example, an exemplary linkage 2 may have a coating 2B, wherein the coating 2B may have threads 12 at both head 1 and tail 0 of the linkage 2. Alternatively, coating 2B of an exemplary linkage 2 may have only contours 3a-e/g and no threads along its length L_C. Any of the surface geometries illustrated by and/or described with respect to **Fig. 16C** may apply equally to exemplary linkage coatings, such as coating 2B, of any other figures, including, but not limited to, **Figs. 3A-D, 16A-B, 5, 11C,** and **15**.

[0053] As further illustrated by **Fig. 16C**, an exemplary component 2A may have a major diameter D_M and a minor diameter D_m. For an exemplary component 2A with a minor diameter D_m, D_m may be dimensioned to engage one or more internal contours 3f of coating/tube 2B. An exemplary contour 3f may allow for better adherence of coating/tube 2B to component 2A, may allow for greater resistance to tearing, wearing, disengagement with, or over-stretching of coating/tube 2B, e.g., in response to flexing or movement of component 2A. As further illustrated in **Fig. 16C**, coating contours 3e may be among any of the coatings 3a-d/f/g/h described herein, including combinations and patterns of the same.

[0054] As further illustrated in **Fig. 16C**, an exemplary face coating 2C may be at the head 1 and/or tail 0 of an exemplary linkage 2. An exemplary face coating 2C may have the same or lesser friction than coating/tube 2B. An exemplary face coating 2C/2D may provide a soft zone or flexible buffer region for an exemplary metal component 2A to allow such a linkage 2 to satisfy any of the tests found in section 18 of the June 2010 United States Consumer Product Safety Commission Laboratory Test Manual for Toy Testing, in particular all subsections of section 9.2 and 18, in particular, section 9.2.4 Sharp Point Test, 9.2.5 Sharp Edge Test, and 9.3.6 Flexure Test. While a face coating 2C/2D may be used to satisfy the aforementioned tests, as disclosed herein, an entirely metal linkage 2 or a linkage 2 comprising flexible coatings substantially along its length but with exposed metal faces and/or ends may also be configured to satisfy such tests. In an exemplary embodiment, face coating 2C/2D may have a maximum amount of material at a height of 0.5D and/or $0.5D_M$. In another exemplary embodiment, face coating 2C/2D may have one or more peaks, valleys, and/or protrusions of various cross sections, e.g., circular, rectilinear.

[0055] In one embodiment, coating 2B may have a thickness T_{C1} measured from an outside contour 3a-e/g and/or thread 12 to an inside contour 3f. In another embodiment, coating 2B may have a thickness T_{C2} measured from a non-contoured surface of the coating 2B to the most radially proximal surface of component 2A. In this embodiment, an area of surface of coating 2B may be considered “non-contoured” if the surfaces within the square area maintain the same perpendicular distance from the axis of component 2A. In another embodiment, coating 2B may have a thickness T_{C3} measured from a contoured surface 3e of coating 2B to the most-radially proximal surface of component 2A. In another embodiment, coating 2B may have a face coating 2C of thickness T_{C4} measured from the outer surface of face coating 2C to the closest surface of component 2A. In yet another embodiment, coating 2B may have a face coating 2D of thickness T_{C5} measured from the furthest end of linkage 2 to the furthest end of component 2A.

[0056] In an exemplary embodiment, T_{C1}, T_{C2}, and T_{C3} are substantially equal. In another exemplary embodiment, one or more of T_{C1}, T_{C12}, or T_{C3} is no greater than about 0.01 inches to about 0.05 inches, such as, for example, 0.031925 inches. In yet another exemplary embodiment, T_{C2} is always less than T_{C1}. Alternatively, in another exemplary embodiment, T_{C3} is substantially equal to T_{C1}. In yet another exemplary embodiment, T_{C3} may be any of the values for exemplary threads 12 in Table 1. In another exemplary embodiment, T_{C4} is substantially equal to T_{C5}. Alternatively, T_{C4} may be greater than, less than, a fraction of, or a multiple of T_{C5}. In another exemplary embodiment, L_C does not necessarily equal $L_M + T_{C4}$. In such an exemplary embodiment, coating 2B may have a coating surface located at $L_M - T_{C4}$, in particular, when the ends of component 2A have their own contours 3f at their axial extrema.

[0057] According to the exemplary embodiment of **Fig. 16D**, flexible coating 2B has a first height X_1, which may be the radial height from the center of linkage 2, the thickness T_C, or other measurement with a defined reference point. As coupled via opening 5, an exemplary linkage 2 may have a junction contour 3h formed in its coating 2B and which may be at a height X_2. X_2 may be slightly less than the height X_1 of coating 2B. The portion of linkage 2 that may be coupled within an exemplary block 10/30-70 may have a coating 2B that is at a height X_3, which is at least less than the height X_1, and may, in certain embodiments, be less than the height X_2. In an exemplary embodiment the ratio X_2/X_1 may be between about 0.925 and about 0.999. In another exemplary embodiment the ratio X_3/X_1 may be between about 0.8725 and about 0.9999. In an exemplary embodiment, X_3/X_1 may be between about 0.95 and about 0.90 for both a resilient and flexible coating 2B that may exert friction forces on the inside of opening 5 of an exemplary block 10/30-70.

[0058] According to the illustrative embodiment of **Fig. 16D**, the portion of an exemplary head/tail 1/0 of an exemplary linkage 2 that contacts the opening 5 of block 10/30-

70 may be a length L_K. In an exemplary embodiment L_K may be less than the depth of opening 5 of block 10 measured from the outermost edge of opening 5 to cavity 8 of an exemplary block 10, e.g., ¼ of the depth, ½ of the depth, or ¾ of the depth. Alternatively, L_K may be such that a free length of an exemplary linkage 2 within an exemplary block 10, denoted L_F, does not interfere with other structures trying to fit within Lego brick 10 (e.g., other Lego bricks 10, other exemplary linkages 2). Further alternatively, L_K may be based on the number of studs and/or LDU of exemplary Lego blocks 10, e.g., two stud lengths, three stud lengths, four stud lengths, etc. In an exemplary embodiment, length L_K may be between about 1 and about 3 LDU in length as measured from the forward-most end of opening 5. In an exemplary embodiment, length L_F may be between about 1 and about 2 LDU in length as measured from the boundary of an exemplary cavity 9 and an exemplary opening 5 of an exemplary block 10/30-70. Alternatively, L_F may be measured from the surface within an exemplary block 10/30-70 that either (i) lies in a plane that is orthogonal to opening 5, or (ii) whose central axis is orthogonal to the central axis of opening 5.

[0059] With further reference to **Fig. 16D**, an exemplary linkage 2 may be coupled to an exemplary block 10/30-70 via opening 5 or any other disclosed aperture by compressing an exemplary elastomeric coating 2B from a height of X_1 (outside of opening 5), to a height X_2 (on the border outside or inside of opening 5), to a height of X_3 (inside of opening 5). In alternative embodiments, coating 2B may regain some, all, or none of its original height X_1 once inside cavity 8 of the aforementioned exemplary block, wherein that cavity height is X_4. An exemplary internal coating 2B height X_4 may be the height at any point on coating 2B along L_F. In an exemplary embodiment, the ratio X_4/X_1 may be between about 0.975 and about 0.999. An exemplary coating 2B may have a juncture 2J with component 2A that may contain one or more adhesives, welds, stitches, and/or impregnated material into component 2A, or combinations of the same. Alternatively, where coating 2B may be a tube, juncture 2J may be a substantially non-permanent junction between component 2A and coating 2B.

[0060] Another exemplary embodiment of posability may be seen with respect to **Figs. 17A-C**. In the illustrative embodiment of **Fig. 17A**, an exemplary linkage 2 having a component 2A, which may be made out of a flexible metal, and a coating 2B, such as, for example, an elastomer or flexible plastic coating, may be coupled to an exemplary block or blocks 10/30-70 via an opening 5. Block or blocks 10/30-70 may be further coupled, either removably or integrally with block or blocks 100/200, which may be the same as blocks 10/30-70, a block described herein, or any conventional block in the prior art.

[0061] At the juncture between linkage 2 and opening 5, an exemplary metal component 2A of an exemplary linkage 2 may be found along a distance L_K circumscribed by opening 5 and a distance L_F beyond the walls of opening 5 and/or found in an exemplary cavity 9 of an exemplary block or blocks 10/30-70. As previously described, component 2A, which may be made of a flexible metal, may be located only along length L_K while a coating thickness 2C may be found along a length L_F. Alternatively, component 2A may be located along L_K and L_F. The ratio **R** of L_F to L_K may be less than about 1.0, and in an alternative embodiment is no more than about 0.75. In another embodiment, L_F may be a length that is about equal to the thickness T_{C4} of linkage section 2C. In another embodiment, L_F may be a length that is about equal to the thickness T_{C5} of linkage section 2D. The person of ordinary skill in the art, by reviewing the interrelated embodiments of **Figs. 16A-D** and **17A-D**, will understand numerous interrelationships between L_C, L_M, L_F, L_K, T_{C4}, and/or T_{C5} that may be understood from the disclosures herein. In an exemplary embodiment, the person skilled in the art would understand the benefits of maintaining some length of component 2A within opening 5 of block or blocks 10/30-70 to increase friction and/or contact forces between coating 2B and the surface(s) of opening 5 of block or blocks 10/30-70.

[0062] With further reference to the illustrative embodiments of **Figs. 17A-D**, an exemplary linkage 2 may be coupled to exemplary block(s) or brick(s) 10/30-70, such as, for example Lego® blocks, Lego-like blocks, hybrid blocks, 3D printed blocks, which may themselves be connected to or be integral with blocks/bricks 100/200. An exemplary linkage 2 may enter opening 5 of block(s) and/or brick(s) 10/30-70 along the x-axis. The plane tangent to the surface of block(s) and/or brick(s) that intersects an exemplary linkage 2 may be perpendicular to the central-most axis of component 2A. At this juncture, the x-, y-, and z-axes for the intersection of the central-most axis of linkage 2 with block(s) and/or brick(s) 10/30-70, which together form joint 20, may be said to have their origins located there. However, persons of skill in the art may determine other locations along an exemplary linkage 2 and/or components 2A and 2B, or exemplary block(s) and/or brick(s) 10/30-70 that may serve as origins for the x-, y-, and z-axes, *see, e.g.*, **Fig, 2** and **Fig. 15**.

[0063] Referring to the illustrative embodiment of **Fig. 17A**, a component 2A of an exemplary linkage 2 may extend from opening 5 substantially along the x-axis while coating 2B may or may not extend from opening 5 substantially along the x-axis due to different contours 3/3a-h in coating 2B, intermittent application of coating 2B on component 2A, and/or other configurations of coating 2B. However, in another exemplary embodiment, coating 2B may extend substantially along the same axes as component 2A, although it may not completely cover component 2A of an exemplary linkage 2. Furthermore, while coating 2B may extend along substantially the same axes as component 2A (e.g., the x-axis), an exemplary coating 2B may or may not extend from the same points as component 2A (*e.g.*, only component 2A may be found along length L_F, while component 2B only begins to exist along length L_K, as may be the case for an exemplary linkage illustratively disclosed in **Fig. 16B**).

[0064] Referring to the illustrative embodiment of **Fig. 17B**, in use, an exemplary linkage 2 may be bent upon application of a user force, e.g., a positioning force that results from a user moving either the linkage 2 and/or a brick or block 10/30-70/100/200 coupled to the linkage 2, and is not one that results exclusively from gravity acting on the linkage 2 and/or the brick or block 10/30-70/100/200 coupled thereto). Such a positioning force may cause an exemplary linkage 2 to have a pose or conformation **ρ**. In an exemplary embodiment, **ρ** may comprise an "elbow" bend (which may be at a substantially right angle) or other arc-like bend. In an exemplary joint 20, there is minimal to no curvature **ρ** along length L_K, although at least some curvature **ρ** may be present along an exemplary linkage 2 (with or without coating 2B) at the outside facing end of opening 5 and/or at position $\mathbf{X_2}$. An exemplary curvature **ρ** may be one or more curved portions of an exemplary linkage 2, and not necessarily just the portion of exemplary linkage 2 at opening 5.

[0065] Referring to the illustrative embodiment of **Fig. 17C**, an exemplary linkage 2 may extend from exemplary block(s) or brick(s) 10/30-70 along the x-axis and then be bent by a user in the y- and/or z-directions so as to have a pose or conformation **ρ**. As also illustratively shown, a portion of component 2A and the component 2's thickness T_{C4} of end covering 2C may together cover a distance of length L_F. The distance L_K illustrated may only relate to a portion of linkage 2 whose head 1 may be too long to fit within opening 5 of the particular block(s) or bricks(s). However, an exemplary linkage 2 may be configured so that the friction forces from opening 5 resulting from compression of a flexible covering 2B against a metal component 2A each serves to securely anchor exemplary linkage 2 within opening 5.

[0066] As illustrated in **Fig. 17C**, an exemplary linkage 2 may be bent by a user force into one or more conformations in positive and negative x-, y- and/or z-axis directions, as has been previously described. In any one of the exemplary conformations, including those illustratively disclosed with respect to **Figs. 17C-D**, an exemplary linkage 2 may substantially maintain its pose **ρ** over a period of time. In an exemplary embodiment, **ρ** may have an origin at opening 5 (as shown from the origin of the x-, y-, and z-axes) and may triangulate with the endpoint of component 2A of an exemplary linkage 2 that is part of length L_K inside brick/block 10/30-70 (point Q), the outer-most edge of opening 5 that is parallel to the y/z axes (point R), and all points along the length of **ρ** (shown in dashed and dotted line in **Figs. 17C-D**) (point(s) S).

[0067] In an exemplary embodiment of posability, a posability triangle ("T") may have angles **α**, **β**, and **γ** between lengths QS and RS, RS and RQ, and RQ and QS, respectively. In an exemplary embodiment **α** is always an acute angle between QS and RS, while **β** and **γ** may be any angle between RS and RQ and RQ and QS, respectively. In another exemplary embodiment, only when portions of an exemplary linkage 2 in **ρ** overlap themselves may **β** and **γ** be substantially 90 degrees. For certain lengths of exemplary linkage 2, only **β** may be substantially 90 degrees for one triangle T among all triangles T for a given **ρ**. For certain lengths of exemplary linkage 2, **β** and **γ** may be substantially 90 degrees for a plurality of triangles T among all triangles T for a given **ρ**.

[0068] In another exemplary embodiment, triangle T may have coordinates on the x-, y-, and z-axes. In another exemplary embodiment, triangle T may have coordinates on the x-, and only one of the y-, and z-axes. In another exemplary embodiment, QR may be the x-axis length of triangle T or T_X, which may be substantially equal to the length of component 2A along length L_K. In yet another exemplary embodiment, QR and/or T_X lies substantially on the central axis of component 2A. In yet another exemplary embodiment, QR and/or T_X lies substantially on the central axis of an exemplary linkage 2.

[0069] An exemplary posability of an exemplary linkage 2 may be contingent on the section modulus of plasticity and/or the area moment of inertia. In an exemplary embodiment, an exemplary linkage 2 may be configured so that its section modulus of plasticity (Z) may be defined by **Equation 1**:

Equation 1: $$Z_p = \frac{(D_{M-AVG} + 2T_{C-AVG})^3}{6}$$

[0070] Where $D_{M\text{-}AVG}$ may be the average of all D_m and D_M for component 2A about L_M plus L_T (to the extent component 2A has such contoured ends) and $T_{C\text{-}AVG}$ may be the average of all T_{C1}, T_{C2}, T_{C3}, T_{C4}, and T_{C5} for covering 2B about L_C. Preferably, a posable linkage 2 with component 2A and 2B may have a Z_p less than about 1.4000. Further preferably, posable linkage 2 may have a Z_p less than about 0.58333.

[0071] In another exemplary embodiment of posability, an exemplary linkage 2 may be configured so that the area moment of inertia ("I") for component 2A is less than or equal to that for covering 2B. In one embodiment, the smaller the area moment of inertia for an exemplary linkage 2, the greater the posability of the exemplary linkage 2. In an exemplary embodiment, the ratio of I_C/I_M for an exemplary posable linkage 2 may be greater than about 1 but less than about 50. In an alternative embodiment of posability, I_M may be less than about 4.9×10^{-6} in^4 and preferably, less than or equal to about 7.4×10^{-7} in^4. In accordance with these and other exemplary embodiments, I_C for an exemplary linkage 2 may be less than about 2.821×10^{-5} in^4.

[0072] As a result of being inserted into an exemplary block 10/30-70 via opening 5, an exemplary linkage 2 may have a coating 2B that may exert the following restoring force (F_R) against opening 5 of one or more of the exemplary blocks and/or their hybrids described by, for example, **Equation 2**:

Equation 2: $$F_R = AE\,[(X_2-X_1)/X_1]$$

[0073] Where A is the area of an exemplary coating 2B within length L_K. An exemplary A is equal to the product of the coating 2B thickness T_C, length L_K, and the product of the number pi (π) and linkage 2 diameter D. Alternatively, A may be equal to the product of $\sum_{0}^{L_K} D - D_M$, length L_K, and πD. Further alternatively, F_R and A may be the derivative of the force and/or area over length L_K. In a further alternative embodiment, A may be derived from any other formulae known to those skilled in the art for determining the area of coating 2B within length L_K. E is the modulus of elasticity of an exemplary coating 2B. The restoring force F_R may represent the force exerted by the compressed portions of coating 2B on the inside surface of an exemplary opening 5.

[0074] As a result of being inserted into an exemplary block 10/30-70 via opening 5, the exemplary length L_K of an exemplary linkage 2 head/tail 1/0 may be held therein at least by a friction force F_F exerted against the coating 2B according to, for example, **Equation 3**:

Equation 3: $$F_F = (F_R)(\mu)$$

[0075] Where F_R is the restoration force for a deflected coating 2B and **μ** is the coefficient of friction for the opening 5 of an exemplary block 10/30-70. Thus, the dimensioning of an exemplary coating 2B vis-à-vis opening 5 may allow for greater frictional forces to retain an exemplary linkage 2 within an exemplary block 10/30-70. The friction forces F_F may be increased by the rigid attachment of coating 2B to an exemplary metal component 2A. In embodiments where blocks 10/30-70 are made of plastic, such as ABS or PLA plastic, an exemplary linkage 2 with a metal wire component 2A having a coating 2B adhered thereto may take greater advantage of the restoring forces F_R generated as a result of coating 2B deflecting in response to insertion within such blocks 10/30-70. Application of **Equation 3** may be made to determine the friction force of coating 2B (F_{Fc}) generated by the resistance forces of the opening 5 of the exemplary block 10/30-70 on coating 2B, where **μ** is that for the material of coating 2B. Use of an exemplary coating 2B in conjunction with component 2A may make for a more robust retention of an exemplary linkage 2 within the opening 5 of an exemplary block 10/30-70 and blocks incorporating the same.

[0076] In a further exemplary embodiment, as illustratively shown in **Figs. 18A-D**, an exemplary linkage 2 of the type disclosed may be an integrated linkage 2E that may be integrally formed with a Lego-like block or brick 80 and/or be a welded linkage 2F that may be mechanically/chemically attached to a block/brick 90. Block/brick 80/90 may be a form of any block or brick 10/30-70, coupled or integrally formed with one of blocks 100/200, and/or may be a form of any other block or brick disclosed or known to those skilled in the art. In an exemplary embodiment, the material comprising linkage 2E may be formed first and then integrated with the mold or fabrication tooling while making block 80 so that linkage 2E can be embedded within block 80 as it is formed and/or be "captured" by the material making up block 80 so as to form one component. An exemplary linkage 2E may be pre-treated to couple to a block 80 by increasing the surface area on the integration end of the linkage 2E, e.g., increasing grooves, gnarling, contouring, cold rolling, and other surface area increases known to those skilled in the art. An exemplary integration end of linkage 2E may be one or more of the head 1 or tail 0 sections of disclosed linkages 2.

[0077] In an alternative embodiment, **Figs. 18A** and **18C** illustrate an exemplary weld linkage 2F that may be adhered to or otherwise held by Lego-like block or brick 90 by way of glues, pressure welding, vibration welding, sintering, soldering, or plastic welding. The adhesion location for linkage 2F to Lego-like brick 90 may be at joinder section 92, which may be intermittent or substantially continuous along the length of linkage 2F bounded by Lego-like brick 90. In exemplary embodiments, linkages 2E and 2F, Lego-like blocks 80 and 90, component 2A, and coating 2B may be interchanged with, interrelated to, combined with, used as an alternative to, and/or modified by any of the disclosures of toy linkages and related systems herein.

[0078] An exemplary integrated linkage 2E may be embedded in block 80 as shown in **Fig. 18B**. An exemplary integrated linkage 2E may have an overall diameter D that may be substantially the same as or less than the thickness of block 80, T_{BR}. Alternatively, an exemplary linkage 2E may have a component 2A of diameter D_M that is integrated with block 80. According to this exemplary embodiment, component 2A may have one section that may be integrated with block 80 and a remainder section that is not integrated with block 80, the “free” section, that may be component 2A in isolation, component 2A with covering 2B, and any form of other linkage 2 forms, components, coverings, and interrelationships disclosed. For example, an exemplary linkage 2E may be integrated with block 80 over a length equivalent to length (i) L_K, (ii) $L_K + L_F$, and/or (iii) L_T. Alternatively, an exemplary linkage 2E may have a threads 12 or contours 3a-h at its head 1 to allow for better integration with block 80. In another embodiment, block 80 may be a more elaborate form of face covering 2C/D applied to a coated linkage 2.

[0079] An exemplary welded linkage 2F may be coupled to block 90 as shown in **Fig. 18C**. An exemplary welded linkage 2E may have an overall diameter D that may be substantially the same as, greater than, or less than the thickness of block 90, T_{BR}. In an exemplary embodiment, block 90 may have a repository **Φ** in its surface for a welded linkage 2F such that a portion of linkage 2F diameter D intersects block 90 thickness T_{BR}. In another exemplary embodiment, block 90 joinder sections 92 may be formed so that the diameter D of linkage 2F may be interconnected with a surface **Γ** or in the thickness T_{BR} of block 90. An exemplary diameter D of linkage 2F or surface **Γ** of block 90 may be treated to increase its surface area to permit an exemplary joinder 92 between both. While joinder 92 may be shown filling in the entire area between diameter D and block 90 surface **Γ**, this may not necessarily be the case, and air gaps, channels, and cavities may be present without affecting the goal. As previously described, joinder 92 may be comprised of a bonding agent or glue, a melted plastic or epoxy, a solder, a stitch, a staple, a vibration weld, pressure weld, sintered edge, and/or other weld form known to those skilled in the art. In an exemplary embodiment where linkage 2F may be a coated linkage having a cover 2B of thickness T_C, the thickness T_C may be smaller at joinder sections 92 than elsewhere on linkage 2F to account for chemical/mechanical augmentations to allow coupling of linkage 2F to brick 90. Alternatively, an uncoated section of linkage 2F having threads 12 and/or contours 3a-h may also interact with joinder section 92 and may be the sole section on linkage 2F to couple with block 90. In accordance with this embodiment, the smaller diameter D_m may be used to weld linkage 2F to block 90 while the larger diameter D may exist outside of the junction zone formed by joinder 92 and surface **Γ**. An exemplary surface **Γ** may be equal to approximately 0.465*D or approximately 1.500*T_C.

[0080] In the exemplary embodiment of **Fig. 18D**, an exemplary integrated Lego-like block 80/90 may also have a user force applied to its integrated linkage 2E or weld linkage 2F so as to cause either linkage to maintain a pose **ρ** in the x-, y-, and z-plane. The origin of the pose **ρ** may be found at the junction of the axis of an exemplary linkage 2E/2F and the orthogonal surface of Lego-like block 80/90. If Lego-like block 80/90 does not have an orthogonal surface, then the plane tangent to the first surface which contacts linkage 2E/2F may be suitable as a plane for the origin point, although persons skilled in the art may choose other suitable origin points. The **ρ** of an exemplary integrated linkage 2E or weld linkage 2F may the same or similar to that of an exemplary linkage 2 with the exception that block 80/90 necessarily will be involved in the pose. In other words, blocks 80/90, like an elaborate face coating 2C/2D are one with the linkage 2E/2F. In an exemplary embodiment, $I_M < I_C$ for integrated linkage 2E or weld linkage 2F. According to this exemplary embodiment, the ratio of I_C/I_M for an exemplary posable integrated linkage 2E or posable weld linkage 2F may be greater than about 1 but less than about 55.

[0081] While exemplary linkages 2 may be illustrated in cross-section and in full by **Figs. 16A-D**, **Figs. 17A-D**, and **Figs. 18A-D**, those skilled in the art will readily understand these illustrations may apply to sections, subsections, ends, or combinations of the same for an exemplary linkage 2 in whole or in part from various vantage points and in any of the other interrelated embodiments described.

[0082] Many further variations and modifications may suggest themselves to those skilled in art upon making reference to above disclosure and foregoing interrelated and interchangeable illustrative embodiments, which are given by way of example only, and are not intended to limit the scope and spirit of the interrelated embodiments of the invention described herein. While many of the exemplary bricks 10/30-90 have been disclosed, these exemplary bricks may be integrated components with other exemplary building blocks and need not exist in isolation. Thus, it is contemplated that the exemplary bricks 10/30-90 and their various surface structures and dimensions may be utilized in conjunction with and as integrated parts of presently available building block systems in addition to functioning on their own.

CLAIMS:

1. A toy linkage, comprising: posable means comprising a metal component, the posable means having a diameter of about the same size as that of a cylindrical opening in a Lego block, the Lego block being selected from the group consisting of Erling Lego blocks and Technic Lego blocks.

2. The toy linkage of claim 1, wherein the posable means further comprises a coating on the metal component.

3. The toy linkage of claim 2, wherein the diameter of the metal component and coating is equal to or greater than the size of the cylindrical opening.

4. The toy linkage of claim 1, wherein the posable means further comprises a contour on a metal component, a coating on the metal component, or a combination thereof.

5. The toy linkage of claim 1, wherein the linkage is configured to couple to a Lego-like block so that a posability triangle is formed with angles $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$, and $\boldsymbol{\gamma}$.

6. The toy linkage of claim 5, wherein the linkage can be conformed so that angle $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ can be greater than 90 degrees in different conformations.

7. A linkage for Lego-like blocks comprising a metal wire and a coating about the metal wire, wherein a ratio of the second moment area of the coating to the second moment area of the metal wire is less than about 50.

8. The linkage of claim 7, wherein the ratio of L_F to L_K is about less than 1.

9. The linkage of claim 7, wherein the linkage is configured to couple to a Lego-like block so that a posability triangle is formed with angles $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$, and $\boldsymbol{\gamma}$.

10. The linkage of claim 8, wherein the linkage is configured to couple to a Lego-like block so that a posability triangle is formed with angles $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$, and $\boldsymbol{\gamma}$.

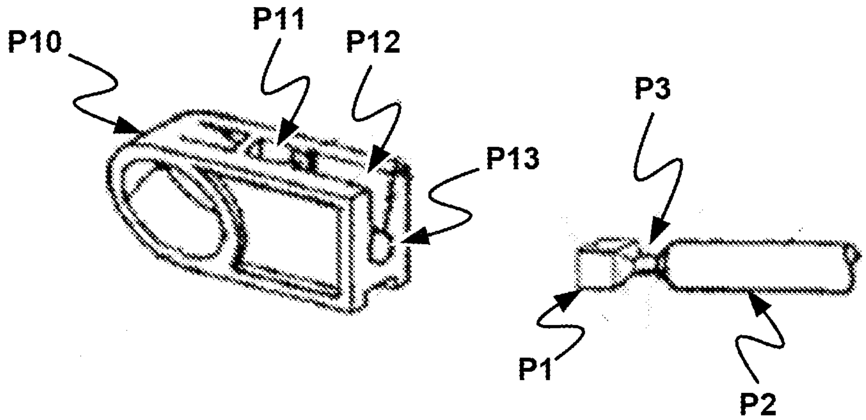


FIG. 1A (PRIOR ART)

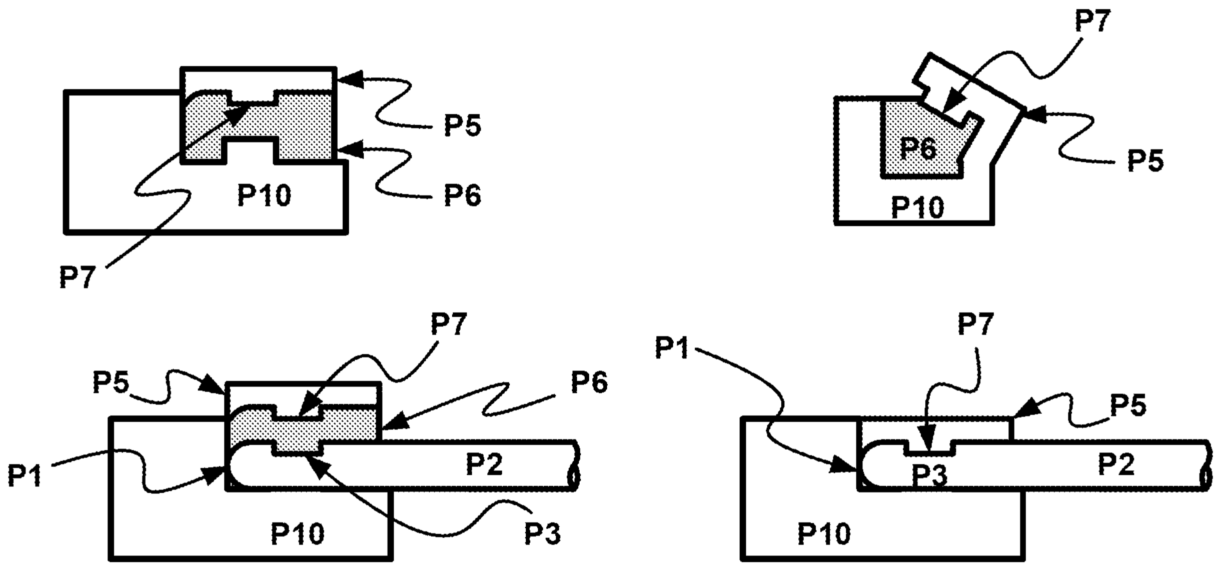


FIG. 1B (PRIOR ART)

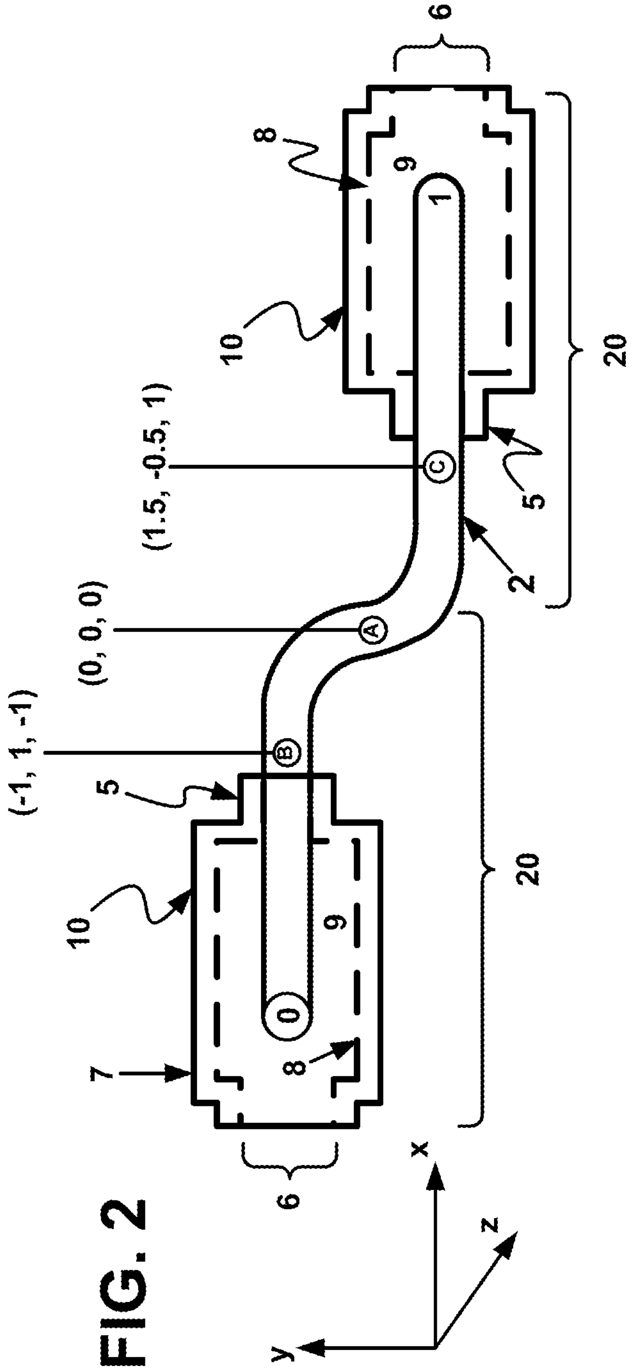


FIG. 2

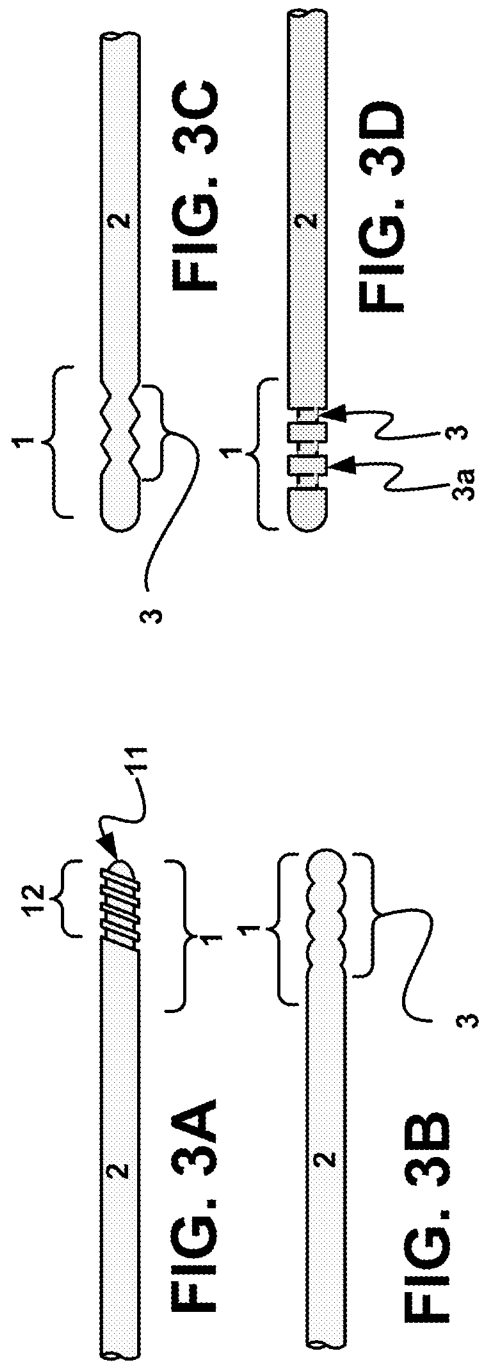


FIG. 3A

FIG. 3B

FIG. 3C

FIG. 3D

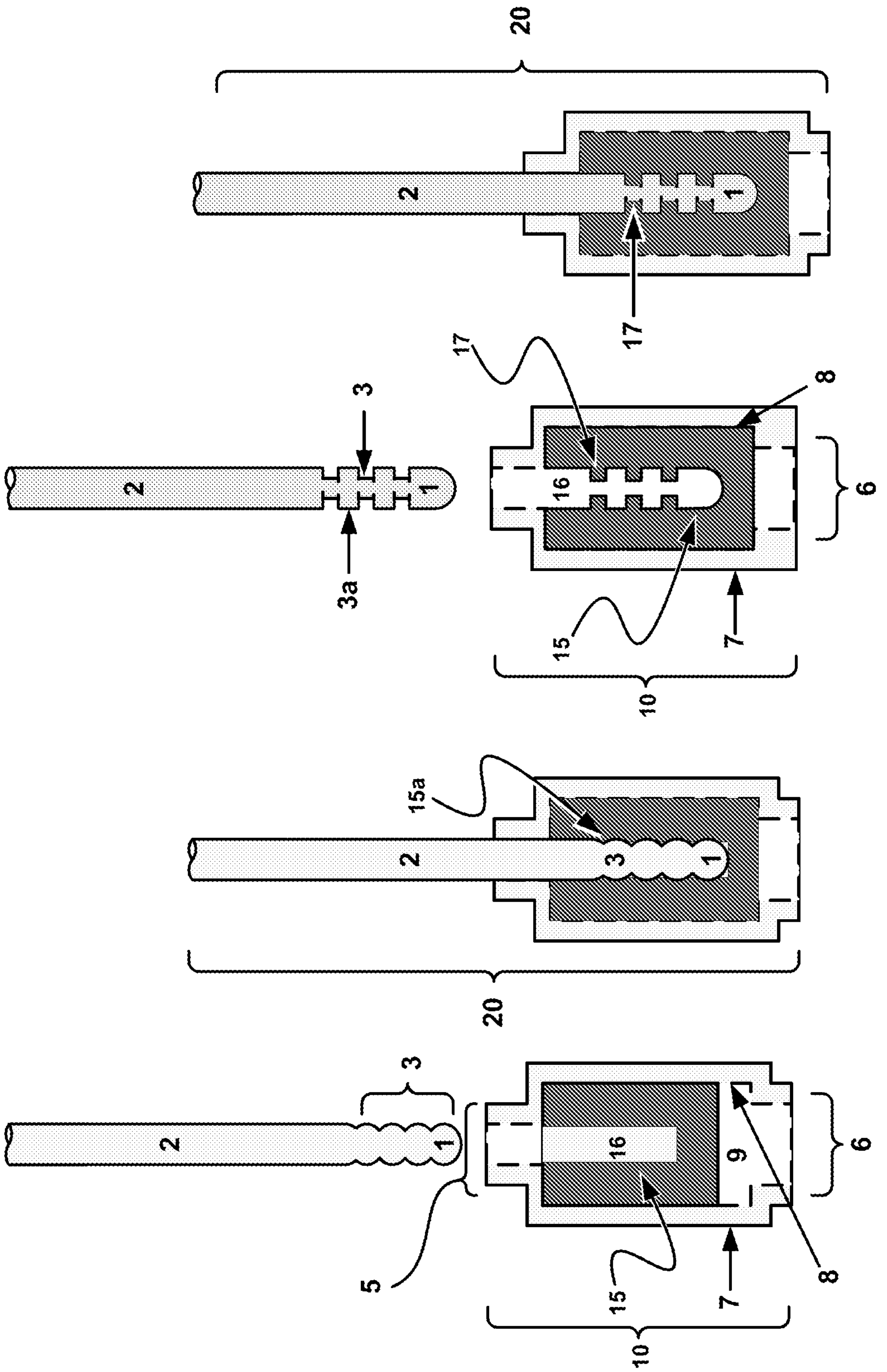


FIG. 4A

FIG. 4B

FIG. 4C

FIG. 4D

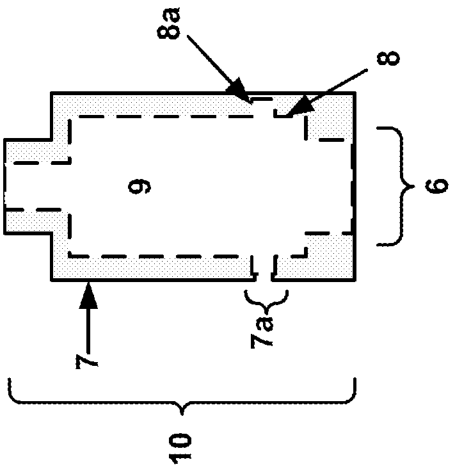


FIG. 4E

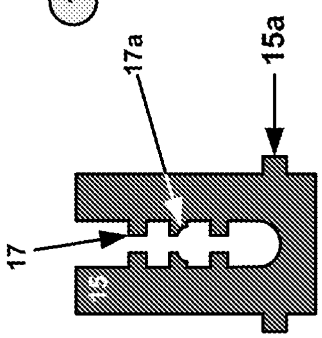


FIG. 4F

FIG. 4G

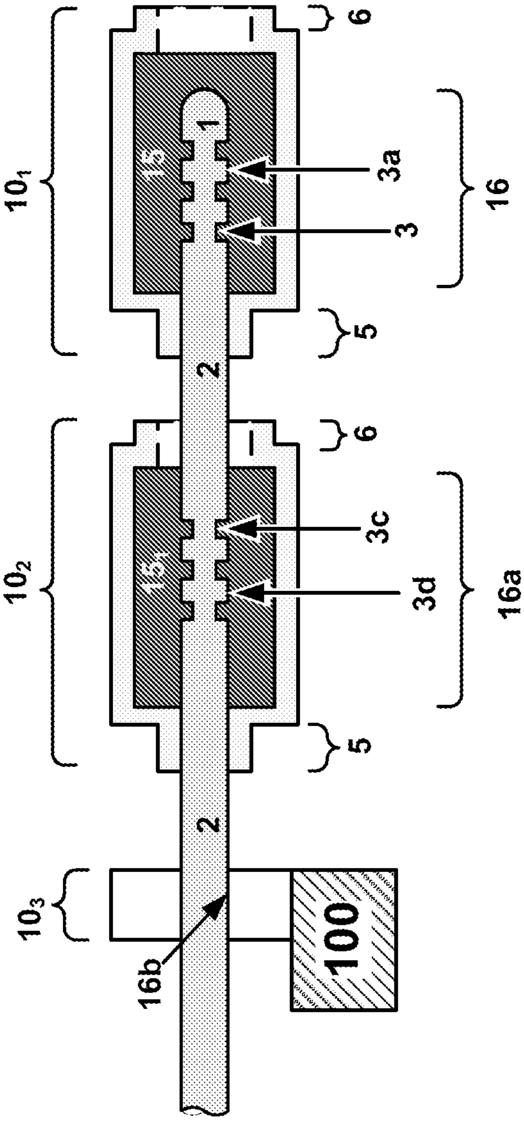


FIG. 5

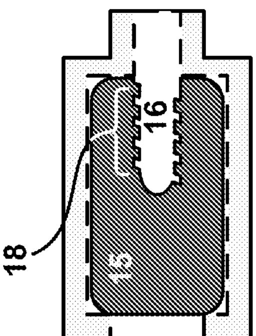


FIG. 6A

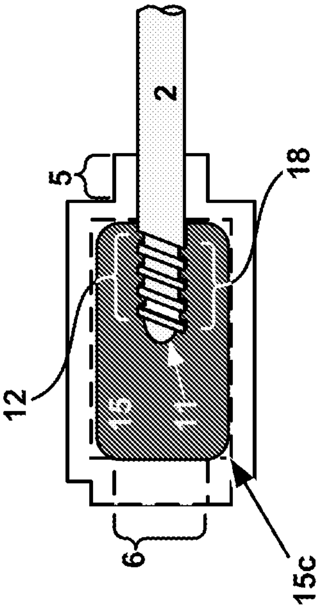


FIG. 6B

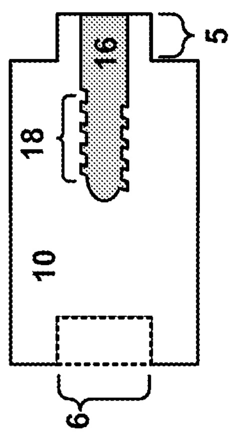


FIG. 7A

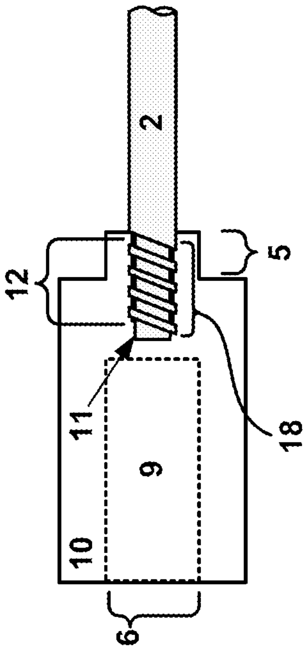


FIG. 7B

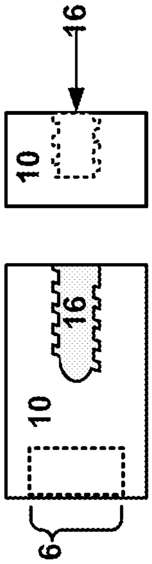


FIG. 7C

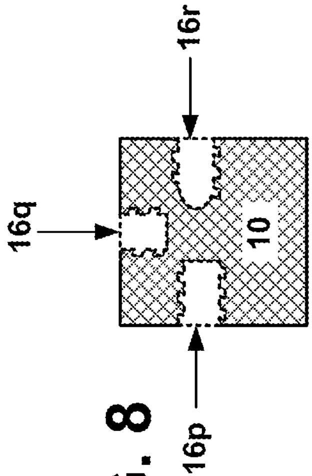


FIG. 8

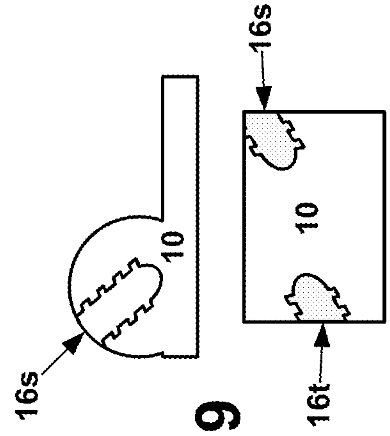


FIG. 9

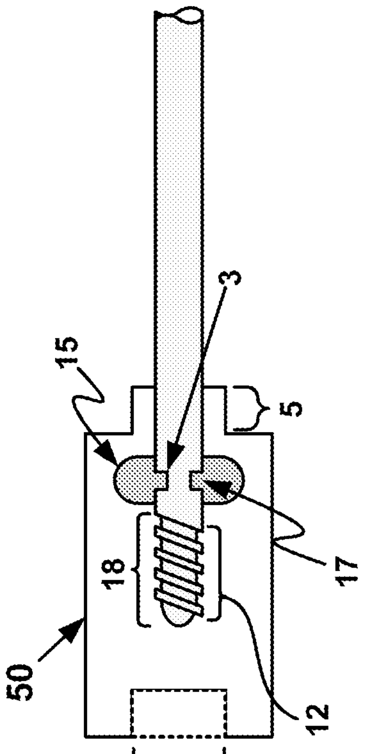


FIG. 10

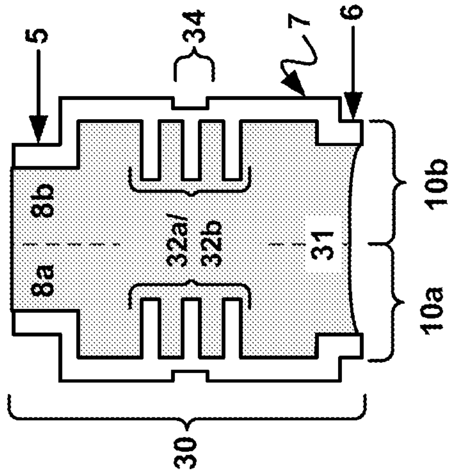


FIG. 11A

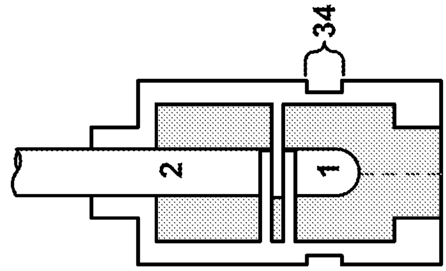


FIG. 11B

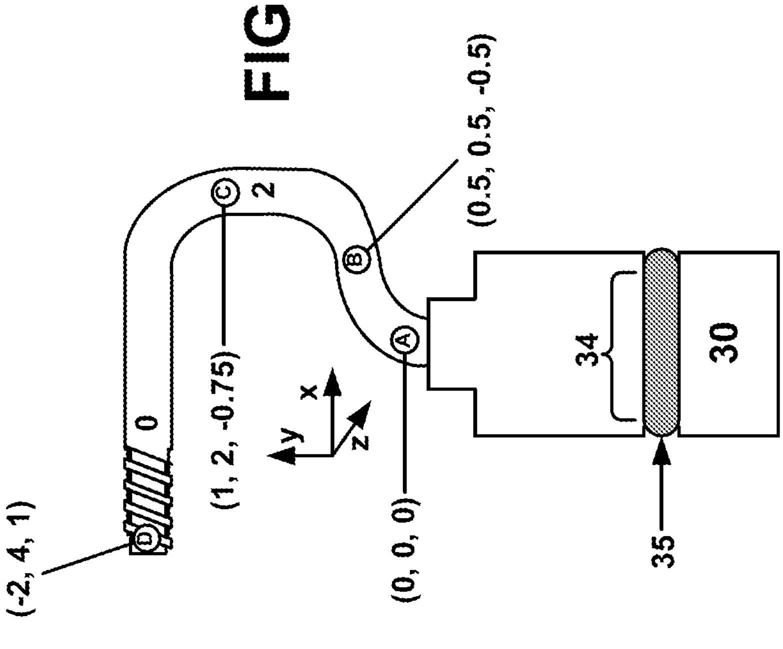


FIG. 11C

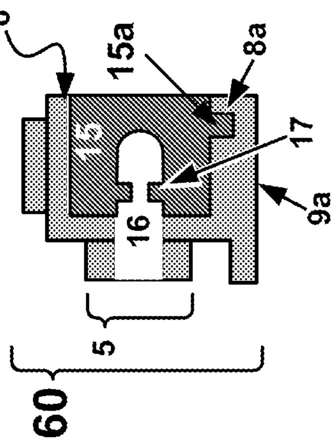


FIG. 12B

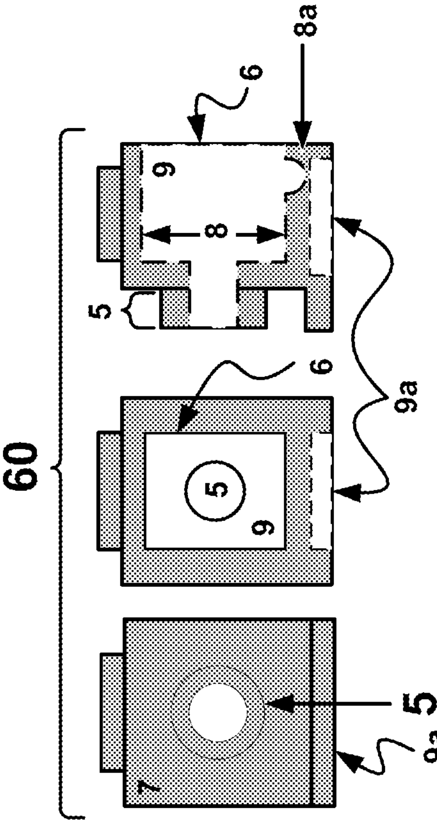


FIG. 12A

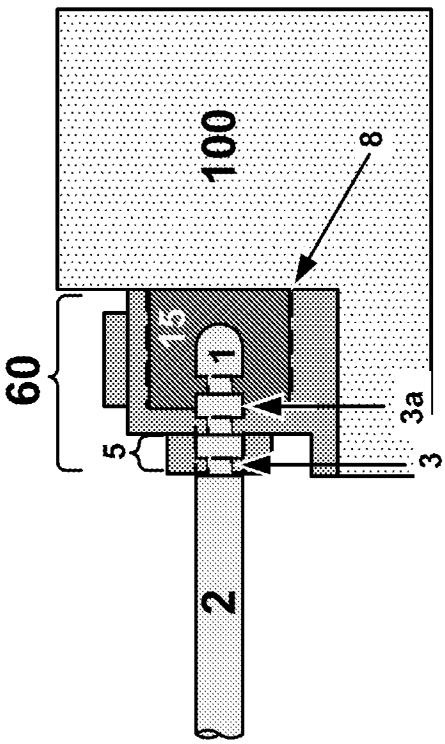


FIG. 13

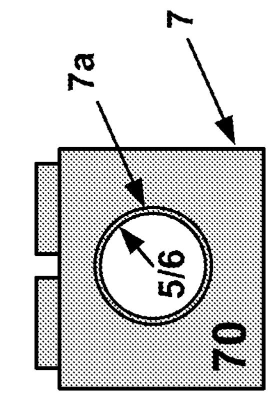


FIG. 14A

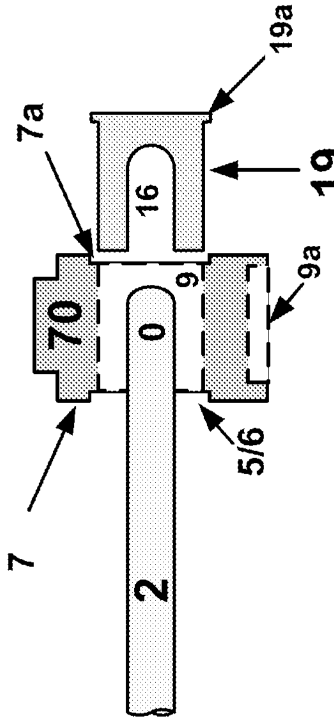


FIG. 14B

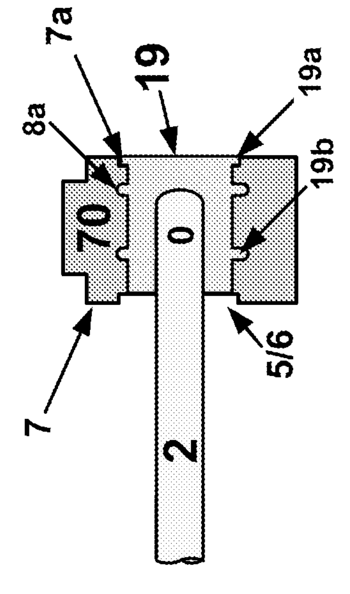


FIG. 14C

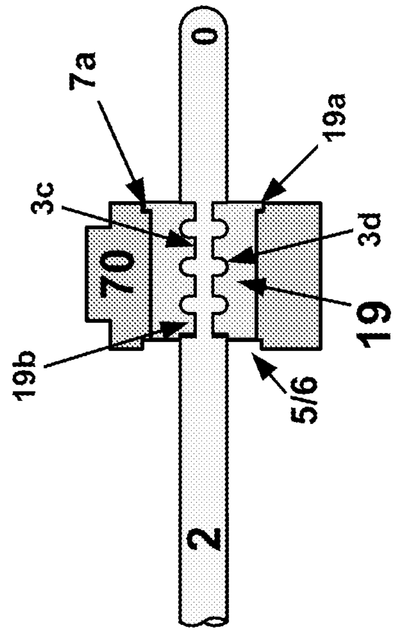
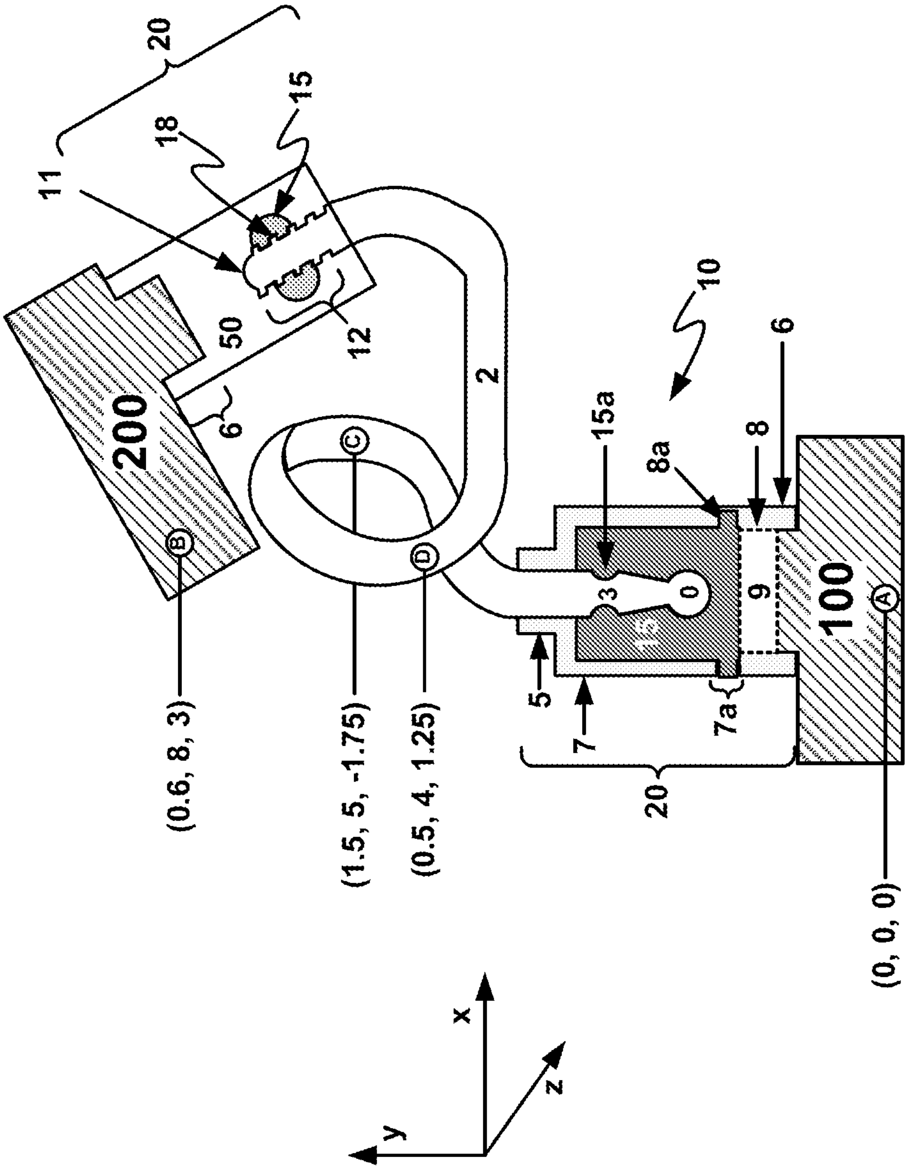


FIG. 14D

FIG. 15


20
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18
15
12
50
200
6
2
C
B
D
10
15a
8a
8
6
3
0
15
9
100
A
5
7
7a
20
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(1.5, 5, -1.75)
(0.5, 4, 1.25)
(0, 0, 0)
x
y
z

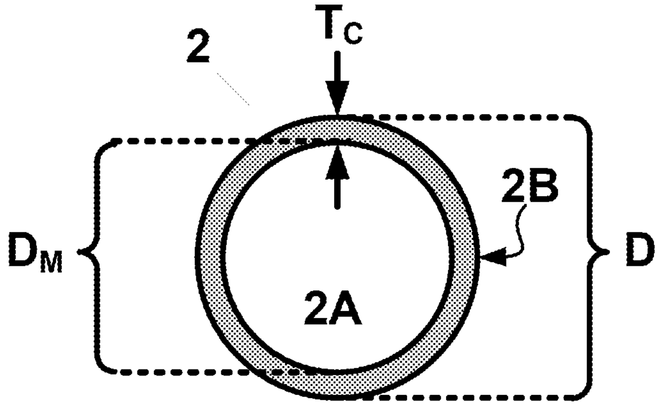


FIG. 16A

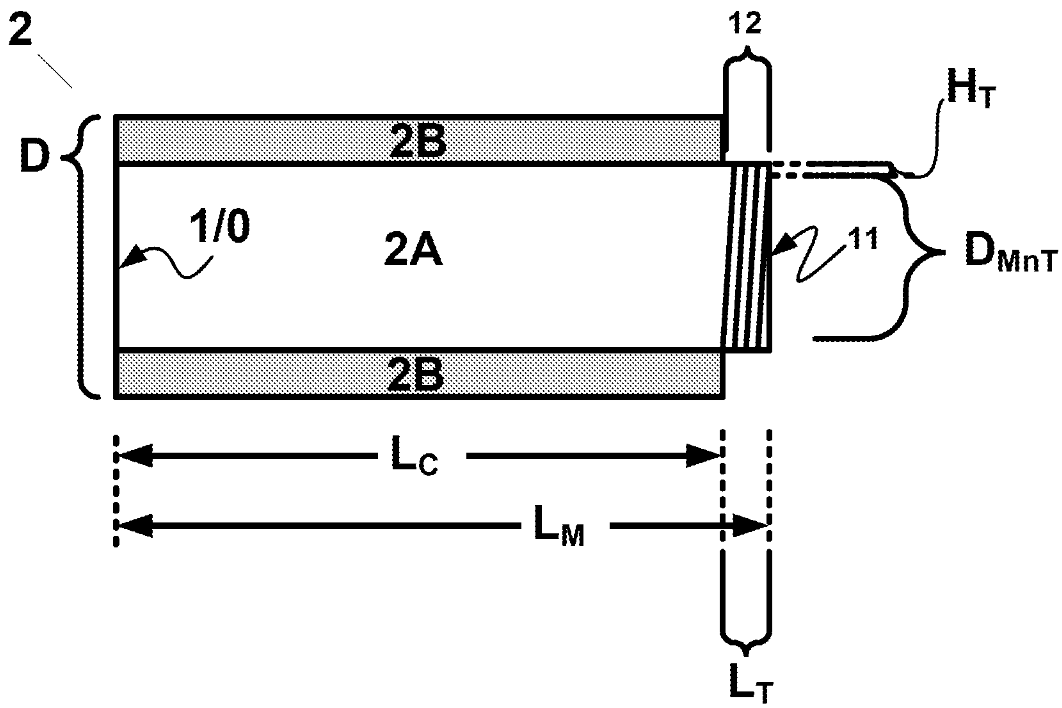


FIG. 16B

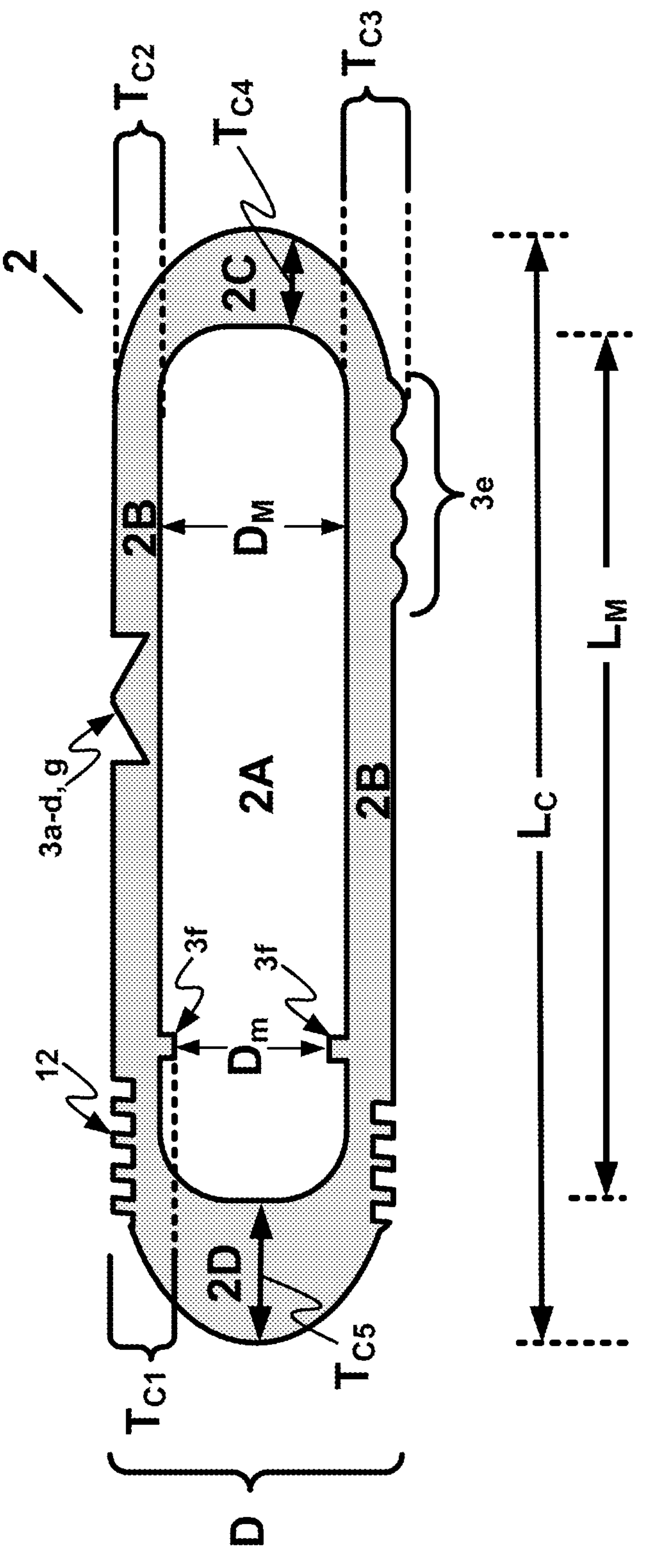


FIG. 16C

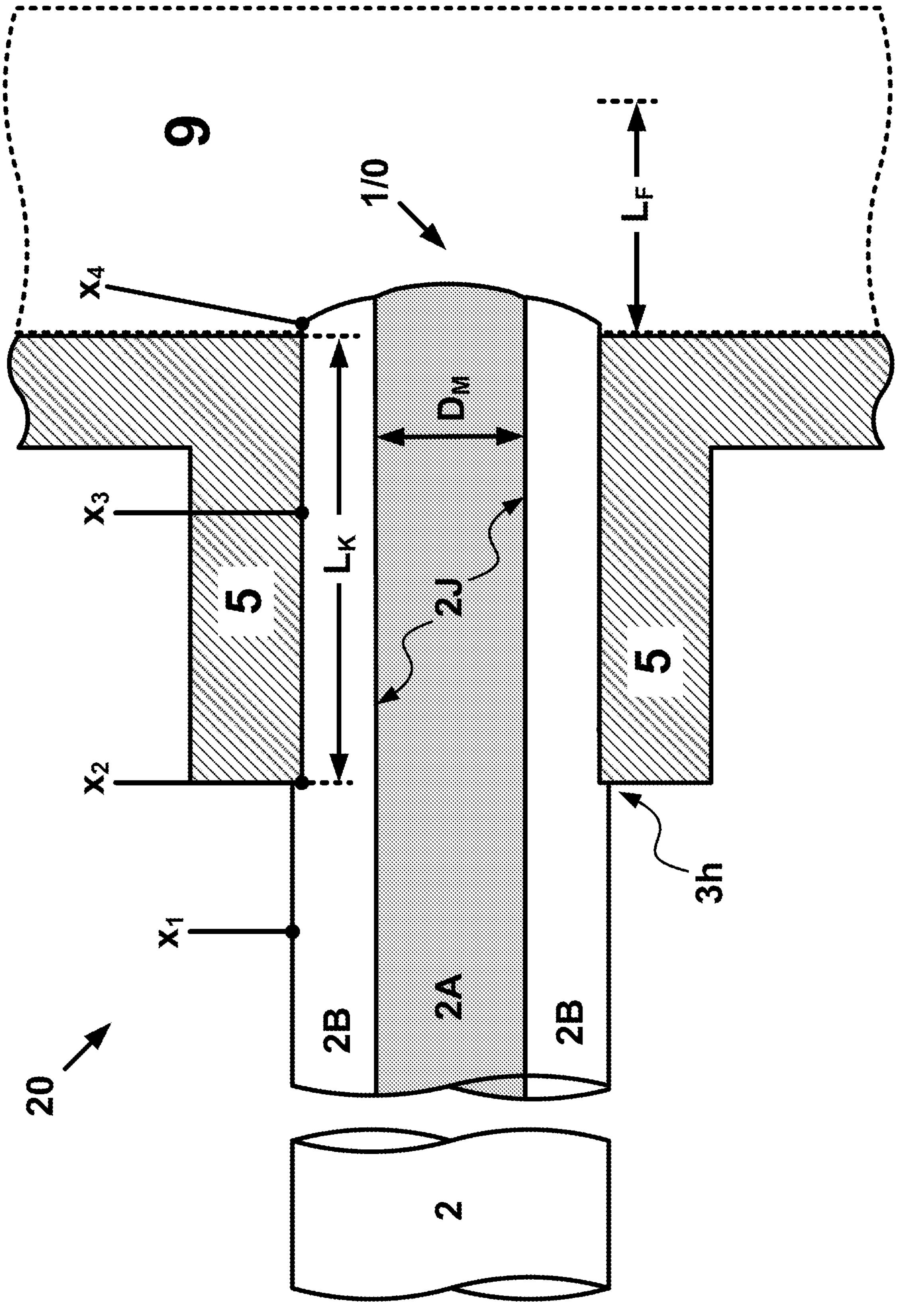


FIG. 16D

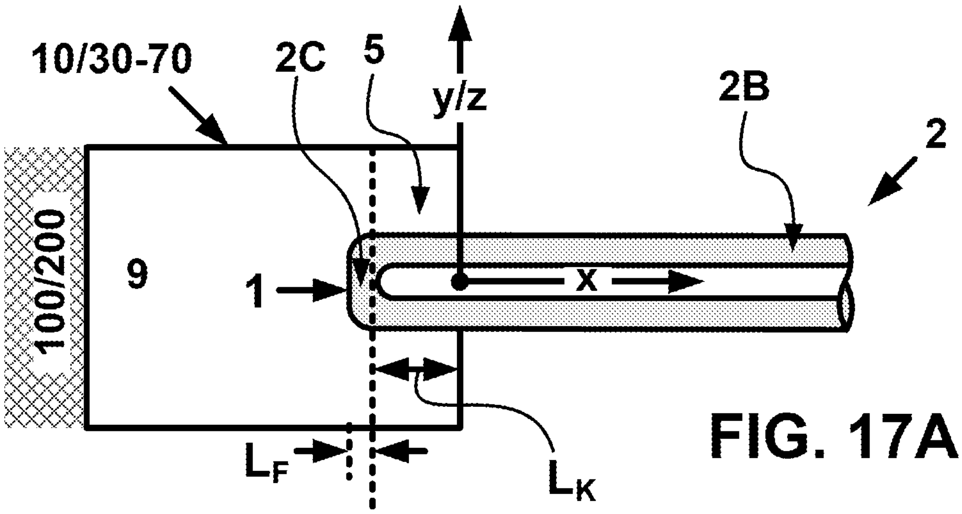


FIG. 17A

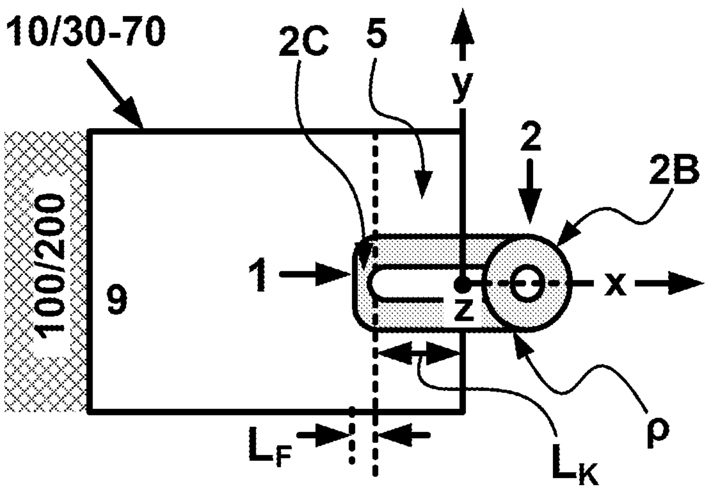


FIG. 17B

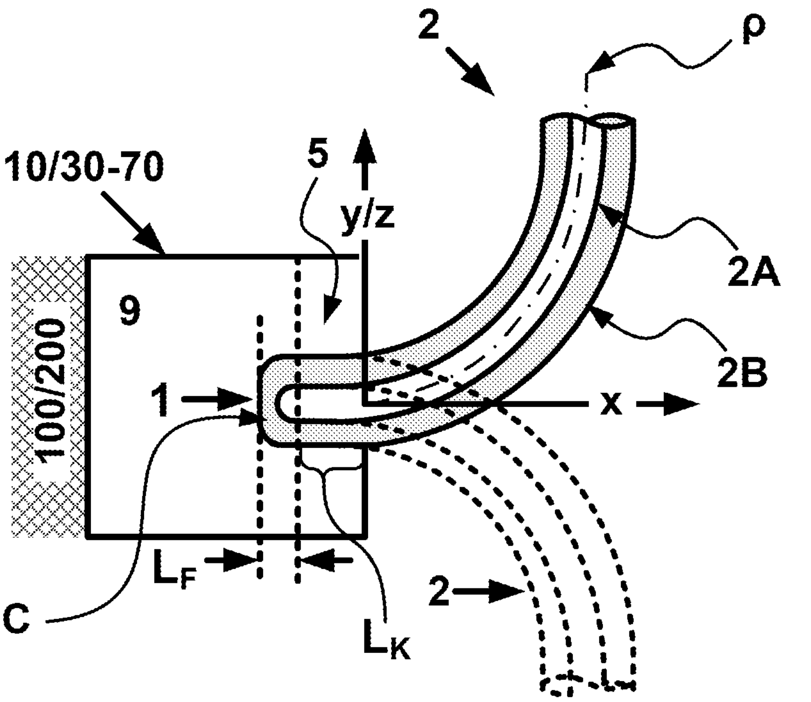


FIG. 17C

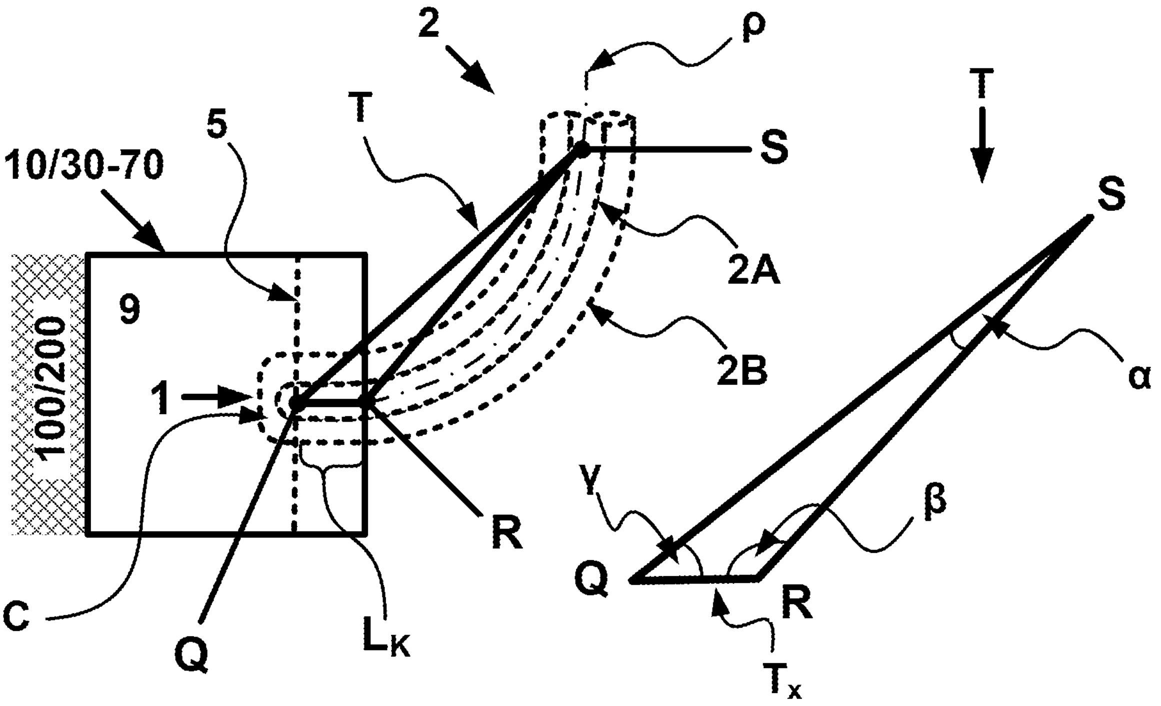


FIG. 17D

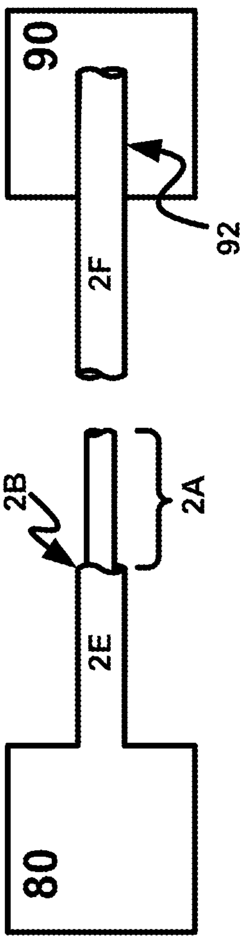


FIG. 18A

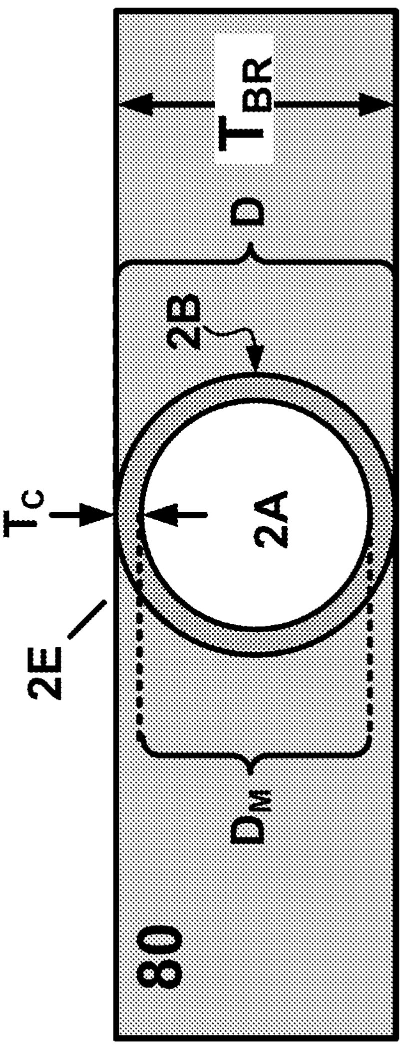


FIG. 18B

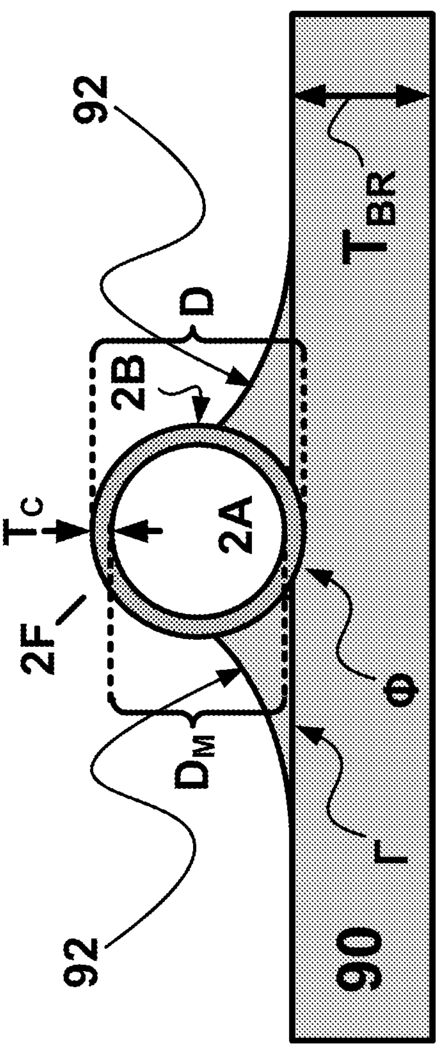
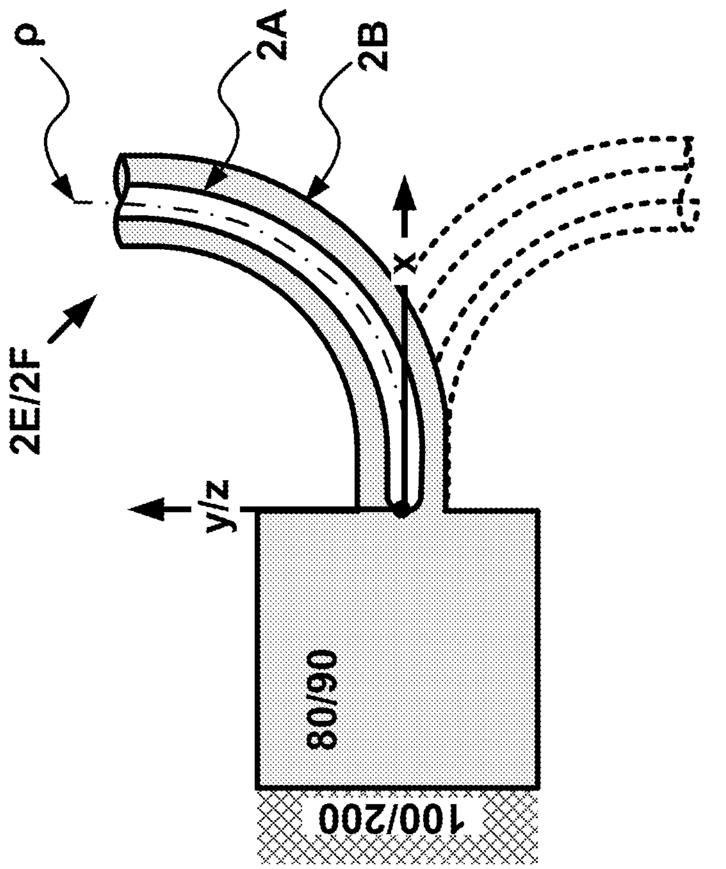


FIG. 18C

FIG. 18D



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/047836

A. CLASSIFICATION OF SUBJECT MATTER
IPC (2015.01) A63H 33/10

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)
IPC (2015.01) A63H 33/10

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9832509 A1 YESH MARVELOUS TOYS LTD 30 Jul 1998 (1998/07/30) the entire document	1-10
X	US 5785529 A HEARN S A 28 Jul 1998 (1998/07/28) the entire document	7-10
Y	the entire document	3
X	US 2007178799 A1 RUDELL ELLIOT 02 Aug 2007 (2007/08/02) the entire document	7-10
Y	the entire document	3
X	US 4666417 A HILLMAN PAUL 19 May 1987 (1987/05/19) the entire document	7-10

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

* Special categories of cited documents:
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07 Jan 2016	11 Jan 2016
Name and mailing address of the ISA: Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616	Authorized officer NARGASI Ayelet Telephone No. 972-2-5651620

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