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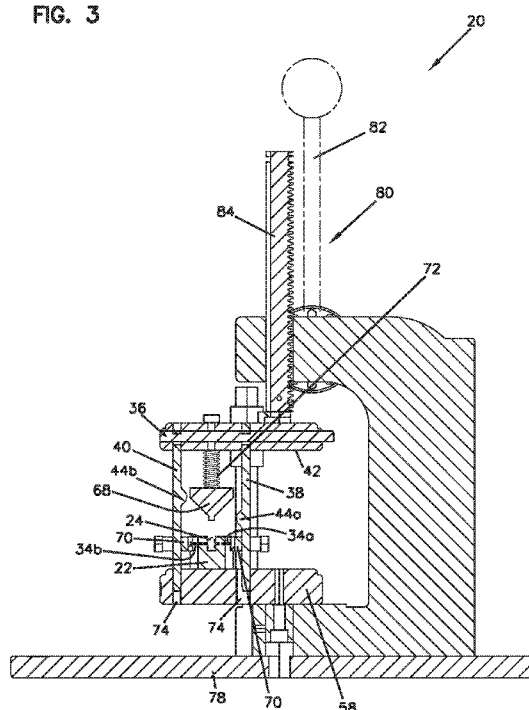
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FIG. 3



(57) Abstract: A device includes a fixed position nest having a channel and first and second pin holes on front and rear sides of the nest that extend to the channel. A pin carrier assembly has first punch pins that extend into the first pin holes on the rear side of the nest and second punch pins that extend into the second pin holes on the front side of the nest. A top plate located above the nest is movable between an upper position, a first punching position, and a second punching position. Rear and front cam blocks each include a protrusion that, respectively, engages the pin carrier assembly causing the first punch pins to enter the channel when the top plate is in the first punching position and the second punch pins to enter the channel when the top plate is in the second punching position.

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FIBER OPTIC CABLE PUNCTURE PRESS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is being filed on April 17, 2018 as a PCT International Patent Application and claims the benefit of U.S. Patent Application Serial No. 62/486,688, filed on April 18, 2017, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to a device for punching adhesive injection ports into a fiber optic cable.

BACKGROUND

[0003] Fiber optic cables typically include a jacket containing one or more optical fibers. Cable jackets can have a variety of shapes such as round cable jackets and flat cable jackets. Fiber optic cables also typically include reinforcing elements such as Aramid yarns or glass reinforced polymer rods that are positioned within or embedded within the cable jackets. The optical fibers within the fiber optic cables can include single optical fibers, loose optical fibers, and ribbonized optical fibers. In one configuration, one or more unbuffered optical fibers are positioned within a buffer tube within the fiber optic cable. The buffer tube can include a water blocking gel that fills voids within the buffer tube. In other examples, a separate buffer tube can be eliminated and the optical fibers can be positioned within a passage defined by the jacket itself.

[0004] Under certain circumstances, tension can be applied to optical fibers within a fiber optic cable. This can be problematic when the tension causes the fibers to pull-back on ferrules of fiber optic connectors mounted at the ends of the optical fibers. When this occurs, the fiber optic connectors can be disconnected from mating fiber optic connectors.

Tension can be applied to optical fibers by a variety of circumstances such as uncoiling the cable, or jacket expansion caused by temperature variations and/or axial loads applied to cable jackets.

[0005] To counter this tension and anchor optical fibers within a fiber optic cable, adhesive can be injected through adhesive injection ports in a jacket and, if present, a buffer tube of a fiber optic cable. Once injected, the adhesive is positioned within a conduit passage in the fiber optic cable and bonded to the optical fiber. The adhesive is longitudinally fixed relative to the conduit passage. The adhesive injection ports can be formed by a punching or drilling process.

[0006] There is a need for a device for efficiently punching such adhesive injection ports into a fiber optic cable with precision.

SUMMARY

[0007] One aspect of the present disclosure relates to a device for punching adhesive injection ports in a fiber optic cable. The device comprises a nest in a fixed position. The nest includes a channel and a plurality of first and second pin holes on front and rear sides of the nest extending through the nest to the channel. The device further comprises a pin carrier assembly. The pin carrier assembly comprises first punch pins extending into the first pin holes on the rear side of the nest and second punch pins extending into the second pin holes on the front side of the nest. The device also comprises a top plate located above the nest. The top plate is movable between an upper position, a first punching position lower than the upper position, and a second punching position lower than the first punching position. In addition, the device comprises a rear cam block and a front cam block. The rear cam block is attached to the top plate and extends from an underside of the top plate. The front cam block is attached to the top plate and extends from the underside of the top plate. The front cam block is also spaced apart from and opposes the

rear cam block. The rear cam block and the front cam block each comprise a protrusion. The protrusion on the rear cam block engages the pin carrier assembly causing the first punch pins to enter the channel when the top plate is in the first punching position. The protrusion on the front cam block engages the pin carrier assembly causing the second punch pins to enter the channel when the top plate is in the second punching position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a perspective view of an embodiment of a device for punching adhesive injection ports in a fiber optic cable disclosed herein, in which a top plate is in an upper position.

[0009] FIG. 2 is a front view of the device of FIG. 1, in which the top plate is in the upper position.

[0010] FIG. 3 is a section view of the device of FIG. 1, in which the top plate is in the upper position, along the line 1-1 in FIG. 2.

[0011] FIG. 4 is a section view of the device of FIG. 1, in which the top plate is in the upper position, along the line 2-2 in FIG. 2.

[0012] FIG. 5 is a perspective view of the device of FIG. 1, in which the top plate is in a first punching position.

[0013] FIG. 6 is a front view of the device of FIG. 1, in which the top plate is in the first punching position.

[0014] FIG. 7 is a section view of the device of FIG. 1, in which the top plate is in the first punching position, along the line 3-3 in FIG. 6.

[0015] FIG. 8 is a section view of the device of FIG. 1, in which the top plate is in the first punching position, along the line 4-4 in FIG. 6.

[0016] FIG. 9 is a perspective view of the device of FIG. 1, in which the top plate is in a second punching position.

[0017] FIG. 10 is a front view of the device of FIG. 1, in which the top plate is in the second punching position.

[0018] FIG. 11 is a section view of the device of FIG. 1, in which the top plate is in the second punching position, along the line 5-5 in FIG. 10.

[0019] FIG. 12 is a section view of the device of FIG. 1, in which the top plate is in the second punching position, along the line 6-6 in FIG. 10.

[0020] FIG. 13 is a perspective view of a nest of the device of FIG. 1.

[0021] FIG. 14 is a top view of the nest of FIG. 13.

[0022] FIG. 15 is a front view of the nest of FIG. 13.

[0023] FIG. 16 is a rear view of the nest of FIG. 13.

[0024] FIG. 17 is a perspective view of a rear cam block of the device of FIG. 1.

[0025] FIG. 18 is a side view of the rear cam block of FIG. 17.

[0026] FIG. 19 is a perspective view of a rear pin carrier of the device of FIG. 1.

[0027] FIG. 20 is a top view of the rear pin carrier of FIG. 19.

[0028] FIG. 21 is a side view of the rear pin carrier of FIG. 19.

[0029] FIG. 22 is a perspective view of a front cam block of the device of FIG. 1.

[0030] FIG. 23 is a side view of the front cam block of FIG. 22.

[0031] FIG. 24 is a perspective view of a pin retainer of the device of FIG. 1.

[0032] FIG. 25 is a side view of the pin retainer of FIG. 24.

[0033] FIG. 26 is another side view of the pin retainer of FIG. 24.

[0034] FIG. 27 shows a punch pin of the device of FIG. 1.

[0035] FIG. 28 is a perspective view of a front pin carrier of the device of FIG. 1.

[0036] FIG. 29 is a top view of the front pin carrier of FIG. 28.

[0037] FIG. 30 is a side view of the front pin carrier of FIG. 28.

[0038] FIG. 31 is a perspective view of a cable hold-down part of the device of FIG. 1.

[0039] FIG. 32 is a perspective view of a cable stop part of the device of FIG. 1.

[0040] FIG. 33 is a perspective view of a cable shim of the device of FIG. 1.

DETAILED DESCRIPTION

[0041] Aspects of the present disclosure relate to a device that efficiently punches adhesive injection ports into a fiber optic cable by simultaneously punching a plurality of the ports into one side of the fiber optic cable and then simultaneously punching a plurality of the ports into another side of the fiber optic cable.

[0042] Aspects of the present disclosure also relate to a device that punches adhesive injection ports into a fiber optic cable at a precise location along the longitudinal axis of the fiber optic cable. To this end, the device can punch the adhesive injection ports at a fixed distance from a ferrule or a connector body of the fiber optic cable.

[0043] Aspects of the present disclosure further relate to a device that punches adhesive injection ports into two opposing sides of a fiber optic cable, where the ports on the opposing sides are offset from one another along a longitudinal axis of the fiber optic cable.

[0044] Additionally, aspects of the present disclosure relate to a device that punches adhesive injection ports into a flat drop fiber optic cable.

[0045] Disclosed herein is a device for punching adhesive injection ports in a fiber optic cable. The device includes a nest in a fixed position. The nest includes a channel and a plurality of first and second pin holes on front and rear sides of the nest extending through the nest to the channel. The device further includes a pin carrier assembly, which includes first punch pins extending into the first pin holes on the rear side of the nest and second punch pins extending into the second pin holes on the front side of the nest. The device also includes a top plate located above the nest. The top plate is movable between an upper position, a first punching position lower than the upper position, and a second

punching position lower than the first punching position. Additionally, the device includes a rear cam block and a front cam block. The rear cam block is attached to the top plate and extends from an underside of the top plate. The front cam block is attached to the top plate and extends from the underside of the top plate. The front cam block is also spaced apart from and opposes the rear cam block. The rear cam block and the front cam block each comprise a protrusion. The protrusion on the rear cam block engages the pin carrier assembly causing the first punch pins to enter the channel when the top plate is in the first punching position. Similarly, the protrusion on the front cam block engages the pin carrier assembly causing the second punch pins to enter the channel when the top plate is in the second punching position.

[0046] In an embodiment of the device disclosed herein, the pin carrier assembly includes a front pin carrier assembly and a rear pin carrier assembly. The front pin carrier assembly comprises the second punch pins and the rear pin carrier assembly comprises the first punch pins.

[0047] In the following detailed description, reference is made to the accompanying drawings showing by way of illustration a specific embodiment of a device disclosed herein for punching adhesive injection ports into a fiber optic cable. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present disclosure. The following detailed description, therefore, is not to be taken in a limiting sense.

[0048] FIGS. 1-4 illustrate an embodiment of the device disclosed herein, when the top plate is in the upper position. FIGS. 5-8 illustrate the embodiment, when the top plate is in the first punching position. FIGS. 9-12 illustrate the embodiment, when the top plate is in the second punching position.

[0049] Referring to FIGS. 1-4, the device 20 has a nest 22 in a fixed position. The nest 22 includes a channel 24. The channel 24 extends along the length of the nest 22. Preferably, the channel 24 accommodates a flat drop fiber optic cable. The nest 22 also includes a plurality of first and second pin holes on front and rear sides of the nest. These pin holes extend through the nest 22 to the channel 24.

[0050] FIGS. 13-16 depict the nest 22 with first and second pin holes 26a, 26b. First pin holes 26b extend from the rear side 30 of the nest 22 to the channel 24. Likewise, second pin holes 26a extend from the front side 28 of the nest 22 to the channel 24.

[0051] As depicted in FIGS. 13-16, the first pin holes 26b on the rear side 30 of the nest 22 can be offset from the second pin holes 26a on the front side 28 of the nest 22 along a longitudinal axis A of the channel 24. It is preferable that the first pin holes 26b are offset from the second pin holes 26a to maintain the structural integrity of the fiber optic cable during and after punching adhesive injection ports. In an embodiment, as depicted in FIGS. 13-16, the nest 22 includes three first pin holes 26b on rear side 30 of nest 22 and three second pin holes 26a on front side 28. Three pin holes 26a, 26b on the front and rear sides 28, 30 of the nest 22 are preferable. This facilitates punching of three adhesive injection ports on opposing sides of a fiber optic cable.

[0052] Turning back to FIGS. 1-4, the device 20 also includes a pin carrier assembly 32. The pin carrier assembly 32 includes first punch pins 34a and second punch pins 34b. The first punch pins 34a extend into first pin holes 26b on the rear side 30 of the nest 22. The second punch pins 34b extend into second pin holes 26a on the front side 28 of the nest 22.

[0053] The device 20 further includes a top plate 36 located above the nest 22. The top plate 36 is moveable between the upper position (shown in FIGS. 1-3), the first punching position (shown in FIGS. 5-7), and the second punching position (shown in FIGS. 9-11). The first punching position of the top plate 36 is lower than the upper punching position

and the second punching position of the top plate 36 is lower than the first punching position. However, the top plate 36 is located above the nest 22 in each of the upper position, the first punching position, and the second punching position.

[0054] The device 20 also includes a rear cam block 38 and a front cam block 40 (see FIG. 3). The rear cam block 38 is attached to the top plate 36 and extends from an underside 42 of the top plate 36. The front cam block 40 is also attached to the top plate 36 and extends from the underside 42 of the top plate 36. The front cam block 40 is also spaced apart from and opposes the rear cam block 38. As depicted in the embodiment of the device 20 in FIG. 3, the rear cam block 38 and the front cam block 40 can be parallel to each other.

[0055] The rear cam block 38 and the front cam block 40 each comprise a protrusion 44a, 44b. The protrusion 44a on the rear cam block 38 engages the pin carrier assembly 32 causing the first punch pins 34a to enter the channel 24 when the top plate 36 is in the first punching position (see FIGS. 7 and 8). The protrusion 44b on the front cam block 40 engages the pin carrier assembly 32 causing the second punch pins 34b to enter the channel 24 when the top plate 36 is in the second punching position (see FIGS. 11 and 12).

[0056] In order to punch adhesive injection ports in a fiber optic cable, the top plate 36 is moved to the upper position. When the top plate 36 is in the upper position, the first and second punch pins 34a, 34b do not extend into the channel 24 (see FIGS. 3 and 4). The fiber optic cable is inserted into the channel 24, which holds the fiber optic cable in position during the punching process.

[0057] The top plate 36 is then moved to the first punching position, which is lower than the upper position. Since the rear cam block 38 and the front cam block 40 are both attached to the top plate 36 and extend from the underside 42 of the top plate 36, as the top plate 36 moves downward into the first punching position, the rear cam block 38 and the

front cam block 40 also move downward. When the top plate 36 reaches the first punching position, the protrusion 44a on the rear cam block 38 engages the pin carrier assembly 32. As a result, the first punch pins 34a enter the channel 24 (see FIGS. 7 and 8). Since the fiber optic cable is located within the channel 24, the first punch pins 34a are driven into and puncture the cable jacket (and buffer tube, if present) thereby forming adhesive injection ports on one side of the fiber optic cable.

[0058] Next, the top plate 36 is moved into the second punching position. When the top plate 36 moves out of the first punching position, the protrusion 44a on the rear cam block 38 no longer engages the pin carrier assembly 32 and the first punch pins 34a no longer enter the channel 24. As the top plate 36 moves further downward into the second punching position, the rear cam block 38 and the front cam block 40 also move further downward. When the top plate 36 reaches the second punching position, the protrusion 44b on the front cam block 40 engages the pin carrier assembly 32. As a result, the second punch pins 34b enter the channel 24 (see FIGS. 11 and 12). Since the fiber optic cable is located within the channel 24, the second punch pins 34b are driven into and puncture the cable jacket (and buffer tube, if present) thereby forming adhesive injection ports on the other side of the fiber optic cable.

[0059] The top plate 36 can then be moved back to the upper position. When the top plate 36 reaches the upper position again, neither the first punch pins 34a nor the second punch pins 34b enter the channel 24 and the fiber optic cable can then be removed from the channel 24 (see FIGS. 3 and 4).

[0060] As discussed above, the embodiment of the device 20 punches three adhesive injection ports on each side of the fiber optic cable. Although it is appreciated that only one or two or alternatively more than three adhesive injection ports can be punched simultaneously on each side of the cable (depending on the number of first and second

punch pins and first and second pin holes), it is desirable for the device to punch three adhesive injection ports on each side of the fiber optic cable. The middle adhesive injection port can be used to inject adhesive and the other two adhesive injection ports can be used as vent ports during injection of adhesive. During injection of adhesive into the conduit passage of the fiber optic cable through the middle port, the adhesive flows in upstream and downstream directions. Adhesive flow continues in the upstream and downstream directions until the adhesive reaches the upstream and downstream vent ports. At this time, the adhesive begins to flow out of the conduit passage through the vent ports. Thus, the upstream and downstream vent ports effectively control the longitudinal length of the adhesive volume within the conduit passage. After the adhesive has been injected into the conduit passage, the adhesive can be cured over time or through a temperature-based curing process (e.g., heating over a certain time) or other curing process (e.g., UV curing, room temperature curing, etc.).

[0061] To facilitate movement of the top plate 36 between the upper position, the first punching position, and the second punching position, a force is applied to the top plate 36. In particular, a first force must be applied to the top plate 36 to move the top plate 36 from the upper position to the first punching position. A second force must be applied to the top plate 36 to move the top plate 36 from the first punching position to the second punching position. In an embodiment, the first force and the second force are equal.

[0062] To facilitate movement of the top plate 36 between the upper position, the first punching position, and the second punching position and exert the first force and the second force on the top plate 36, the device 20 can include a crank assembly 80. The crank assembly 80 includes a crank 82 and a linkage 84. The crank 82 rotates between a first position (see FIG. 3), a second position (see FIG. 7), and a third position (see FIG. 11). The first position corresponds to the upper position of the top plate 36. The second

position corresponds to the first punching position of the top plate 36. The third position corresponds to the second punching position of the top plate 36. The linkage 84 moves the top plate 36 between the upper position, the first punching position, and the second punching position as the crank 82 is rotated between the first position, the second position, and the third position, respectively. FIG. 3 shows the crank in the first position in which the crank 82 is oriented vertically. FIG. 7 shows the crank 82 in the second position in which the crank 82 is oriented 45 degrees from vertical. FIG. 11 shows the crank 82 in the third position in which the crank 82 is oriented horizontally. However, it is appreciated that the position of the crank 82 can have different orientations when the crank 82 is in the first, second, and third positions.

[0063] The embodiment of the device 20 further includes a bottom plate 58. The bottom plate 58 is in a fixed position below the top plate 36. The nest 22 is attached to an upper side 66 of the bottom plate 58. Thus, in the embodiment of the device 20, the top plate 36 moves up and down relative to the stationary bottom plate 58. The embodiment of the device 20 also includes a base 78 below the bottom plate 58.

[0064] As best depicted in FIGS. 3, 7, and 11, the bottom plate 58 can include a pair of slots 74 extending through the height of the bottom plate 58. These slots 74 can accommodate the downward movement of the front cam block 40 and the rear cam block 38. The front cam block 40 and the rear cam block 38 can traverse the slots 74 when the top plate 36 is in the first punching position and the second punching position.

[0065] In order to ensure the first punch pins 34a remain outside the channel 24 when the top plate 36 is in the upper position and the second punching position, the first punch pins 34a can be biased outside of the channel 24 by springs. When the protrusion 44a on the rear cam block 38 engages the pin carrier assembly 32, the springs compress and the first punch pins 34a enter the channel 24.

[0066] Similarly, in order to ensure the second punch pins 34b remain outside the channel 24 when the top plate 36 is in the upper position and the first punching position, the second punch pins 34b can be biased outside of the channel by springs. When the protrusion 44b on the front cam block 40 engages the pin carrier assembly 32, the springs compress and the second punch pins 34b enter the channel 24.

[0067] Focusing on FIG. 4, according to the embodiment of the device 20, the pin carrier assembly 32 includes a front pin carrier assembly 46 and a rear pin carrier assembly 48. The front pin carrier assembly 46 comprises the second punch pins 34b and the rear pin carrier assembly 48 comprises the first punch pins 34a.

[0068] In the embodiment of the device 20, each of the front pin carrier assembly 46 and the rear pin carrier assembly 48 includes two parts. Specifically, the front pin carrier assembly 46 includes a front pin carrier and a pin retainer. Likewise, the rear pin carrier assembly 48 comprises a rear pin carrier and a pin retainer. FIGS. 19-21 depict the rear pin carrier 50. FIGS. 28-30 depict the front pin carrier 60. FIGS. 24-26 depict the pin retainer 70.

[0069] As shown in FIGS. 19-21, the rear pin carrier 50 is U-shaped and has a rear recess 52 formed by its U-shape. The rear pin carrier 50 has opposing mounting arms 54. These mounting arms 54 are attached to the rear side 30 of the nest 22 as shown in FIG. 4. Also, as shown in FIGS. 19-21, the rear pin carrier 50 includes a plurality of holes 55 between the mounting arms 54. The number of holes 55 corresponds to the number of first punch pins 34a extending from the rear pin carrier 50. These holes 55 each include a counterbore 57. The counterbores 57 hold heads of the first punch pins 34a in place. The pin retainer 70 is located in the rear recess 52 of the rear pin carrier 50. The pin retainer 70 abuts the pin heads to retain the first punch pins 34a in place in the rear pin carrier 50, as shown in

FIG. 4. The first punch pins 34a extend from the rear pin carrier 50 into the first pin holes 26b on the rear side 30 of the nest 22, also as shown in FIG. 4.

[0070] As shown in FIGS. 28-30, the front pin carrier 60 is U-shaped and has a front recess 62 formed by its U-shape. The front pin carrier 60 has opposing mounting arms 64. These mounting arms 64 are attached to the front side 28 of the nest 22 as shown in FIG. 4. Also, as shown in FIGS. 28-30, the front pin carrier 60 includes a plurality of holes 65 between the mounting arms 64. The number of holes 65 corresponds to the number of second punch pins 34b extending from the front pin carrier 60. These holes 65 each include a counterbore 67. The counterbores 67 hold heads of the second punch pins 34b in place. The pin retainer 70 is located in the front recess 62 of the front pin carrier 60. The pin retainer 70 abuts the pin heads to retain the second punch pins 34b in place in the front pin carrier 60, as shown in FIG. 4. The second punch pins 34b extend from the front pin carrier 60 into the second pin holes 26a on the front side 28 of the nest 22, also as shown in FIG. 4.

[0071] In order to maintain the first punch pins 34a and the second punch pins 34b in an appropriate position (i.e., inside or outside the channel 24) when the top plate 36 is in the upper position, the first punching position, and the second punching position, respectively, the mounting arms 54, 64 of the rear and front pin carriers 50, 60 can be attached to the nest 22 via an attachment mechanism 56 including a spring. See FIG. 4. The springs in the attachment mechanisms 56 bias the rear pin carrier 50 and the front pin carrier 60 away from the rear side 30 and front side 28, respectively, of the nest 22.

[0072] As a result, the springs bias the first punch pins 34a outside the channel 24 when the top plate 36 is in the upper position and the second punching position. However, the protrusion 44a on the rear cam block 38 engages the pin retainer 70 when the top plate 36 is in the first punching position causing the springs to compress and the first punch pins

34a to enter the channel 24. See FIGS. 7-8. This compression results in the first punch pins 34a puncturing a fiber optic cable in the channel 24 creating adhesive injection ports on one side of the fiber optic cable.

[0073] Similarly, the springs bias the second punch pins 34b outside of the channel 24 when the top plate 36 is in the upper position and the first punching position. However, the protrusion 44b on the front cam block 40 engages the pin retainer 70 when the top plate 36 is in the second punching position causing the springs to compress and the second punch pins 34b to enter the channel 24. See FIGS. 11-12. This compression results in the second punch pins 34b puncturing a fiber optic cable in the channel creating adhesive injection ports on the other side of the fiber optic cable.

[0074] As shown in FIGS. 24-26, the pin retainers 70 are shaped so that they fit into the rear recess 52 and front recess 62 of the rear pin carrier 50 and the front pin carrier 60, respectively. The purpose of the pin retainers 70 is to hold the first punch pins 34a and the second punch pins 34b in the rear pin carrier 50 and the front pin carrier 60, respectively. In order to achieve this purpose, the pin retainers 70 are attached to the rear pin carrier 50 and the front pin carrier 60. The pin retainers 70 can be attached to the rear and front pin carriers 50, 60 with one or more bolts that extend through one or more holes 71 including counterbores 73 in the pin retainers 70. One or more additional holes 59, 69 in the rear and front pin carriers 50, 60 can receive the one or more bolts. If the one or more bolts extend beyond the one or more holes 59, 69, one or more auxiliary holes 27 in the rear and front sides 28, 30 of the nest 22 can accommodate the extension. See FIGS. 13-16.

[0075] An exemplary punch pin 34a, 34b is depicted in FIG. 27. The punch pin 34a, 34b includes a cylindrical portion 112 extending from a pin head 114. The cylindrical portion has a pointed end 116 opposite the pin head 114. The pointed end 116 of the punch pin 34a, 34b punctures the cable jacket (and buffer tube, if present) of the fiber optic cable.

[0076] The profile of the pointed end 116 generally fulfills two requirements. First, the profile should not break any optical fibers in the conduit passage of the fiber optic cable. Rather, the profile of the pointed end 116 should push aside any fibers that it comes into contact with. This is especially important, for example, if the punch pin 34a, 34b does not enter a buffer tube along the diameter of the tube but rather enters the buffer tube offset from the center. In this situation, the risk of fiber damage increases. Second, the profile of the pointed end 116 should be sufficient to puncture a suitably large hole for adhesive injection and/or venting. Angles between about 30 degrees and about 45 degrees are preferable. Preferably, the pointed end 116 forms a pin tip having an angle of about 30 degrees.

[0077] FIGS. 17 and 18 illustrate the rear cam block 38 according to the embodiment of the device 20. The rear cam block 38 has a generally planar shape having a length L_1 , a width W_1 , and a depth D_1 . A vertical axis VA_1 extends along the length L_1 of the rear cam block 38. A horizontal axis HA_1 extends along the width W_1 of the rear cam block 38. The protrusion 44a on the rear cam block 38 is located at an intermediate portion of the vertical axis VA_1 of the rear cam block 38. As depicted in FIG. 17, the protrusion 44a can extend across the width W_1 of the rear cam block 38 along the horizontal axis HA_1 of the rear cam block 38.

[0078] FIGS. 22 and 23 illustrate the front cam block 40 according to the embodiment of the device 20. Like the rear cam block 38, the front cam block 40 has a generally planar shape having a length L_2 , a width W_2 , and a depth D_2 . A vertical axis VA_2 extends along the length L_2 of the front cam block 40. A horizontal axis HA_2 extends along the width W_2 of the front cam block 40. The protrusion 44b on the front cam block 40 is located at an intermediate portion of the vertical axis VA_2 of the front cam block 40. As depicted in

FIG. 22, the protrusion 44b can extend across the width W_2 of the front cam block 40 along the horizontal axis HA_2 of the front cam block 40.

[0079] With the configuration of the rear and front cam blocks 38, 40 shown in FIGS. 17-18 and 22-23, the protrusions 44a, 44b of the rear and front cam blocks 38, 40 can engage faces 76 of the pin retainers 70 opposing the rear pin carrier 50 and the front pin carrier 60. More particularly, the protrusion 44a of the rear cam block 38 can engage the face 76 of the pin retainer 70 opposing the rear pin carrier 50 when the top plate 36 is in the first punching position. The protrusion 44b of the front cam block 40 can engage the face 76 of the pin retainer 70 opposing the front pin carrier 60 when the top plate 36 is in the second punching position.

[0080] As best viewed in FIGS. 3, 7, and 11, the embodiment of the device 20 further includes a cable hold-down part 68. The cable hold-down part 68 is above the nest 22 and moves in conjunction with the top plate 36. In use, the cable hold-down part 68 prevents movement of a fiber optic cable in the vertical direction in the channel 24 when the top plate 36 is in the first punching position and the second punching position (see FIGS. 7 and 11). More particularly, when the top plate 36 is in the upper position, the cable hold-down part 68 can be located above the channel 24 and spaced apart from the fiber optic cable in the channel 24. See FIG. 3. When the top plate 36 is in the first punching position and the second punching position, respectively, the cable hold-down part 68 is in a more downward position near the channel 24 and the cable-hold down part 68 contacts the fiber optic cable in the channel 24 to maintain its position in the channel 24. See FIGS. 7 and 11.

[0081] As shown in FIG. 3, the cable hold-down part 68 can be biased away from the top plate 36 by a spring 72 when the top plate 36 is in the upper position. As shown in FIG. 7, the spring 72 can be compressed when the top plate 36 is in the first punching position.

Similarly, as shown in FIG. 11, the spring 72 can be further compressed when the top plate 36 is in the second punching position.

[0082] FIG. 31 shows the cable hold-down part 68 of the embodiment of the device 20 in further detail. The cable-hold down part 68 includes a contact portion 88. The contact portion 88 is rectangular in shape having a length L_3 , a width W_3 , and a height H_3 . The width W_3 is slightly smaller than the width of the channel 24. A bottom face 90 of the contact portion 88 contacts the fiber optic cable in the channel 24 to maintain its position in the channel 24 when the top plate 36 is in the first punching position and the second punching position. See FIGS. 7 and 11.

[0083] The device disclosed herein can include a cable stop part. The cable stop part ensures the adhesive injection ports are punctured at a fixed distance from a ferrule or a connector body of the fiber optic cable. The device as disclosed herein can also include one or more cable shims. In use, one or more cable shims are inserted in the channel of the nest so that the nest can accommodate different sizes of fiber optic cables. The cable shim(s) elevate smaller fiber optic cables in the channel of the nest. The cable shim(s) can be removed from the channel. Thus, the cable shim(s) are removably insertable into the channel.

[0084] FIG. 32 shows a cable stop part 100 of the embodiment of the device 20. The cable stop part 100 has an upper side 92 including a notch 94. The notch 94 is designed to receive a ferrule of the fiber optic cable. The cable stop part 100 also has a cable stop channel 96 in the upper side 92. The cable stop channel 96 extends along the upper side 92 of the cable stop part 100 along a longitudinal axis B from the notch 94 to a side 98 opposite the notch 94. Preferably, the width of the cable stop channel is the same as the width of the channel 24. The cable stop part 100 additionally includes a foot 102. The foot 102 extends along the longitudinal axis B of the cable stop part 100 from the side 98.

The foot 102 can be inserted under the bottom plate 58 and removed from under the bottom plate 58. Thus, the foot 102 is removably insertable under the bottom plate 58.

[0085] FIG. 33 depicts a cable shim 110 of the embodiment of the device 20. The cable shim 110 is paddle-shaped and includes wider paddle portions 104 on its longitudinal ends. A longitudinal section 106 extends between the wider paddle portions 104. The width of the longitudinal section 106 fits within the width of the channel 24. The length of the longitudinal section 106 also fits within the length of the channel 24. Preferably, the length of the longitudinal section 106 is equal to the length of the channel 24. In use, the longitudinal section 106 is placed inside the channel 24 with the longitudinal section 106 lying flat against the bottom of the channel 24. The wider paddle portions 104 are outside the channel 24 at its ends preventing the longitudinal section 106 from slipping from the channel 24. Thus, the wider paddle portions 104 secure the longitudinal section 106 within the channel 24.

[0086] From the foregoing detailed description, it will be evident that modifications and variations can be made to the device disclosed herein without departing from the spirit or scope of the disclosure.

REFERENCE LETTERS/NUMBERS

[0087] longitudinal axis A

[0088] longitudinal axis B

[0089] depth D₁

[0090] depth D₂

[0091] height H₃

[0092] horizontal axis HA₁

[0093] horizontal axis HA₂

[0094] length L₁

[0095] length L_2

[0096] length L_3

[0097] vertical axis VA_1

[0098] vertical axis VA_2

[0099] width W_1

[0100] width W_2

[0101] width W_3

[0102] device 20

[0103] nest 22

[0104] channel 24

[0105] second pin hole 26a

[0106] first pin hole 26b

[0107] auxiliary hole 27

[0108] front side 28

[0109] rear side 30

[0110] pin carrier assembly 32

[0111] first punch pin 34a

[0112] second punch pin 34b

[0113] top plate 36

[0114] rear cam block 38

[0115] front cam block 40

[0116] underside 42

[0117] protrusion 44a

[0118] protrusion 44b

[0119] front pin carrier assembly 46

[0120] rear pin carrier assembly 48

[0121] rear pin carrier 50

[0122] rear recess 52

[0123] mounting arm 54

[0124] hole 55

[0125] attachment mechanism 56

[0126] counterbore 57

[0127] bottom plate 58

[0128] hole 59

[0129] front pin carrier 60

[0130] rear recess 62

[0131] mounting arm 64

[0132] hole 65

[0133] upper side 66

[0134] counterbore 67

[0135] cable hold-down part 68

[0136] hole 69

[0137] pin retainer 70

[0138] hole 71

[0139] spring 72

[0140] counterbore 73

[0141] slot 74

[0142] face 76

[0143] base 78

[0144] crank assembly 80

[0145] crank 82

[0146] linkage 84

[0147] contact portion 88

[0148] bottom face 90

[0149] upper side 92

[0150] notch 94

[0151] cable stop channel 96

[0152] side 98

[0153] cable stop part 100

[0154] foot 102

[0155] paddle portion 104

[0156] longitudinal section 106

[0157] cable shim 110

[0158] cylindrical portion 112

[0159] pin head 114

[0160] pointed end 116

CLAIMS

What is claimed is:

1. A device for punching adhesive injection ports in a fiber optic cable, comprising:
 - a nest in a fixed position including a channel and a plurality of first and second pin holes on front and rear sides of the nest extending through the nest to the channel;
 - a pin carrier assembly comprising first punch pins extending into the first pin holes on the rear side of the nest and second punch pins extending into the second pin holes on the front side of the nest;
 - a top plate located above the nest and movable between an upper position, a first punching position lower than the upper position, and a second punching position lower than the first punching position;
 - a rear cam block attached to the top plate and extending from an underside of the top plate;
 - a front cam block attached to the top plate and extending from the underside of the top plate, the front cam block being spaced apart from and opposing the rear cam block, wherein
 - the rear cam block and the front cam block each comprise a protrusion;
 - the protrusion on the rear cam block engages the pin carrier assembly causing the first punch pins to enter the channel when the top plate is in the first punching position;
 - and
 - the protrusion on the front cam block engages the pin carrier assembly causing the second punch pins to enter the channel when the top plate is in the second punching position.

2. The device of claim 1, wherein the first pin holes on rear side of nest are offset from the second pin holes on the front side of nest along a longitudinal axis of the channel.
3. The device of claim 1, comprising three first pin holes on rear side of nest and three second pin holes on front side of nest.
4. The device of claim 1, wherein the pin carrier assembly comprises a front pin carrier assembly and a rear pin carrier assembly, wherein the front pin carrier assembly comprises the second punch pins and the rear pin carrier assembly comprises the first punch pins.
5. The device of claim 1, wherein the first punch pins are biased outside of the channel by springs when the top plate is in the upper position and the second punching position.
6. The device of claim 1, wherein the second punch pins are biased outside of the channel by springs when the top plate is in the upper position and the first punching position.
7. The device of claim 4, wherein
the front pin carrier assembly comprises a front pin carrier that has a front recess formed by its U-shape and a first pin retainer in the front recess of the front pin carrier;
the rear pin carrier assembly comprises a rear pin carrier that has a rear recess formed by its U-shape and a second pin retainer in the rear recess of the rear pin carrier;
each of the front pin carrier and the rear pin carrier have opposing mounting arms;

the mounting arms of the front pin carrier are attached to the front side of the nest;
the mounting arms of the rear pin carrier are attached to the rear side of the nest;
the first punch pins extend from the rear pin carrier into the first pin holes on the rear side of the nest; and
the second punch pins extend from the front pin carrier into the second pin holes on the front side of the nest.

8. The device of claim 7, wherein

the mounting arms of the front pin carrier and the rear pin carrier are each attached to the nest via an attachment mechanism including a spring;

the springs bias the first punch pins outside the channel when the top plate is in the upper position and the second punching position;

the springs bias the second punch pins outside of the channel when the top plate is in the upper position and the first punching position;

the protrusion on the rear cam block engages the second pin retainer when the top plate is in the first punching position causing the springs to compress and the first punch pins to enter the channel; and

the protrusion on the front cam block engages the first pin retainer when the top plate is in the second punching position causing the springs to compress and the second punch pins to enter the channel.

9. The device of claim 1, further comprising a cable hold-down part above the nest moveable in conjunction with the top plate, wherein the cable hold-down part prevents movement of a cable in the channel in the vertical direction when the top plate is in the first punching position and the second punching position.

10. The device of claim 9, wherein the cable hold-down part is biased away from the top plate by a spring when the top plate is in the upper position and the spring is compressed when the top plate is in the first punching position and the second punching position.

11. The device of claim 1, further comprising a bottom plate in a fixed position below the top plate, wherein the nest is attached to an upper side of the bottom plate.

12. The device of claim 1, further comprising a crank assembly including a crank and a linkage, wherein linkage moves the top plate between the upper position, the first punching position, and the second punching position as the crank is rotated between a first position, a second position, and a third position.

13. The device of claim 1, further comprising a cable shim removably insertable into the channel.

14. The device of claim 11, further comprising a cable stop part having:

a notch in an upper side of the cable stop part for receiving a ferrule of the fiber optic cable;

a cable stop channel in the upper side of the cable stop part extending along the upper side of the cable stop part along a longitudinal axis of the cable stop part from the notch to a side of the cable stop part opposite the notch, a width of the cable stop channel corresponding to a width of the channel in the nest; and

a foot removably insertable under the bottom plate, the foot extending along a longitudinal axis of the cable stop part from the side of the cable stop part opposite the notch.

15. The device of claim 11, wherein the bottom plate comprises a pair of slots extending through a height of the bottom plate, the front cam block and the rear cam block traversing the slots when the top plate is in the first punching position and the second punching position.

16. The device of claim 1, wherein the protrusions on the rear cam block and the front cam block are located at intermediate portions of vertical axes of the rear cam block and the front block.

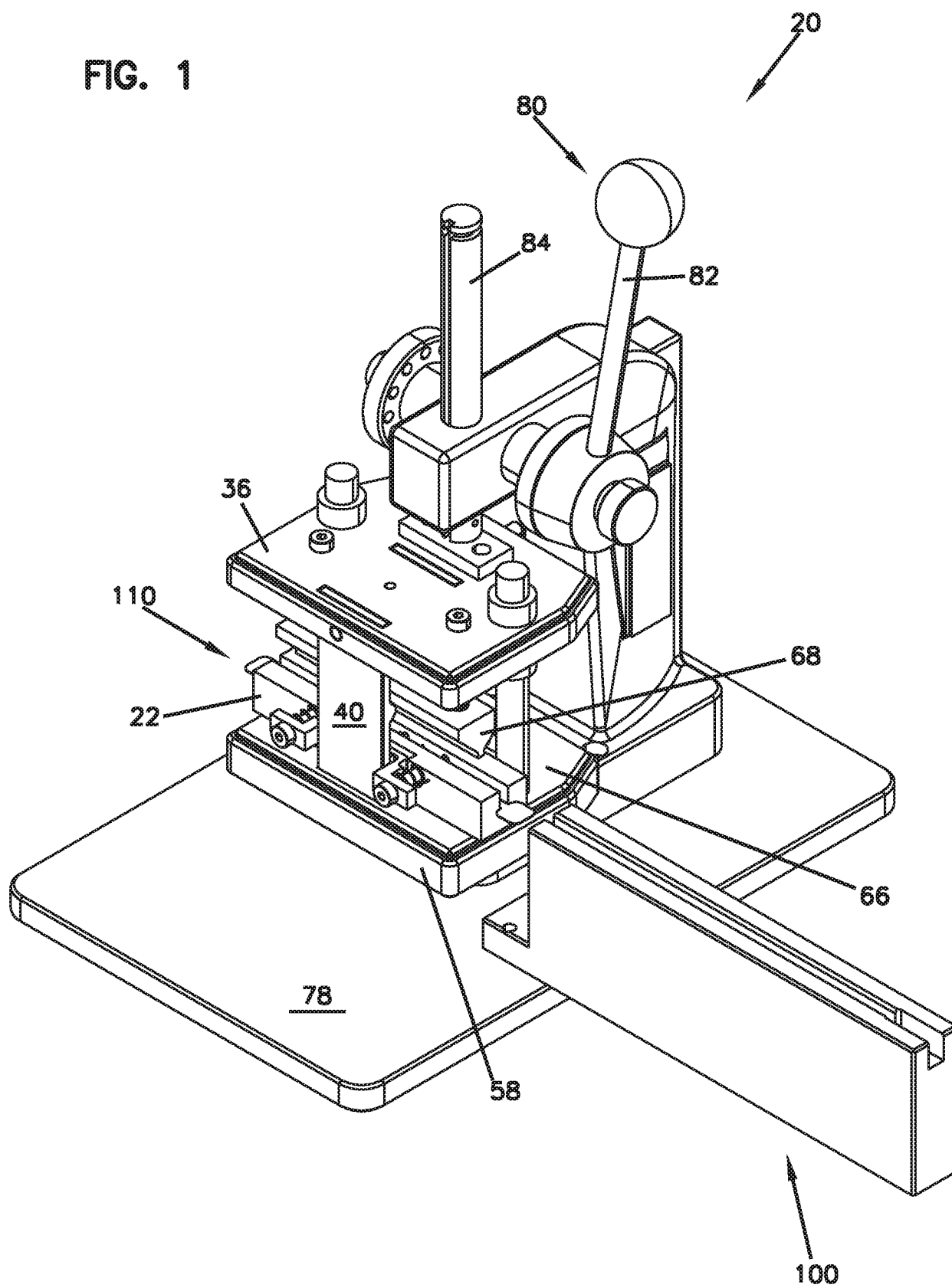
17. The device of claim 1, wherein the protrusions on the rear cam block and the front cam block extend across widths of the rear cam block and the front cam block along horizontal axes of the rear cam block and the front cam block.

18. The device of claim 1, wherein the channel in the nest accommodates a flat drop cable.

19. The device of claim 1, wherein a first force must be applied to the top plate to move the top plate from the upper position to the first punching position and a second force must be applied to move the top plate from the first punching position to the second punching position.

20. The device of claim 1, further comprising a base below the bottom plate.

FIG. 1



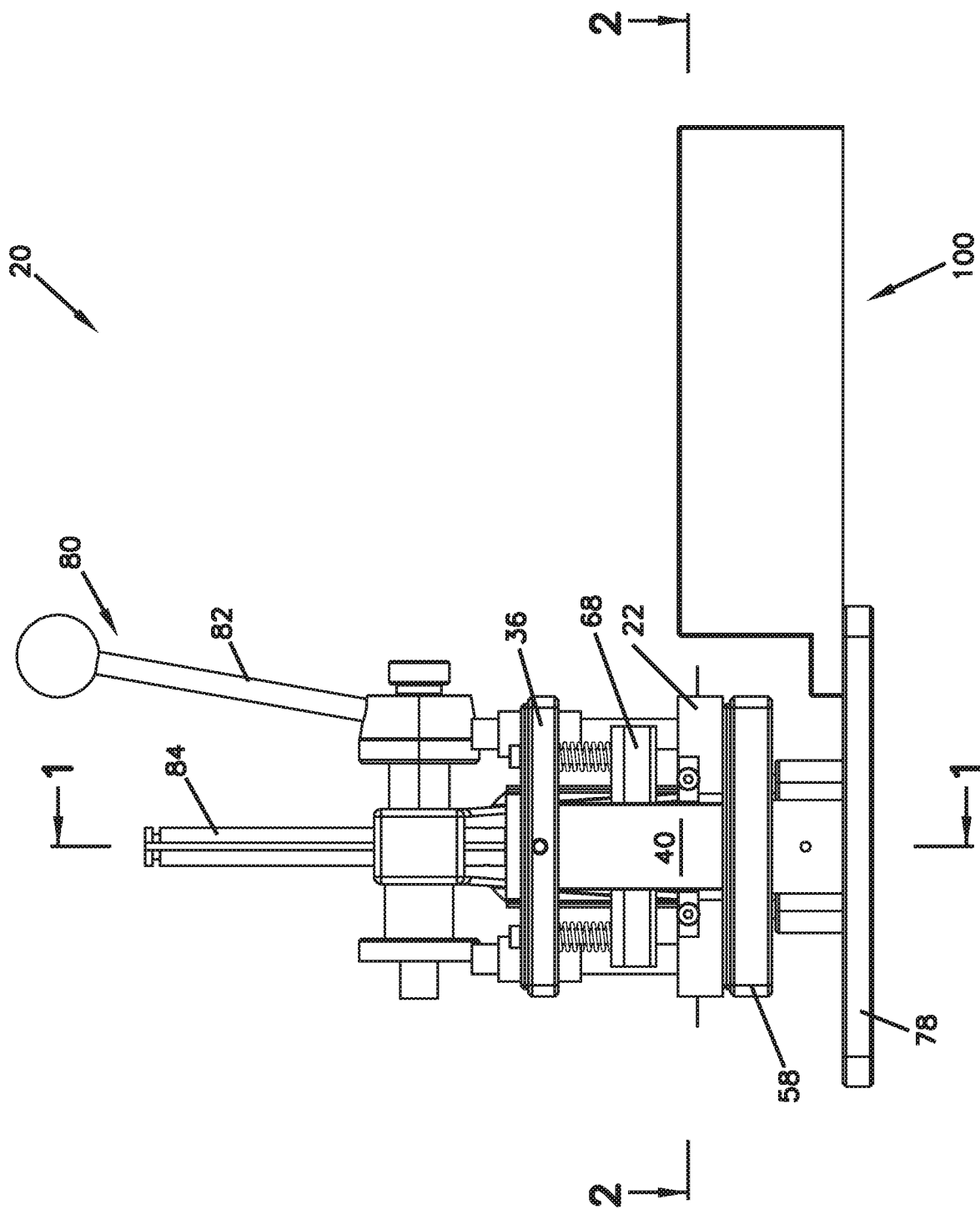


FIG. 2

FIG. 3

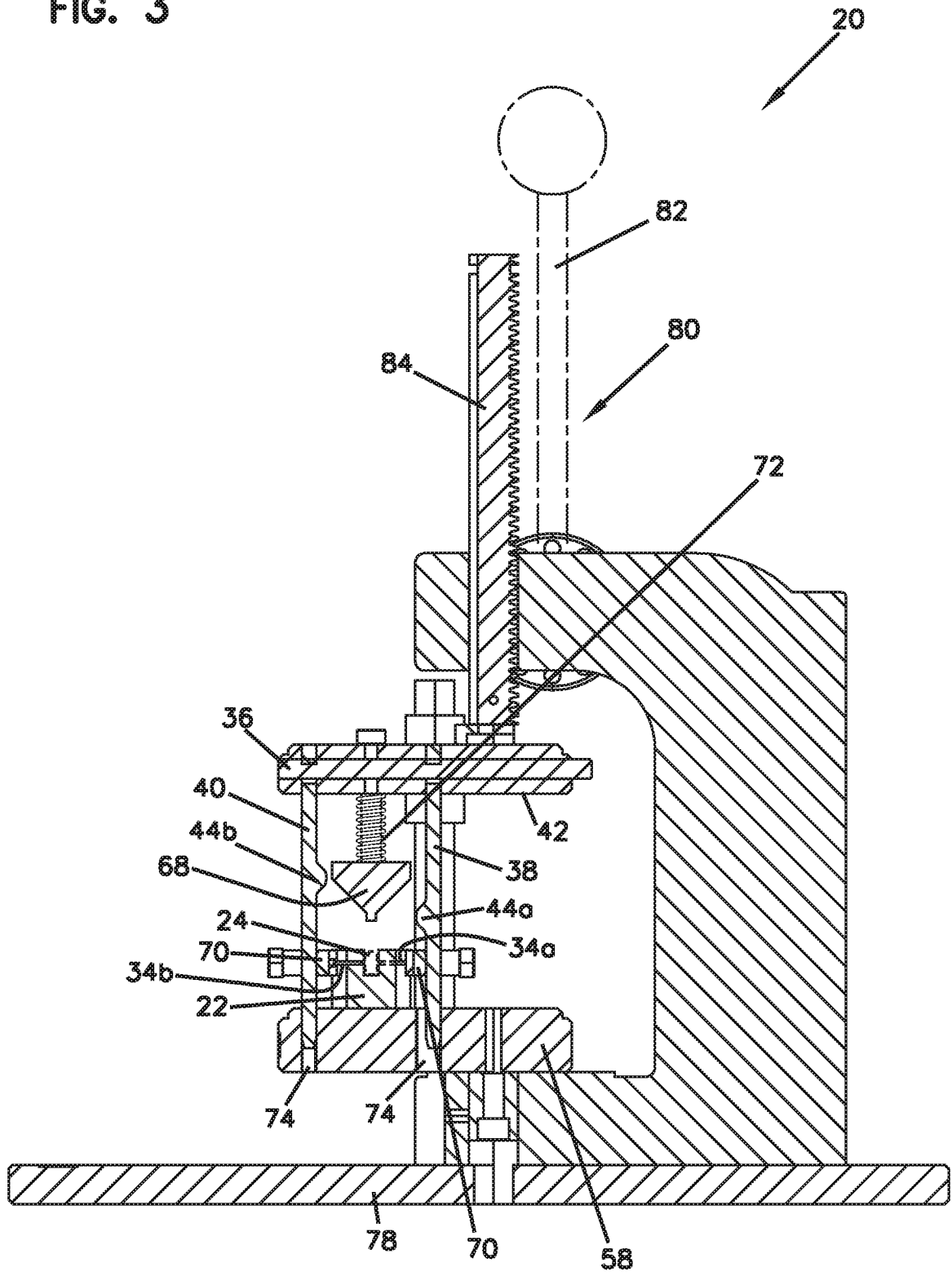
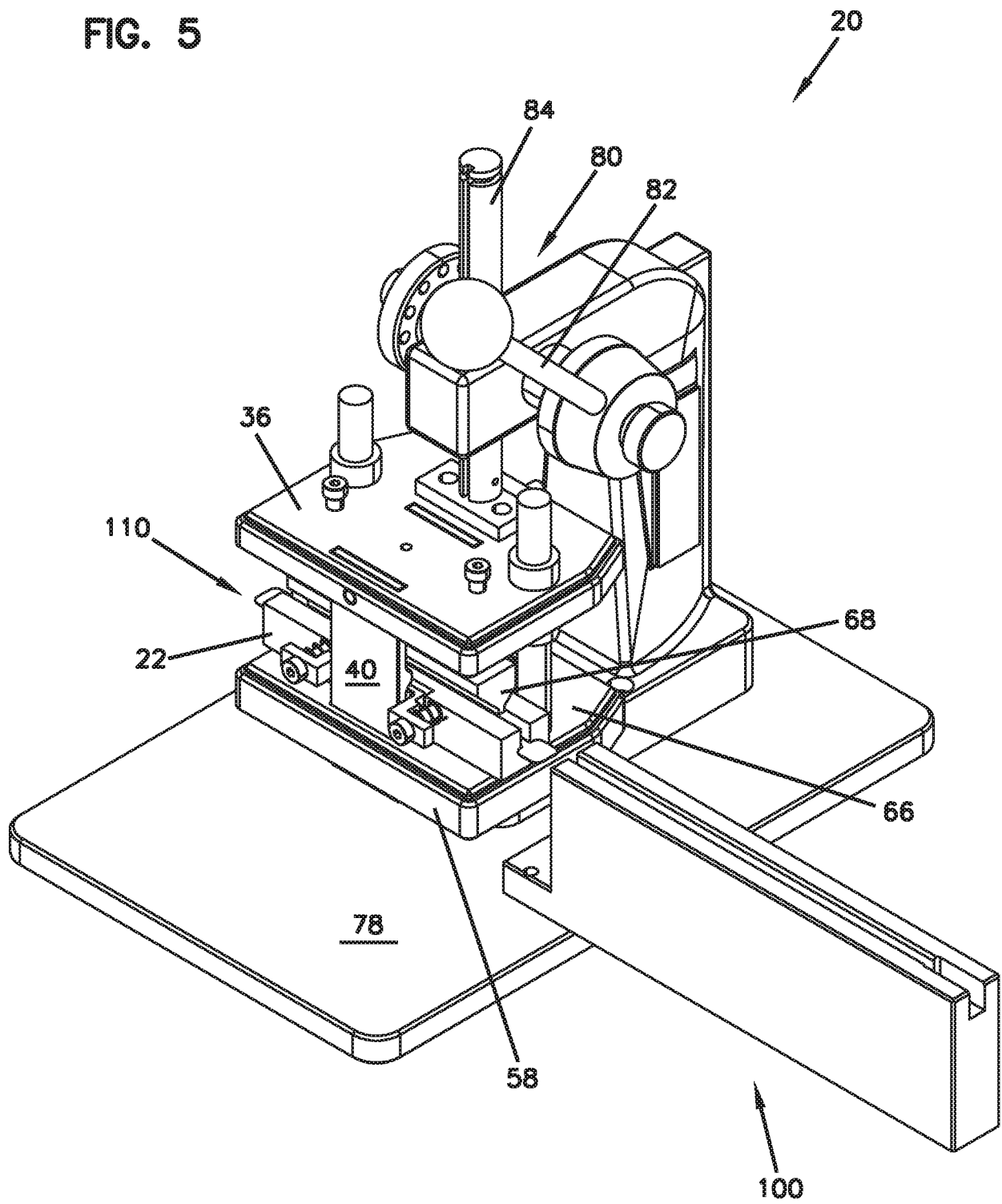
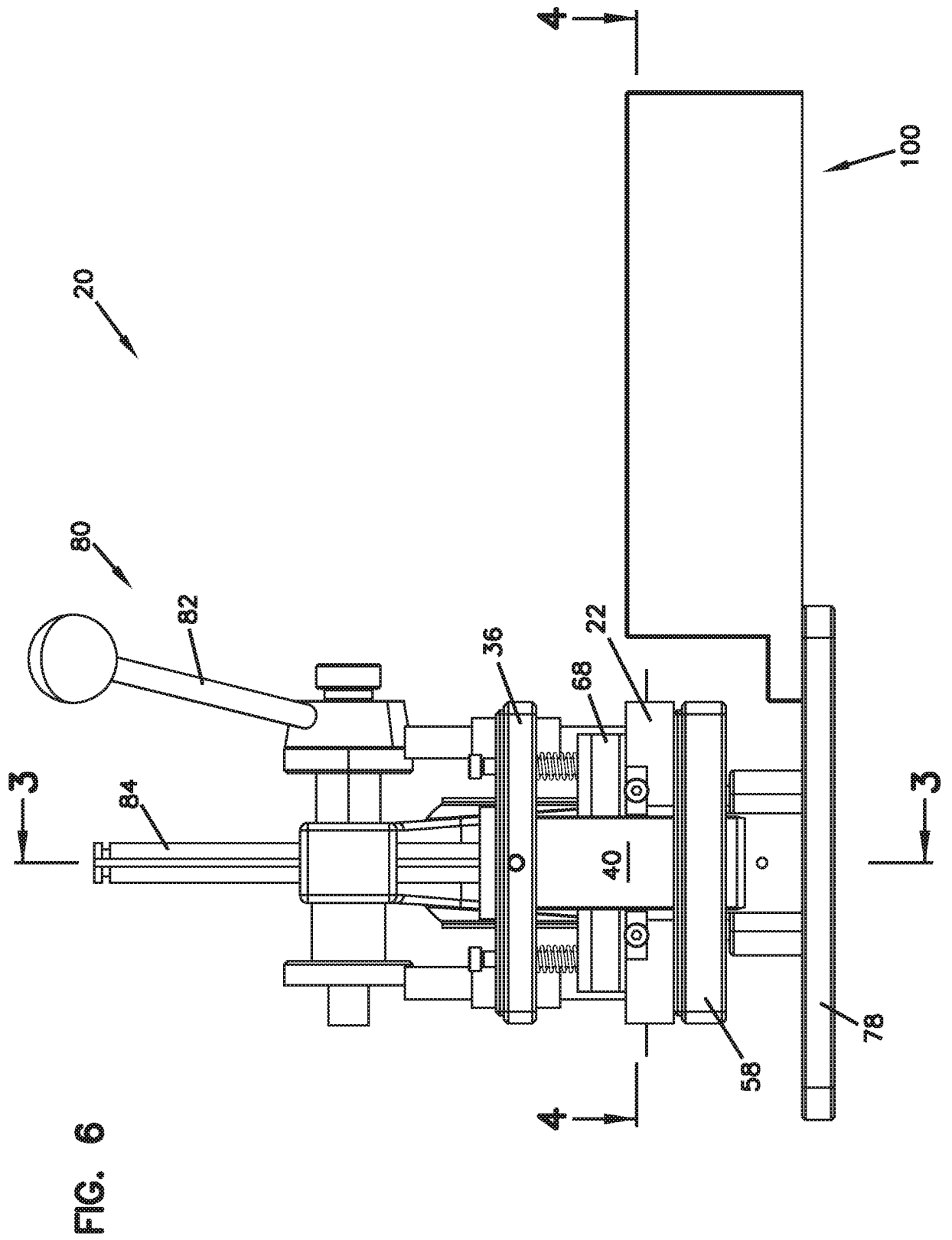
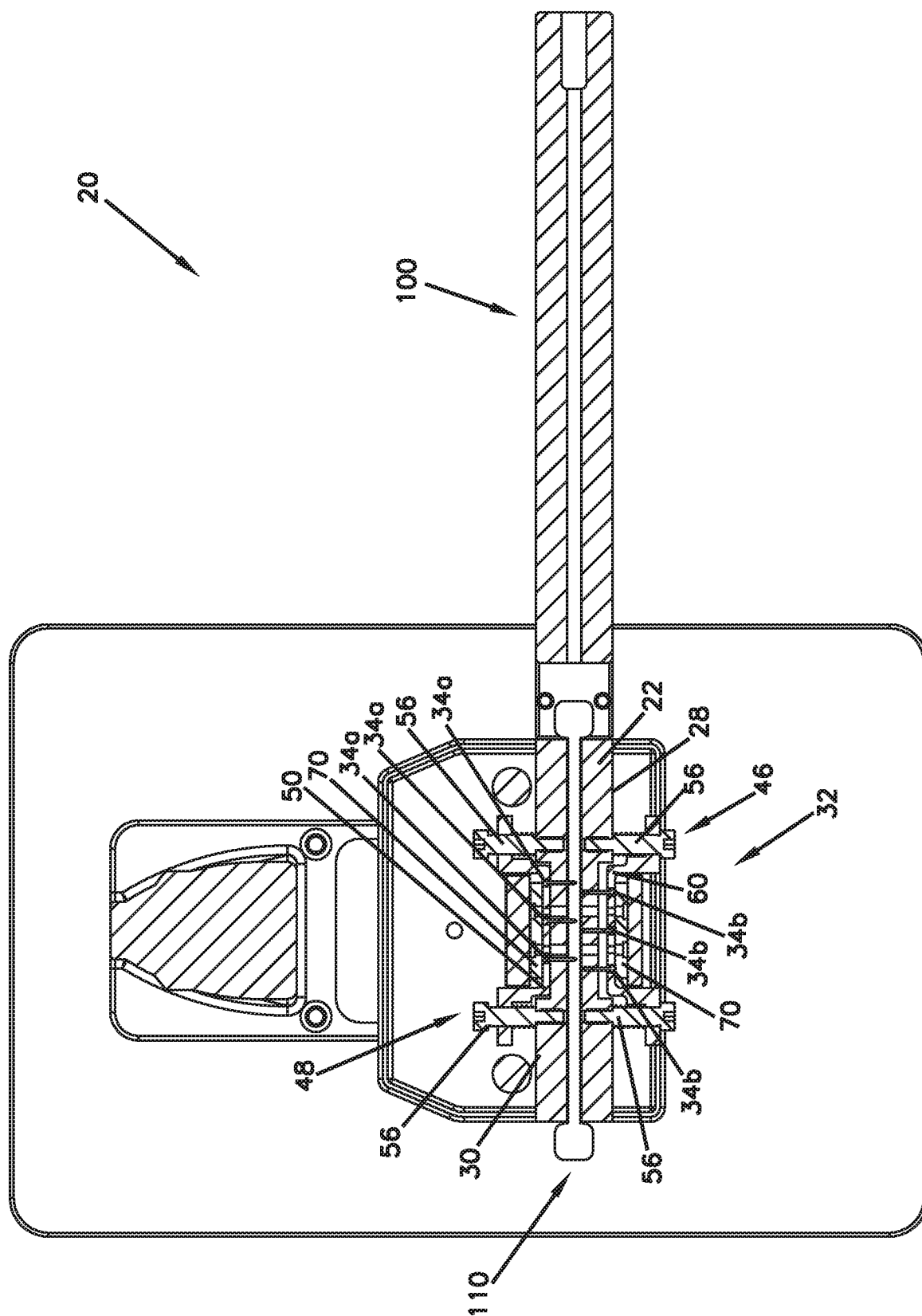


FIG. 5







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FIG. 9

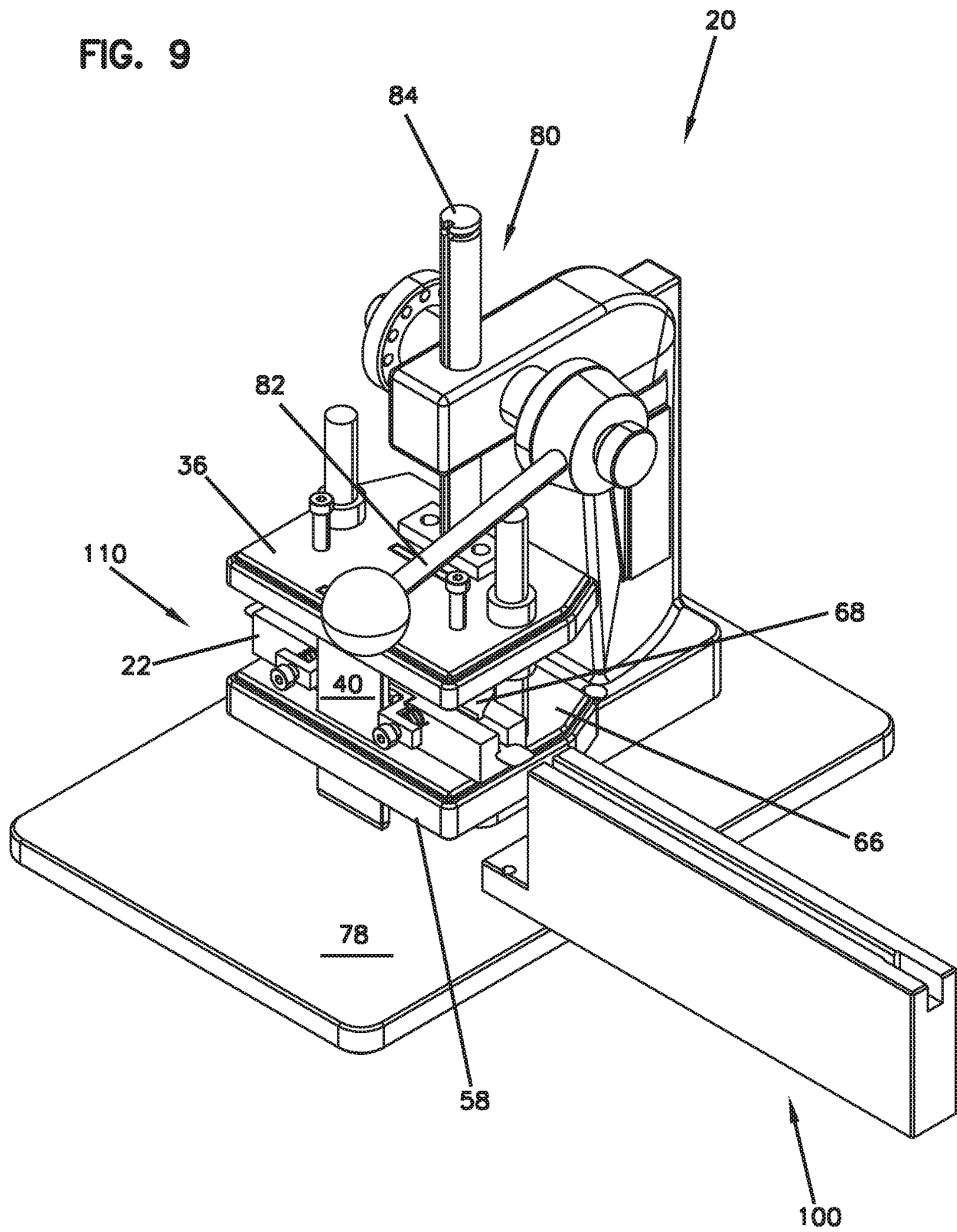
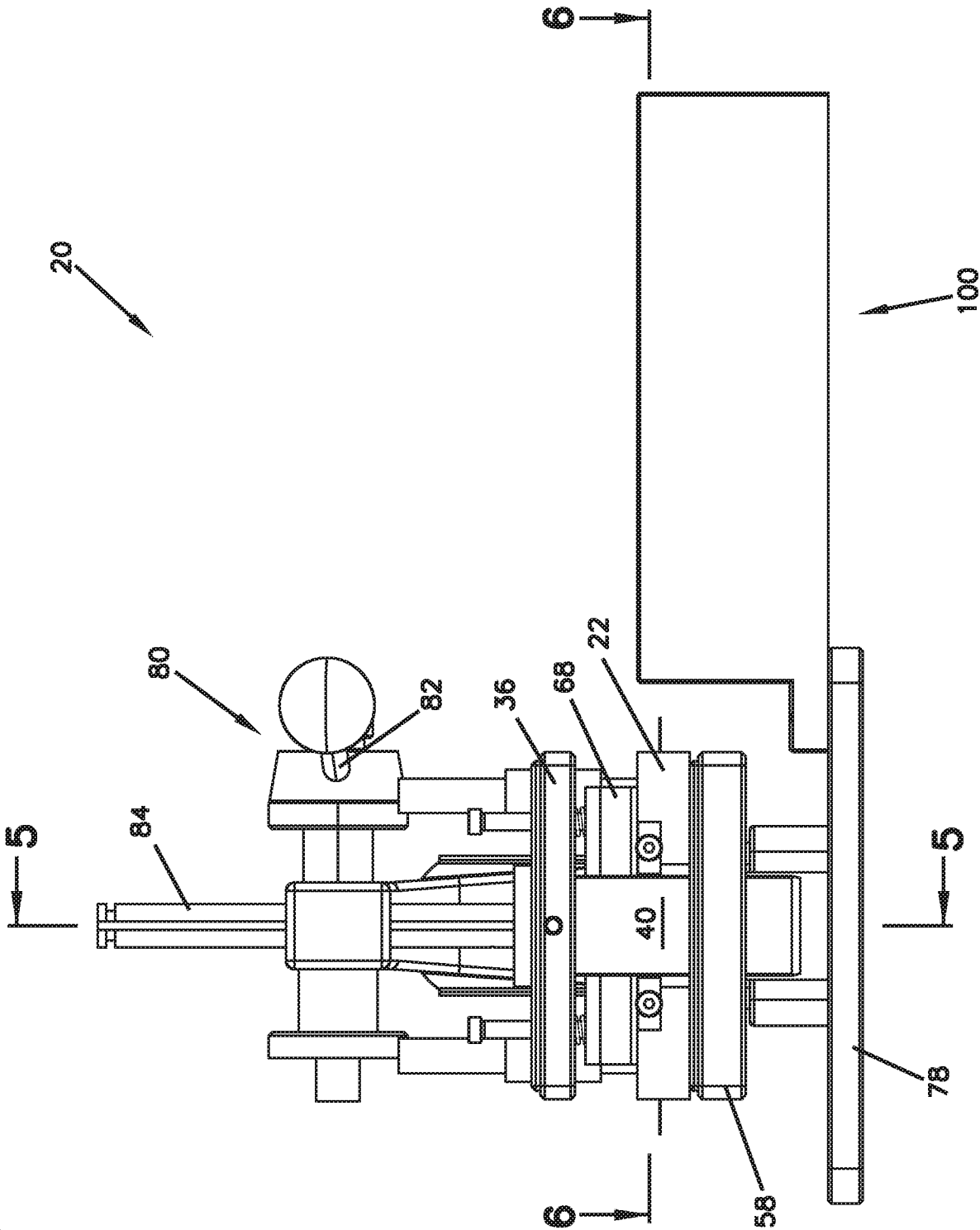


FIG. 10



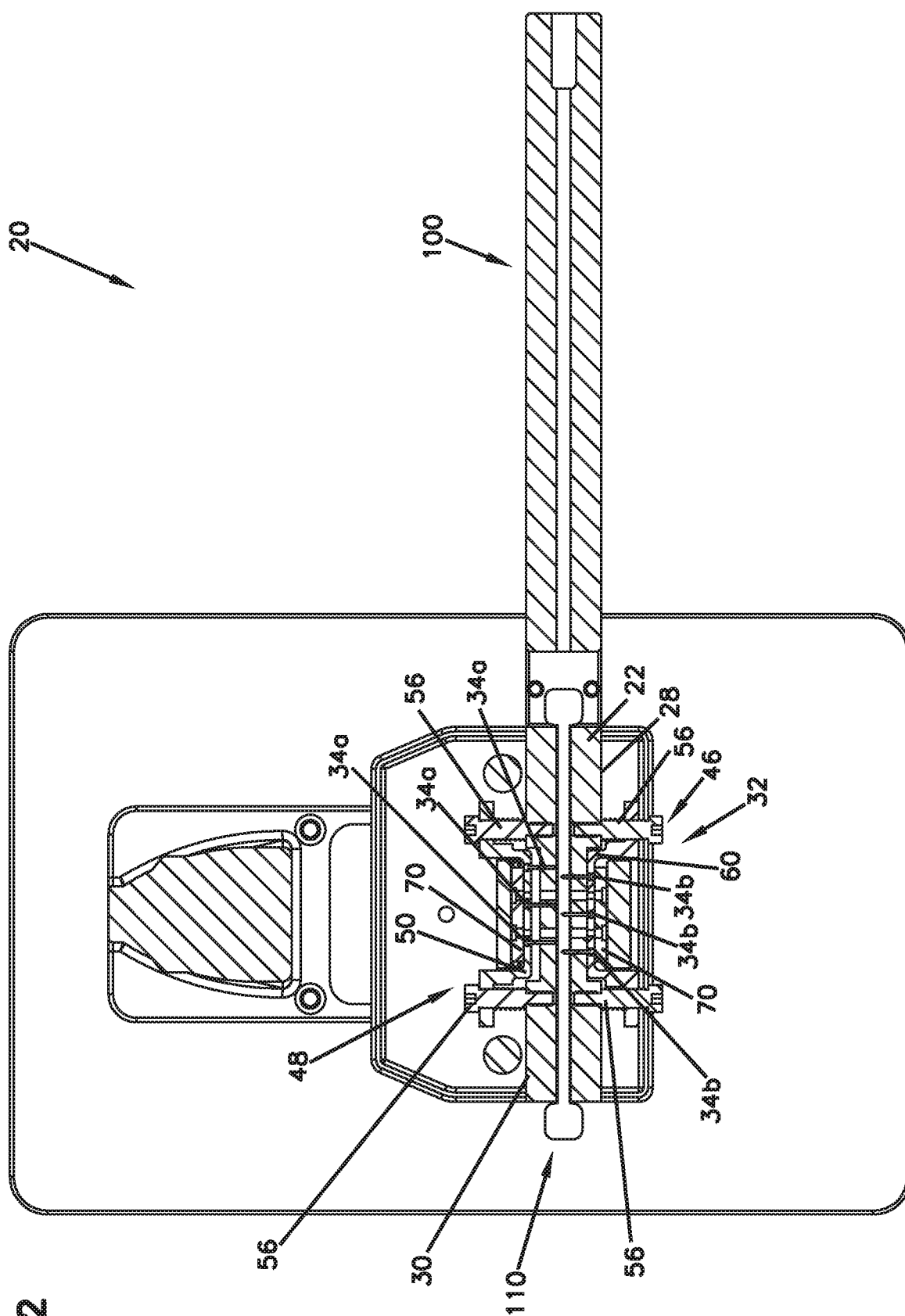


FIG. 13

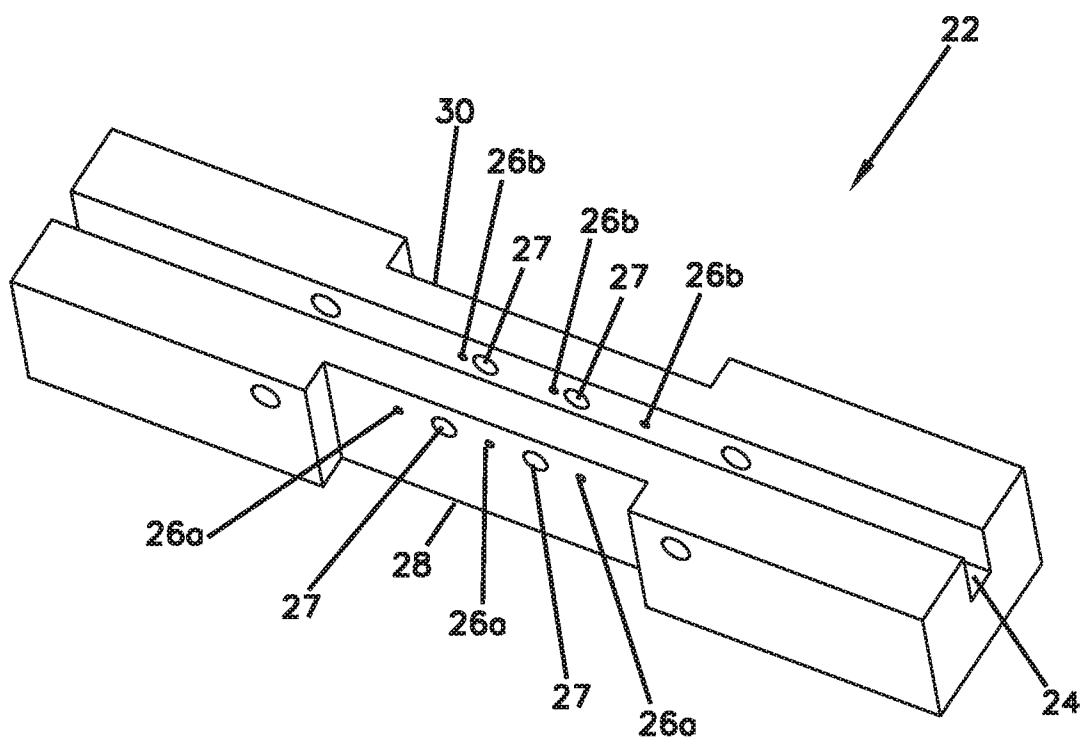


FIG. 14

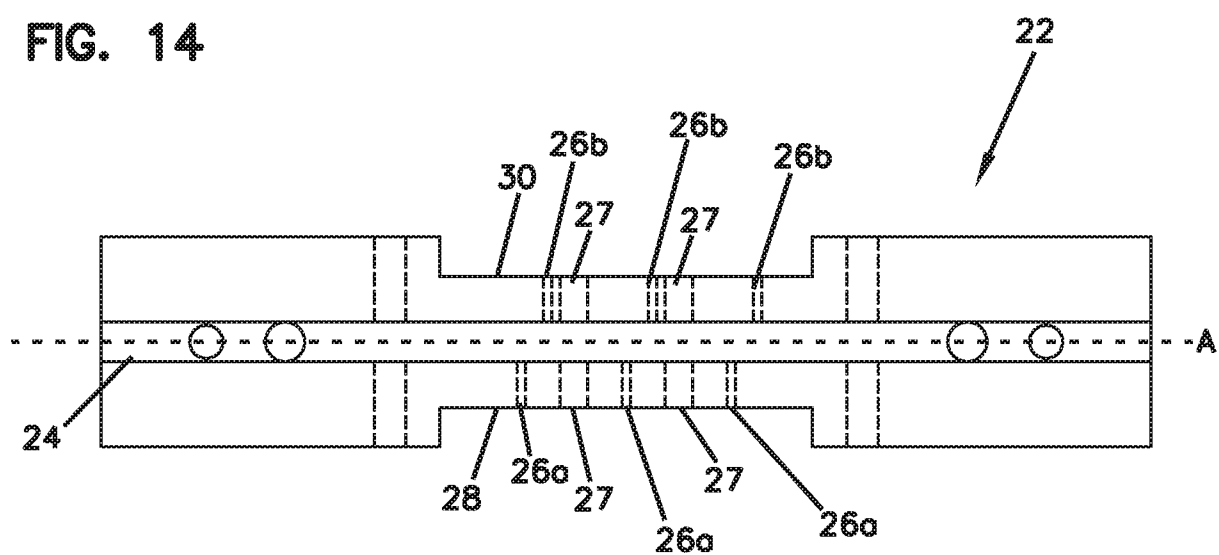


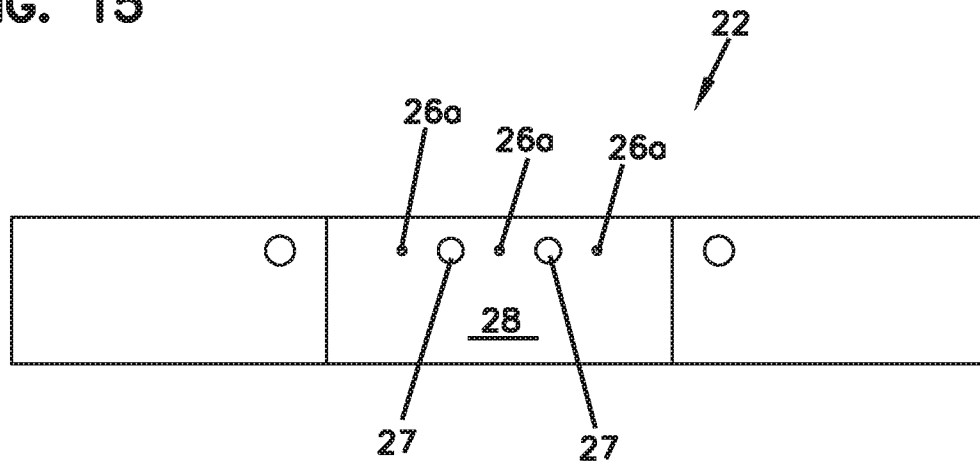
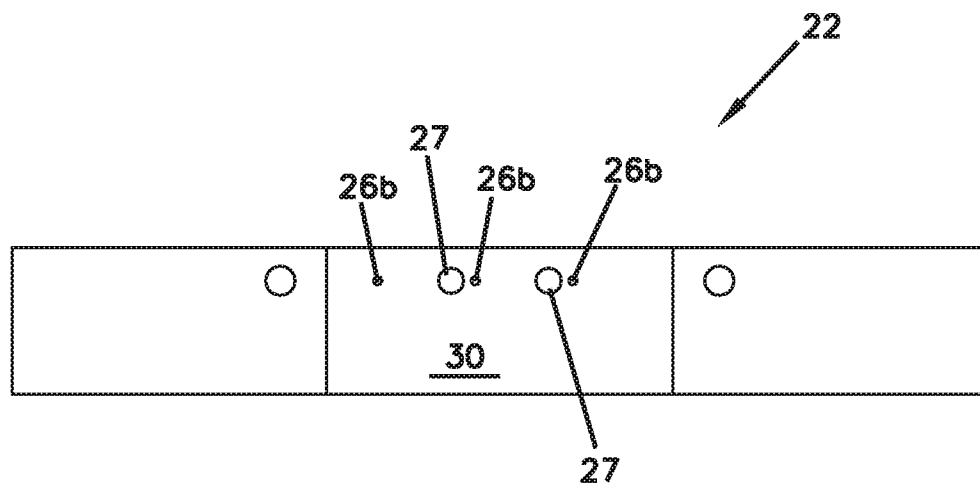
FIG. 15**FIG. 16**

FIG. 18

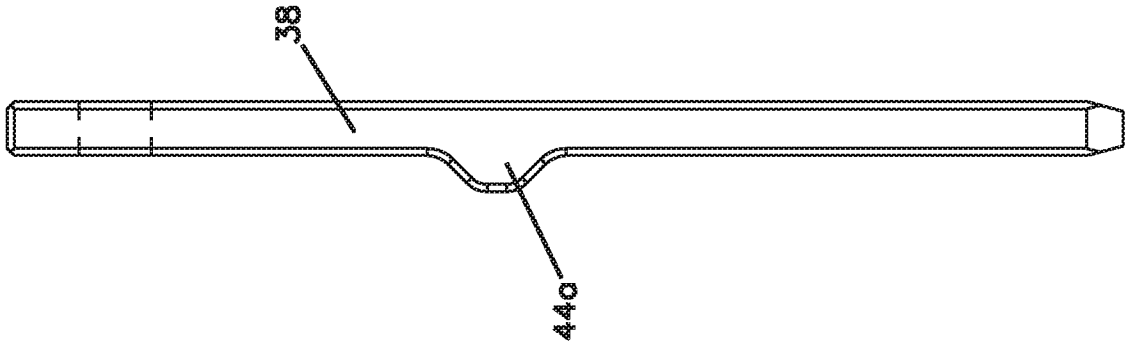


FIG. 17

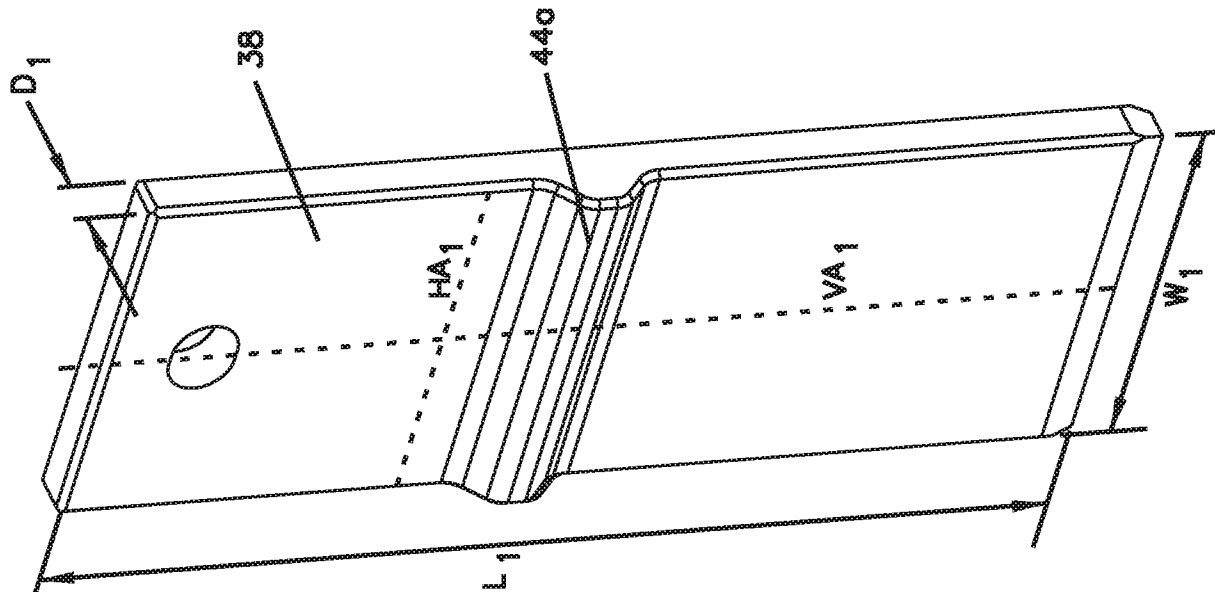
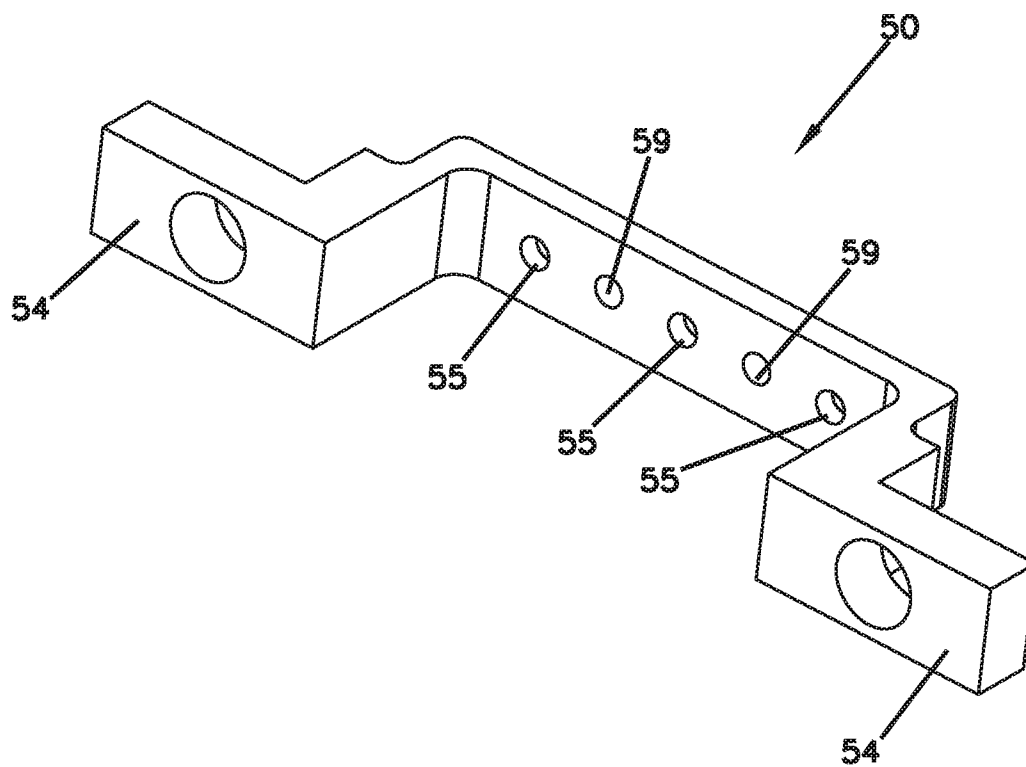
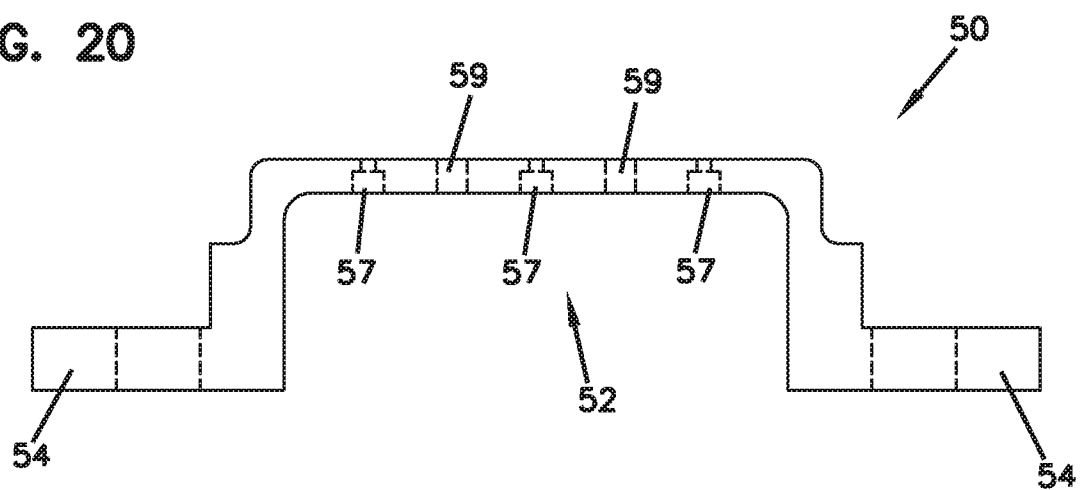
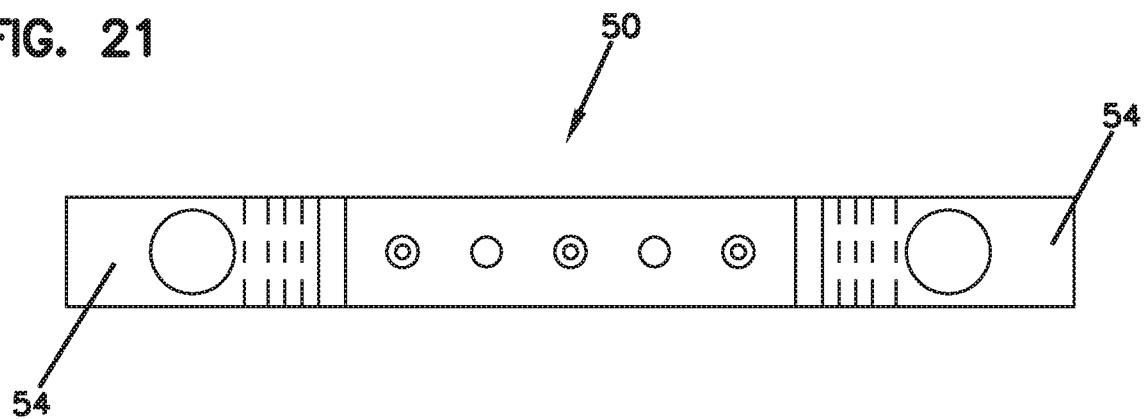
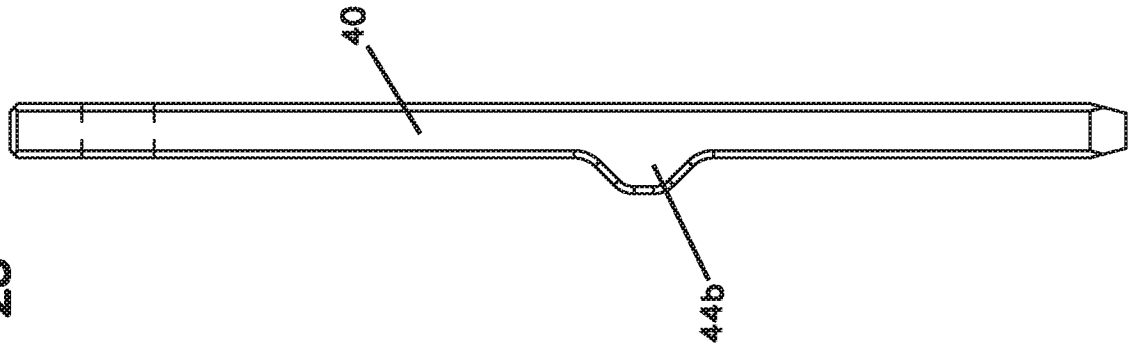
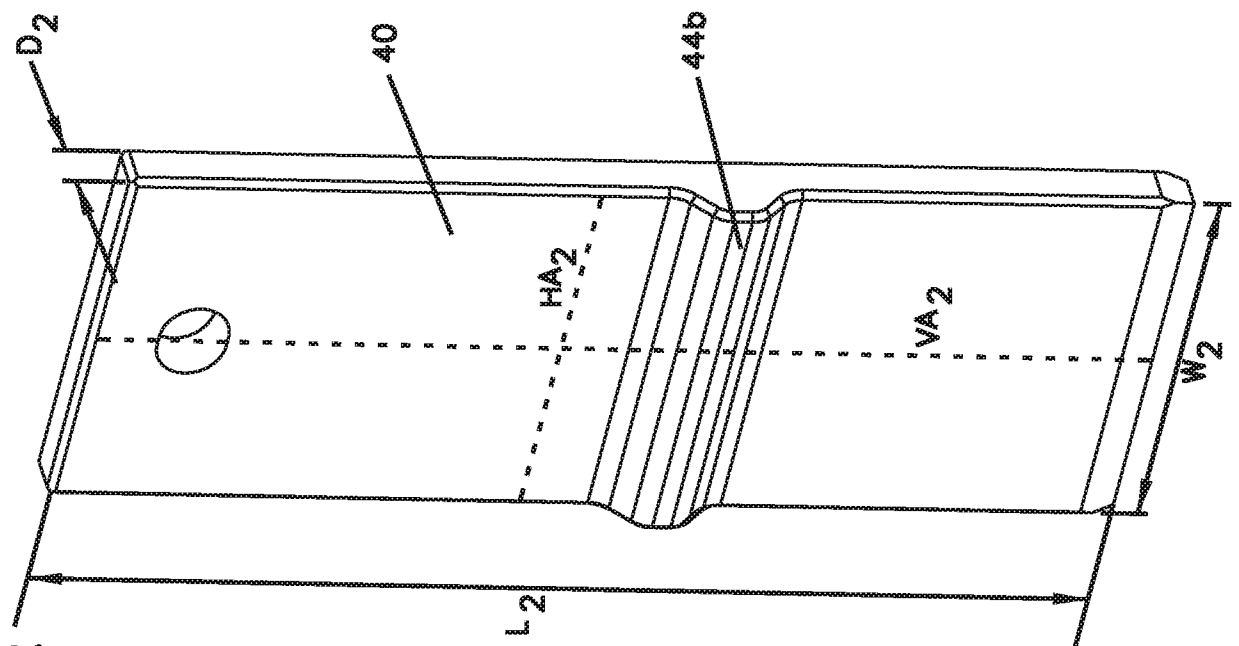


FIG. 19**FIG. 20****FIG. 21**



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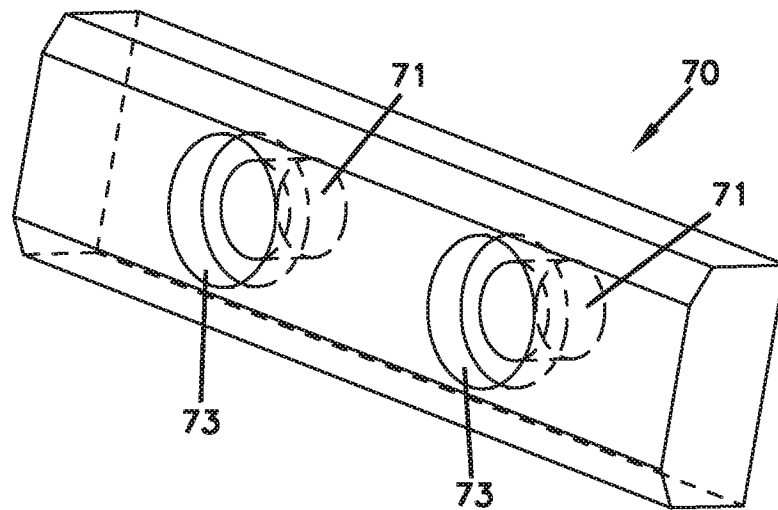
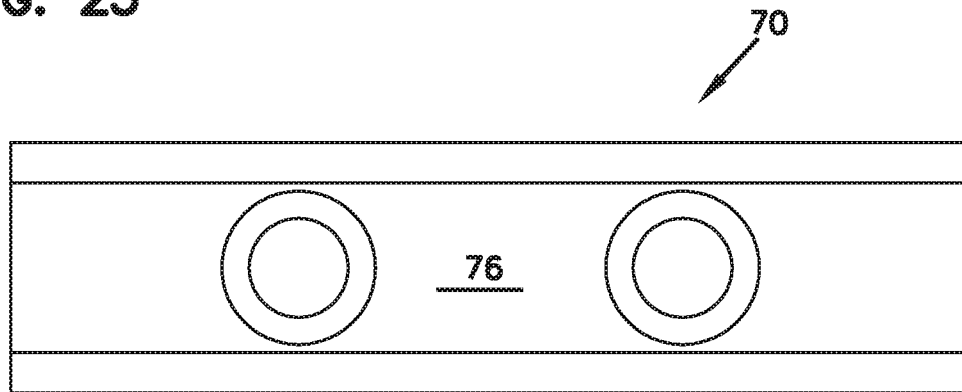
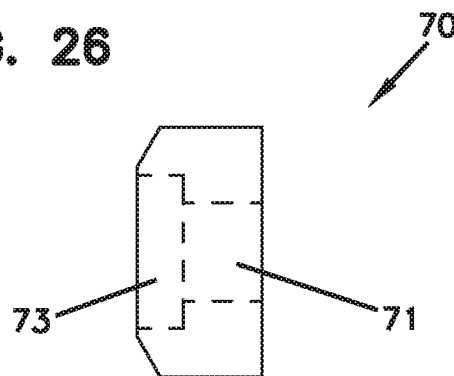
FIG. 24**FIG. 25****FIG. 26**

FIG. 27

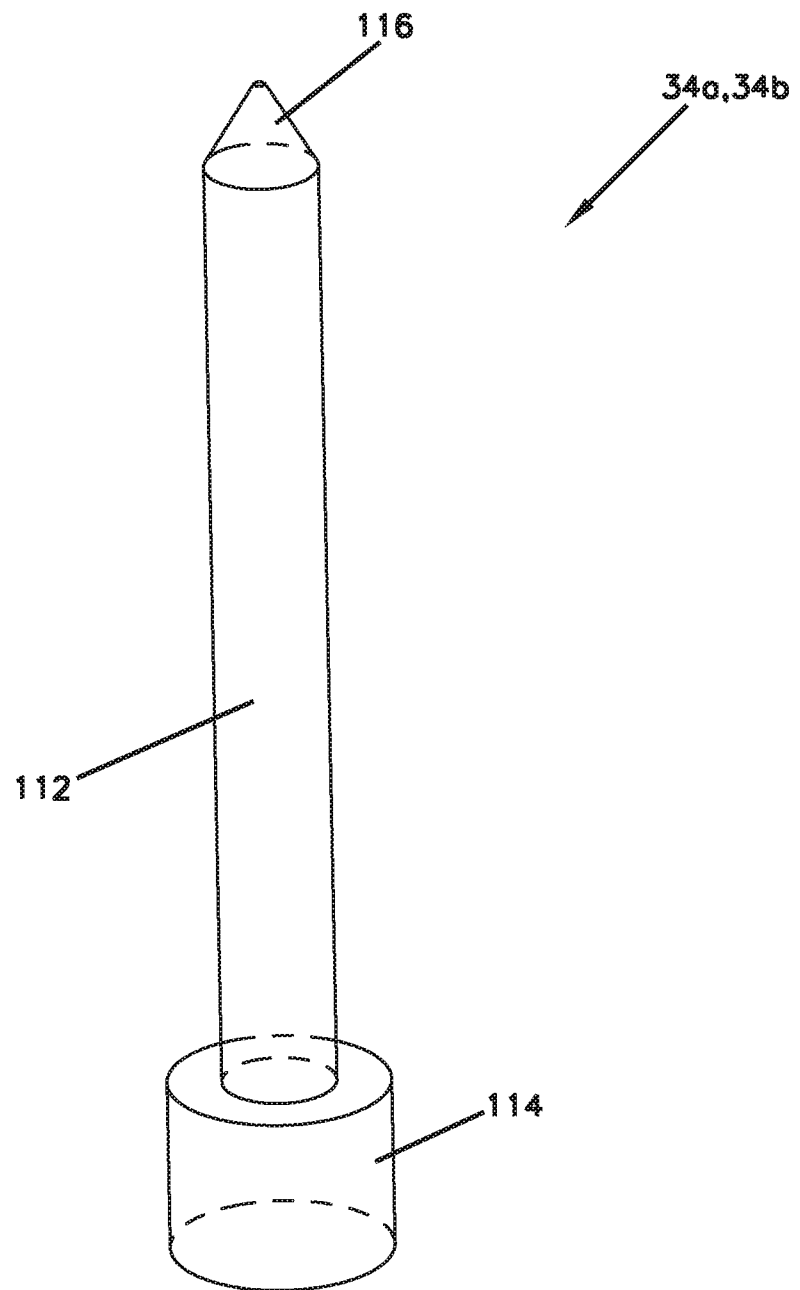


FIG. 28

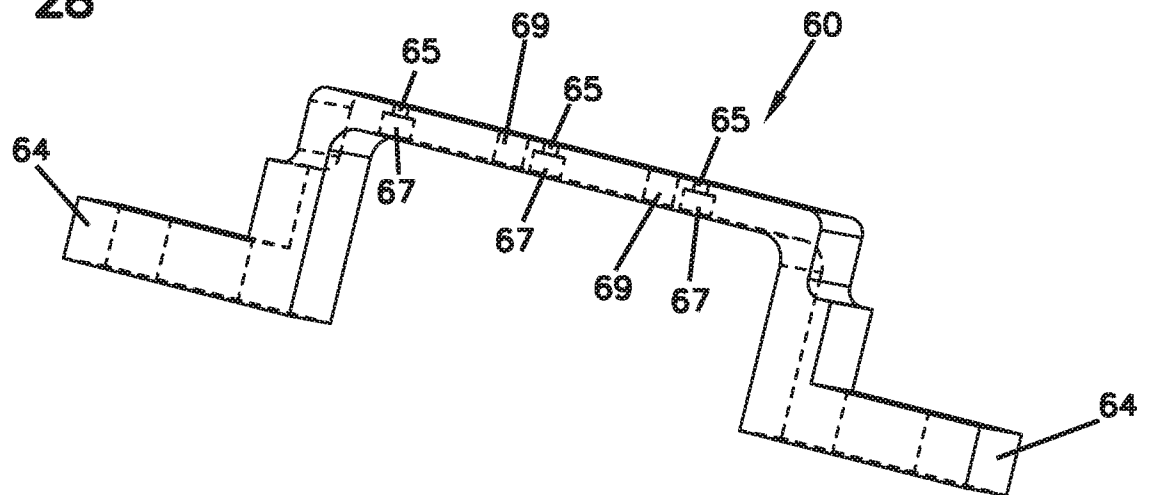


FIG. 29

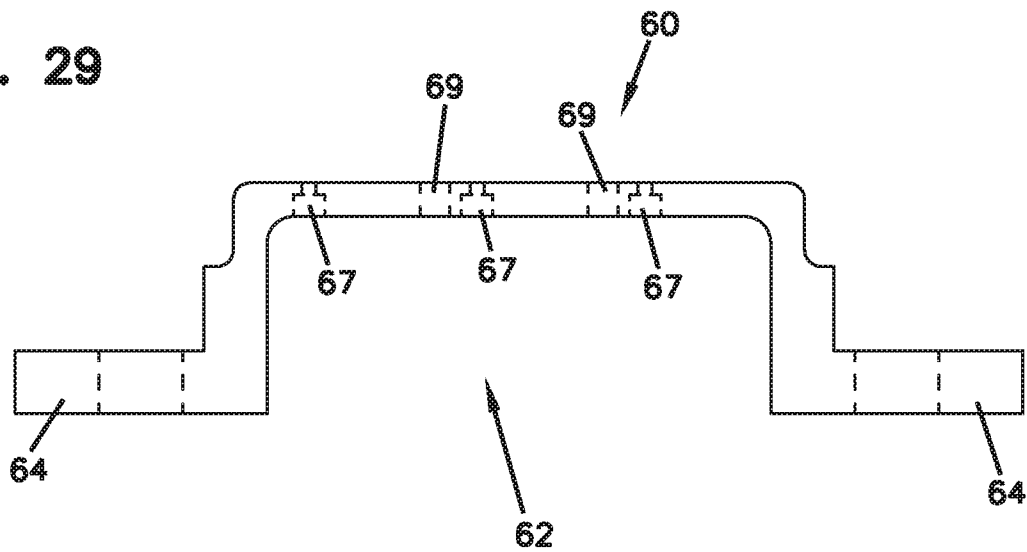


FIG. 30

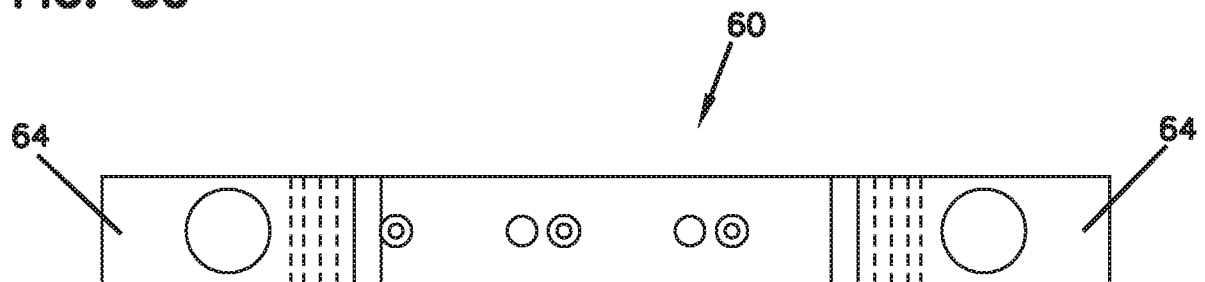
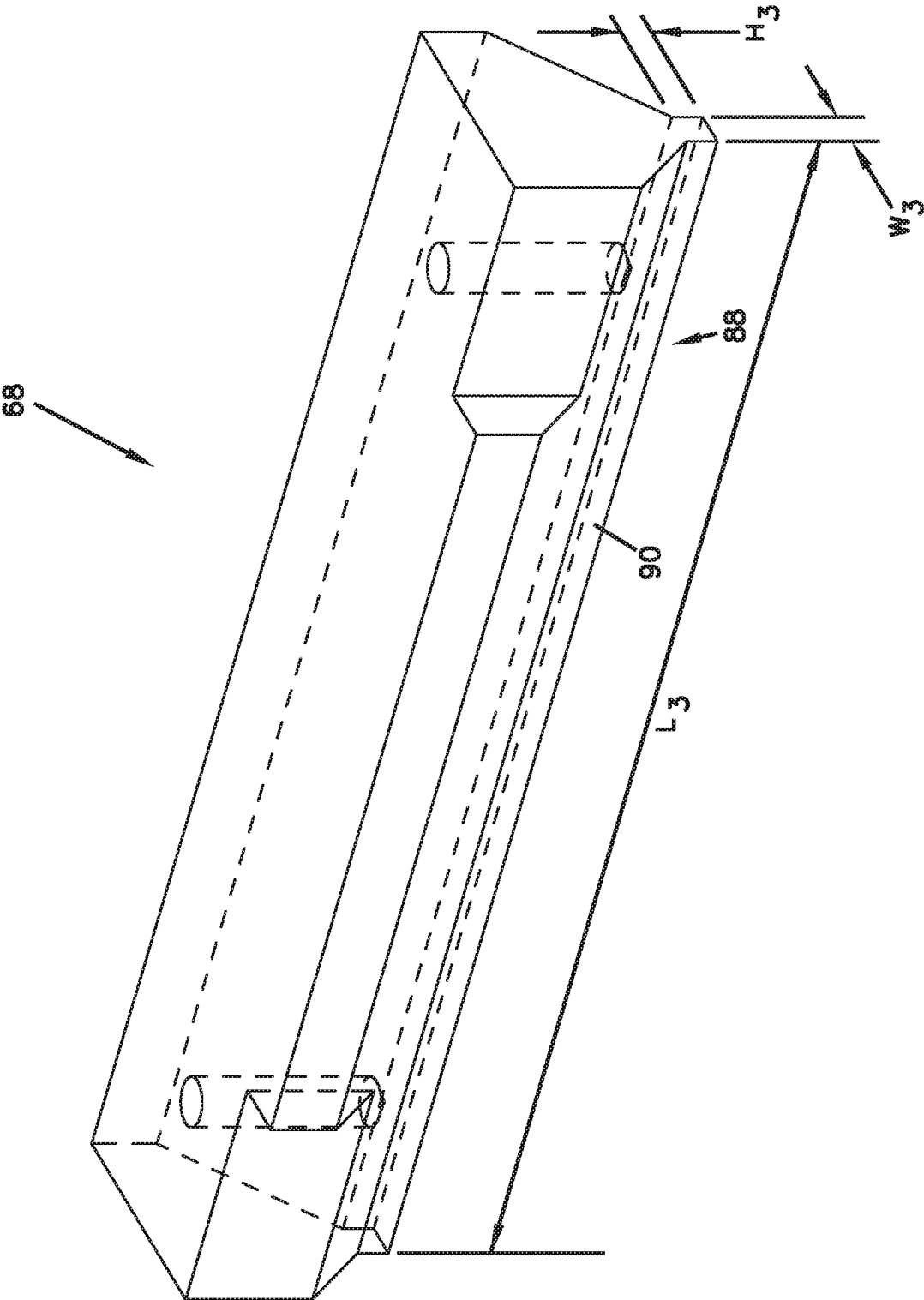
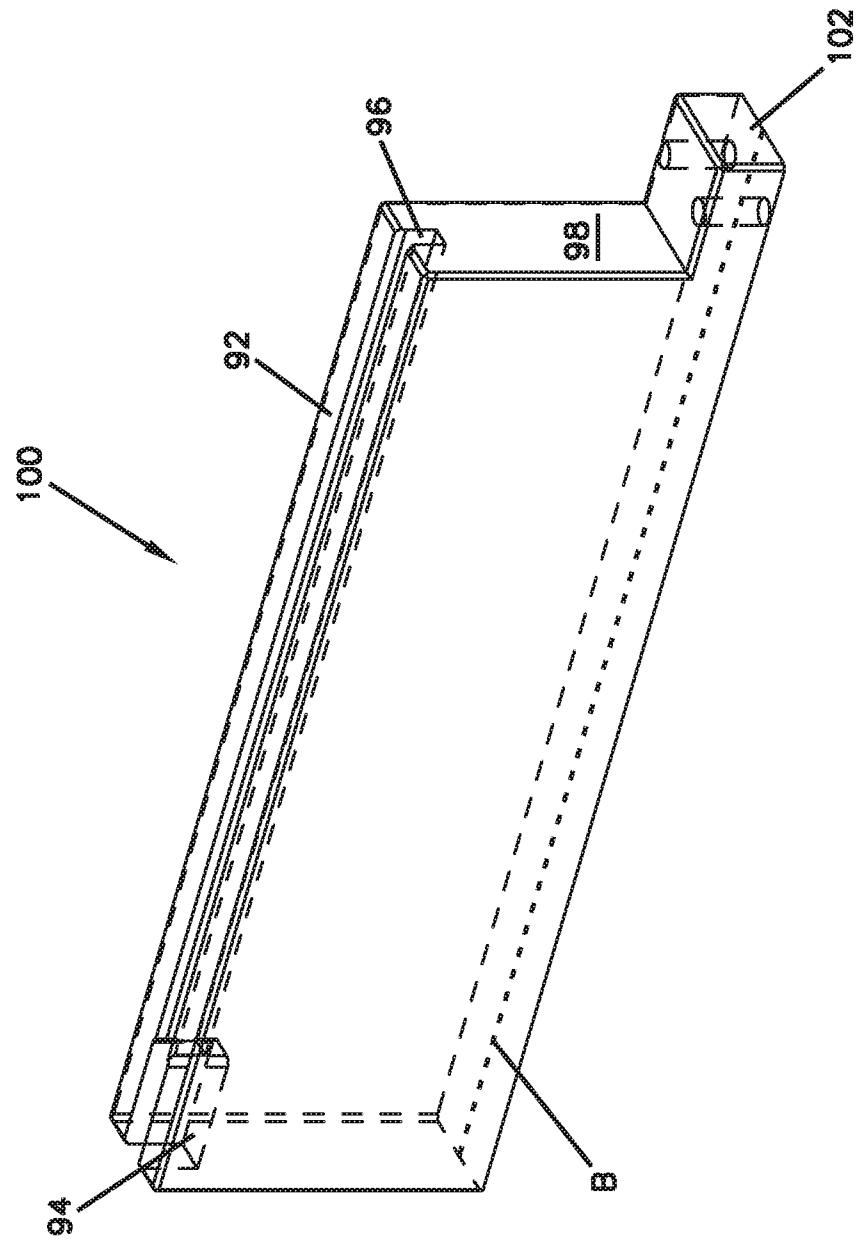


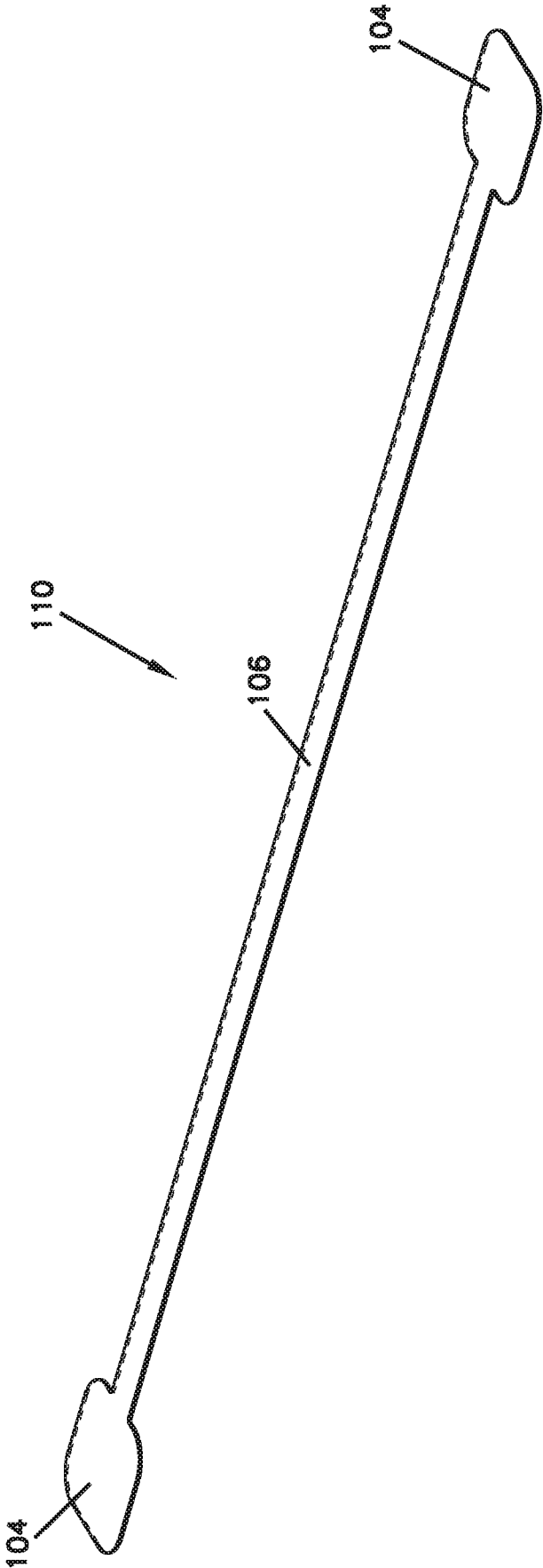
FIG. 31





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FIG. 33



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/027993**A. CLASSIFICATION OF SUBJECT MATTER****G02B 6/02(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G02B 6/02; B21J 13/04; G02B 6/38; B21D 28/26; B29D 11/00; G02B 6/36

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: fiber optic cable, adhesive injection port, punch, pin, hole, plate, protrusion, engage, channel

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 8109678 B1 (ZHOVNIROVSKY et al.) 07 February 2012 See column 3, line 27 - column 4, line 29; claim 1; and figures 1, 3.	1-20
A	CN 102809785 A (SHANGHAI FANGAO COMMUNICATION TECHNOLOGY CO., LTD.) 05 December 2012 See figures 1, 3, 9-10.	1-20
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A	US 6702962 B2 (KIHARA et al.) 09 March 2004 See figures 1-2, 3A-3B.	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

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"&" document member of the same patent family

Date of the actual completion of the international search

09 August 2018 (09.08.2018)

Date of mailing of the international search report

09 August 2018 (09.08.2018)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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