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(54) **Title**: HEATING APPARATUS FOR FIBER OPTIC CONNECTOR

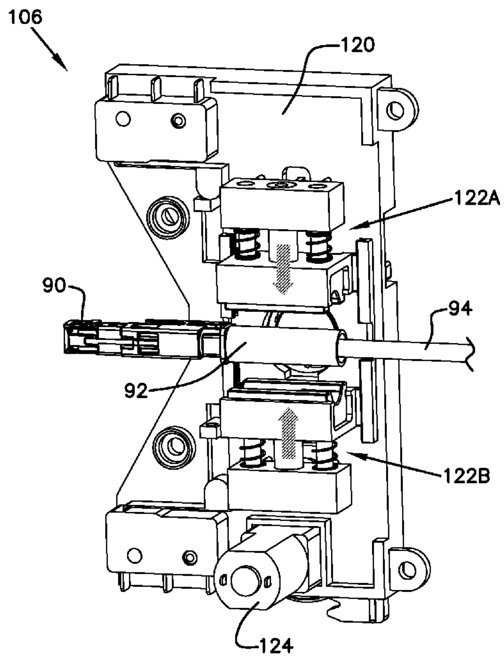

FIG. 2A

(57) Abstract: A heating assembly is provided to heat a heat-shrink tube of a fiber optic connector to anchor the connector relative to its corresponding fiber optic cable. The heating assembly includes opposing heating devices movable between an open position and a closed position. Each of the heating devices may include a heating shell and a biasing member. The heating shell includes a contact surface configured to at least partially contact the heat-shrink tube. The biasing member is configured to bias the heating device toward the closed position such that a compression force is exerted on the heat-shrink tube engaged between opposing heating shells to continuously contact at least part of the heat-shrink tube as the heat-shrink tube shrinks.

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HEATING APPARATUS FOR FIBER OPTIC CONNECTOR

BACKGROUND

[1] Cable preparation processes are used to prepare a cable prior to terminating the cable with a fiber optic connector. The steps required to prepare a cable for connectorization are typically performed manually by a technician and often require the use of a number of different tools. The length of time required to prepare a cable for termination by a fiber optic connector as well as the precision of the preparation steps is highly dependent upon the skill of the technician preparing the cable for termination. In this regard, advancements are needed to simplify the cable preparation process so as to reduce the time required to perform cable preparation while concurrently providing more consistent and reliable results regardless of the skill of the operator.

[2] In certain applications, the fiber optic connector includes a heat-shrink tube that shrinks, when heated, to anchor the connector to a cable. Various heating tools, such as hot air guns and infrared heaters, are used to heat the tube in the field. However, such tools can spread heat to other components adjacent the heat-shrink tube, thereby causing damage to them.

SUMMARY

[3] The present disclosure relates generally to a heating apparatus for a fiber optic connector. More particularly, the present disclosure relates to a heating device for heating a heat-shrink tube of a fiber optic connector to anchor the connector relative to its corresponding fiber optic cable. Various aspects are described in this disclosure, which include, but are not limited to, the following aspects.

[4] One aspect is a heating assembly including a base, opposing heating devices, and an actuation device. The opposing heating devices are configured to heat a heat-shrink tube of a fiber optic connector. The heating devices are movable between an open position and a closed position. Each of the heating devices may include a heating shell and a biasing member. The heating shell is movably supported by the base and configured to convert electricity into heat. The heating shell includes a contact surface configured to at least partially contact the heat-shrink tube. The biasing member is configured to bias the heating device toward the closed position such that a compression force is exerted on the heat-shrink tube engaged between opposing heating shells to continuously contact at least part of the heat-shrink tube as the heat-shrink tube shrinks. The actuation device is

configured to control the heating shells of the heating devices to move the heating devices between the open and closed positions.

[5] Another aspect is an apparatus for heating a heat-shrink tube of a fiber optic connector. The apparatus may include a body, a loading tray assembly, a heating assembly, and a power source. The loading tray assembly is configured to receive the connector and place the heat-shrink tube of the connector within the body. The heating assembly is configured to heat the heat-shrink tube within the body. The heating assembly may be configured as in the first aspect above. The power source is configured to provide power to the loading tray assembly and the heating assembly.

[6] In certain examples, the contact surface of the heating shell has a length configured to be substantially the same as a length of the heat-shrink tube such that the contact surface only contacts the heat-shrink tube. The contact surface may provide different contact areas for the heat-shrink tube as the heat-shrink tube shrinks. The contact surface may be at least partially eye-shaped or rounded in transverse cross-sectional profile. The opposing contact surfaces cooperate to define a cavity (or chamber or channel) for receiving a heat shrink tube. The cavity (or chamber or channel) has a transverse cross-sectional shape or profile that is rounded (e.g., eye-shaped, obround, race-track shaped, etc.).

[7] In certain examples, the contact surface has a coating configured to provide nonstick finish. Such a coating can be made of one or more of various materials, such as polytetrafluoroethylene (PTFE), anodized aluminum, ceramics, silicone, enameled cast iron, and seasoned cast iron.

[8] In certain examples, the heating assembly may further include a holder secured to the base, and a thermal isolation block disposed between the holder and the heating shell and configured to reduce heat transfer from the heating shell.

[9] The above features and advantages and other features and advantages of the present teachings are readily apparent from the following detailed description of the best modes for carrying out the present teachings when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[10] Figure 1 is an exploded view of an example heating apparatus in accordance with the principles of the present disclosure.

[11] Figure 2A illustrates an example of the heating assembly in an open position.

[12] Figure 2B illustrates an example of the heating assembly in a closed position.

[13] Figure 3 is a schematic perspective view of an example heating device.

[14] Figure 4 is an exploded view of the heating device of Figure 3

[15] Figure 5A illustrates an example configuration and operation of the heating device of Figure 3.

[16] Figure 5B illustrates the heating device of Figure 5A.

DETAILED DESCRIPTION

[17] Various embodiments will be described in detail with reference to the drawings, wherein like reference numerals represent like parts and assemblies throughout the several views.

[18] Figure 1 is an exploded view of an example heating apparatus 100 in accordance with the principles of the present disclosure. The heating apparatus 100 is configured to automatically heat a heat-shrinkable tube or sleeve, which is positioned around an end terminal of a fiber optic connector. The heating apparatus 100 operates to heat the connector to shrink the heat-shrink tube so as to anchor the connector relative to its corresponding fiber optic cable. The heating apparatus 100 may also operate to cool the tube once heated.

[19] In some examples, the heating apparatus 100 includes a body 102 (e.g., an outer housing), a loading tray assembly 104, a heating assembly 106, a cooling device 108, a power source 110, and a control device 112.

[20] The loading tray assembly 104 is configured to receive a fiber optic connector 90 outside the body 102 and place the fiber optic connector 90 within the body 102 for heat processing. The loading tray assembly 104 is movable between a first position (e.g., a pushed-in position) and a second position (e.g., an ejected position). In the first position, the loading tray assembly 104 is received into, or pushed into, the body 102 so that the fiber optic connector 90 is placed within the body 102. In the second position, the loading tray assembly 104 is extended or ejected outside the body 102 to receive the fiber optic connector 90 therein. The loading tray assembly 104 can be operated between the first and second positions by various actuation systems, such as a solenoid control system or an electric motor control system. The loading tray assembly 104 can be configured to be ejected from, and loaded into, the body, either manually or automatically.

[21] The heating assembly 106 is configured to heat a heat-shrink tube 92 of the fiber optic connector 90 when the fiber optic connector 90 is loaded into the body 102 by the loading tray assembly 104. An example of the heating assembly 106 is illustrated and described in more detail with reference to Figures 2-5.

[22] The cooling device 108 is configured to cool at least a portion of the connector 90 (e.g., the heat-shrink tube 92) heated by the heating assembly 106. In some examples, the cooling device 108 includes one or more fans and a vent system, which are configured to cool the fiber optic connector 90 heated by the heating assembly 106 before the loading tray assembly 104 moves from the loaded position to the ejected position. The cooling device 108 can cause air to flow across or over the exterior of the heat shrink tube after heating, thereby expediting the cooling process.

[23] The power source 110 provides power to at least some of the components in the heating apparatus 100, such as the loading tray assembly 104, the heating assembly 106, the cooling device 108, and the control device 112. In some examples, the power source 110 includes an electrical power source, such as one or more batteries mounted within the body 102. In other examples, the power source 110 can be an external power source connected through a power cord that may supply A/C or D/C voltage.

[24] The control device 112 operates to control various components in the heating apparatus 100, such as the loading tray assembly 104, the heating assembly 106, and the cooling device 108. In some examples, the control device 112 includes a control board configured to display the status of several components of the heating apparatus 100.

[25] Other examples of the heating apparatus 100 are also described in PCT Application No. PCT/CN2014/093134, titled CABLE TERMINATION METHOD FOR OPTIMIZED CABLE, filed December 5, 2014, the disclosure of which is incorporated herein by reference in its entirety.

[26] Figures 2A and 2B illustrate an example of the heating assembly 106. The heating assembly 106 is in an open position in Figure 2A, and in a closed position in Figure 2B.

[27] The heating assembly 106 operates to heat at least the heat-shrink tube 92 to a temperature suitably high for causing the heat-shrink tube 92 to shrink down upon the connector 90 and a fiber optic cable jacket 94 so as to secure the fiber optic connector 90 to the fiber optic cable. In certain examples, the heat-shrink tube 92 includes heat sensitive adhesive provided therein. In certain examples, the heat-shrink tube 92 is made of a heat activated shape-memory material that shrinks when heated to a predetermined temperature. In certain examples, a temperature sensitive adhesive within the heat-shrink tube is activated at a temperature less than or equal to the temperature required to shrink the heat-shrink tube 92. In certain examples, the heat-shrink tube and the adhesive provided therein function to secure strength members of the fiber optic cable to the fiber optic connector so as to enhance the axial pull strength of the interface between the fiber optic cable and the fiber optic connector. In this way, the fiber optic connector is securely anchored to the fiber optic cable. The heating assembly 106, through the positioning of the heating devices, can provide localized heating to the heat shrink sleeve without applying substantial heat to the majority of the connector.

[28] In some examples, the heating assembly 106 includes a base 120, a set of opposing heating devices 122A and 122B (collectively 122), and an actuation device 124.

[29] The heating devices 122 are configured to heat the heat-shrink tube 92 without heating the connector 90. The heating devices 122 are operated by the actuation device 124 between an open position (Figure 2A) and a closed position (Figure 2B). The heating devices 122 are complementary to each other for receiving the heat-shrink tube 92 of the connector 90 therebetween and physically contacting the heat-shrink tube 92 and transferring heat to the tube 92 in the closed position. In some examples, the heating devices 122A and 122B are identically configured. Once the heating process finishes, the heating devices 122 moves to the open position so that the loading tray assembly 104 removes the connector 90 from the body 102. An example heating device 122 is described and illustrated in more detail with reference to Figures 3 and 4.

[30] The actuation device 124 is configured to control and move the heating devices 122 between the open and closed positions. In some examples, the actuation device 124 includes a motor. In other examples, other types of actuation device 124 are also possible.

[31] In some examples, all of the heating devices 122 are movable and actuated by the actuation device 124. In other examples, one of the heating devices 122 is movable by the actuation device 124 and the other heating device 122 is fixed.

[32] Referring to Figures 3 and 4, an example of the heating device 122 is described. In particular, Figure 3 is a schematic perspective view of an example heating device 122, and Figure 4 is an exploded view of the heating device 122 of Figure 3.

[33] In some examples, the heating device 122 includes a holder 130, a thermal isolation block 132, a heating shell 134, and a biasing member 136.

[34] The holder 130 is configured to movably hold the thermal isolation block132 and the heating shell 134 through the biasing member 136. The holder 130 is secured to the base 120 so that two complementary heating shells 134 are arranged to oppose each other. The holder 130 is movable between an open position (FIG. 2A) and a closed position (FIG. 2B). The holder 130 can be operated by the actuation device 124.

[35] The thermal isolation block 132 is disposed between the holder 130 and the heating shell 134 to reduce heat transfer from the heating shell 134 to the holder 130 and other associated or adjacent components. The thermal isolation block 132 has a construction that has dielectric or heat insulating properties and can at least partially cover the back and sides of the heating shell 134.

[36] The heating shell 134 is fixed to the thermal isolation block 132. The heating shell 134 is a heating element configured to convert electricity into heat. In some examples, the heating shell 134 includes electrodes 140 and 142 (e.g., resistive heating elements) through which electric current passes. The heating shell 134 can operate as resistance to result in heating of the heating shell 134.

[37] The heating shell 134 can be made of various materials. The heating shell 134 is made of a heat conductive material that conducts heat substantially better than the isolation block 132. In some examples, the heating shell 134 is made of aluminum or aluminum alloys. In other examples, other materials can also be used, such as metallic materials, ceramic materials, and other exotic materials.

[38] The heating shell 134 includes a contact surface 144 configured to contact the heat-shrink tube 92 while the heating devices 122 are in the closed position. In some examples, the contact surface 144 is shaped to be cylindrical or rounded. In particular, the opposing contact surfaces 144 define a cavity (or chamber or channel) having a rounded (e.g., eye-shaped, obround, elliptical, race-tracked shaped, etc.) transverse cross-sectional profile or shape.

[39] The contact surface 144 of the heating shell 134 has a length L configured to precisely control the heating length and only heat the heat-shrink tube 92 while not damaging other components adjacent the heat-shrink tube 92. The length L of the contact surface 144 can be substantially the same as a length of the heat-shrink tube 92. In some examples, the length L of the contact surface 144 (or the heating shell 134) ranges from about 10 mm to about 30 mm. In other examples, the length L of the contact surface 144 (or the heating shell 134) is about 20 mm with tolerance of ± 1 mm.

[40] An example configuration of the heating shell 134 is further described and illustrated with reference to Figure 5.

[41] The biasing member 136 is configured to bias the heating devices 122 (e.g., the heating shell 134 and/or the isolation block 132) to the closed position so that the two heating shells 134 exert compression force on the heat-shrink tube 92 engaged therebetween to improve heat transfer to the tube 92. In some examples, the biasing member 136 includes one or more spring elements engaged between the holder 130 and the isolation block 132. The biasing members 136 (e.g., springs) allow the heating shells 134 of the opposing heating devices 122 to automatically follow the heat shrink tube 92 as the tube 92 heats and shrinks without need for active control. The biasing members 136 allow the heating shells 134 to maintain continuous contact with the heat shrink tube 92 as it shrinks so that effective contact is maintained for conductive heating throughout the heat shrink process, instead of relying on convective heating. An example operation of the biasing member 136 is further described and illustrated with reference to Figure 5.

[42] Figures 5A and 5B illustrate an example configuration and operation of the heating device 122 in accordance with the present disclosure.

[43] As described above, the heating device 122 includes the heating shell 134 configured to directly contact the heat-shrink tube 92 to transfer thermal energy to the tube 92 effectively. As described herein, the two pieces of heating devices 122 are biased into the closed position until the heating shells 134 are physically in contact with the heat-shrink tube 92, and then increase the temperature of the heating shells 134 at a predetermined temperature. This configuration can provide quick heating with lower power, thereby saving more energy, compared with other heating tools, such as hot air guns and infrared heaters. Hot air guns and infrared heaters typically cause overheating to other components adjacent the heat-shrink tube 92.

[44] An example performance of the heating device 122, compared with other heating tools, is provided as follows:

Items	TE's heater	Hot air gun	infrared heater
Power supply	12V (battery)	220V (AC)	220V
Heating time	30s	30~60s	>60s
Energy	<48W	500W~2000W	>150W

[45] Further, the heating device 122 is configured such that the heating shell 134 has the length L suitable for heating the heat-shrink tube 92 only. In addition, the heating temperature can be precisely controlled by using the heating shell 134 configured to directly contact the heat-shrink tube 92. By way of example, the heating device 122 is configured to provide a heating temperature of about 200 °C with tolerance of ± 5 °C.

[46] As illustrated in Figures 5A and 5B, each of the heating devices 122 includes the biasing member 136 configured to bias the heating shell 134 to the closed position. Accordingly, as the heat-shrink tube 92 shrinks (e.g., from Figure 5A to Figure 5B), the biasing member 136 allows the heating shell 134 to continuously contact the heat-shrink tube 92. For example, as the heat-shrink tube 92 shrinks between the heating shells 134 during heating process, the heating shells 134 become closer to each other by the biasing or compression force of the biasing member 136.

[47] In some examples, the opposing holders 130 are actuated by the actuation device 124 to move from the open position (FIG. 2A) to the closed position (FIG. 2B). When the holders 130 are in the closed position and the heat-shrink tube 92 are engaged between the opposing heating shells 134, the heat-shrink tube 92 can push out the opposing heating shells 134 (including the isolation blocks 132) against a biasing force of the biasing members 136 (i.e., toward the holders 130), so that the biasing members 136 are compressed between the holders 130 and the heating shells 134 (including the isolation blocks 132). In some examples, the opposing heating shells 134 do not touch each other, depending on a dimension (e.g., a diameter) of the tube 92 engaged therebetween, as illustrated in FIG. 5A. In other cases, the opposing heating shells 134 can touch each other, when the holders 130 are in the closed position. As the heat-shrink tube 92 shrinks during heating, the holders 130 remain stationary and the compression force of the biasing members 136 pushes the heating shells 134 (including the isolation blocks 132) to come closer to each other, thereby enabling the heating shells 134 to continuously contact the heat-shrink tube 92, as illustrated in FIG. 5B. As such, while holders 130 are stationary, the heating shells 134 are movable between a first position where the heat-shrink tube 92 is engaged between the heating shells 134 before heating (i.e., a shell open position or retracted position relative to the holder 130), and a second position where the heat-shrink tube 92 is shrinking or has shrunk between the heating shells 134 (i.e., a shell closed position or extended position relative to the holder 130). The heating shells 134 can move from the first position to the second position via the biasing members 136.

[48] The heating shell 134 has a contact surface having a fixed profile or shape that does not change to match the curvature of the heat-shrink tube 92 as the heat-shrink tube 92 shrinks. Thus, the contact area between the opposing heating shells 134 and the heat-shrink tube 92 gradually reduces as the heat-shrink tube 92 shrinks, but the contact remains at opposing central portions or longitudinal stripes of the contact surface. Heating initially occurs primarily through conduction via the contact surface, and is subsequently achieved by a combination of conductive and convective heating.

[49] Referring again to Figures 3-5, the heating shell 134 has an eye-shaped contact surface 144. For example, the contact surface 144 has a cross-sectional outline that at least partially resembles an eye shape. When the heating shells 134 are opposingly arranged, the cavity defined by the contact surfaces 144 of the heating shells 134 can be eye-shaped (e.g., Figure 5B). The eye-shaped contact surface 144 is adapted to provide different contact areas for the shrink tube 92 during heating process. For example, at the beginning of heating process as illustrated in Figure 5A, the eye-shaped contact surface 144 provides a relatively large area A1 of contact on the heat-shrink tube 92, thereby effectively transferring thermal energy to a large portion of the heat-shrink tube 92. As the tube 92 shrinks, as illustrated in Figure 5B, the eye-shaped contact surface 144 provides a relatively small area A2 (smaller than A1) of contact on the heat-shrink tube 92 in a smaller diameter, thereby preventing overheating and damaging the cable jacket 94 adjacent the heat-shrink tube 82.

[50] The heating device 122 can include resistive heating elements in contact with the heating shells 134 (e.g., embedded within) for converting electrical energy to heat which heats the heating shells 134.

[51] Referring again to Figures 3 and 4, the heating shell 134 has a coating 150 configured to provide nonstick finish. The coating 150 can be made of one or more various materials, such as polytetrafluoroethylene (PTFE), anodized aluminum, ceramics, silicone, enameled cast iron, and seasoned cast iron. One example of the coating 150 is

Teflon™ coatings available from DuPont (Wilmington, DE). The coating 150 is used to keep the contact surface 144 always clean and prevent the heat-shrink tube 92 from sticking to the surface 144 during working process, thereby improving reliability and repeatability of the heating device 122.

[52] In some examples, the heating apparatus 100 is operated by first moving at least one of the opposing holders 130 into the open position using the actuation device 124. Then, the loading tray assembly 104 is ejected outside the body 102, and a fiber optic connector 90 is loaded with the heat-shrink tube 92 over the rear end of the connector 90 and the forward end of a cable socket. Once the connector 90 is loaded, the loading tray assembly 104 is retracted into the body 102. Then, the holders 130 are moved to the closed position, causing the heating shells 134 to engage the heat-shrink tube 92 such that the heating shells 134 are moved against the bias of the biasing members 136 from the extended position relative to the holders 130 to the retracted position relative to the holders 130. When the holders 130 are in the closed position, the heating shells 134 are operated to heat the heat-shrink tube 92. During heating, the heat-shrink tube 92 shrinks, the heating shells 134 follow the decreasing size of the heat-shrink tube 92 by the biasing member 136 that biases the heating shells 134 from the retracted position to the extended position. Once the heating is done, the heat-shrink tube 92 is cooled using the cooling device 108. Then, the loading tray assembly 104 is extended out from the body 102 and the connector 90 with tube 92 can be displaced.

[53] The various examples and teachings described above are provided by way of illustration only and should not be construed to limit the scope of the present disclosure. Those skilled in the art will readily recognize various modifications and changes that may be made without following the example examples and applications illustrated and described herein, and without departing from the true spirit and scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A heating assembly comprising:

a base;

opposing heating devices configured to heat a heat-shrink tube of a fiber optic connector, each of the heating devices comprising:

a holder movable between an open position and a closed position relative to the base;

a heating shell configured to convert electricity into heat, the heating shell including a contact surface configured to at least partially contact the heat-shrink tube when the holder is in the closed position; and

a biasing member disposed between the holder and the heating shell and configured to bias the heating shell against the holder such that a compression force is exerted on the heat-shrink tube engaged between opposing heating shells to continuously contact at least part of the heat-shrink tube as the heat-shrink tube shrinks; and

an actuation device configured to move the holders of the heating devices between the open and closed positions.

2. The heating assembly according to claim 1, wherein the contact surface of the heating shell has a length configured to be substantially the same as a length of the heat-shrink tube such that the contact surface only contacts the heat-shrink tube.

3. The heating assembly according to claim 1 or 2, wherein the contact surface is configured to provide different contact areas for the heat-shrink tube as the heat-shrink tube shrinks.

4. The heating assembly according to claim 3, wherein the contact surface is shaped to be rounded or eye-shaped.

5. The heating assembly according to any of claims 1-4, wherein the contact surface has a coating configured to provide nonstick finish.

6. The heating assembly according to claim 5, wherein the coating includes a material selected from at least one of polytetrafluoroethylene (PTFE), anodized aluminum, ceramics, silicone, enameled cast iron, and seasoned cast iron

7. The heating assembly according any of claims 1-6, wherein each of the heating devices further comprises a thermal isolation block disposed between the holder and the heating shell and configured to reduce heat transfer from the heating shell.

8. The heating assembly according to any of claims 1-7, wherein the heating shell is made of aluminum.

9. The heating assembly according to any of claims 1-8, wherein the biasing member includes one or more spring elements

10. The heating assembly according to any of claims 1-9, wherein the actuation device includes a motor.

11. An apparatus for heating a heat-shrink tube of a fiber optic connector, the apparatus comprising:

a body;

a loading tray assembly configured to receive the connector and place the heat-shrink tube of the connector within the body;

a heating assembly configured to heat the heat-shrink tube within the body, the heating assembly comprising:

a base;

opposing heating devices configured to heat a heat-shrink tube of a fiber optic connector, each of the heating devices comprising:

a holder movable between an open position and a closed position relative to the base;

a heating shell configured to convert electricity into heat, the heating shell including a contact surface configured to at least partially contact the heat-shrink tube when the holder is in the closed position; and a biasing member disposed between the holder and the heating shell and configured to bias the heating shell against the holder such that a compression force is exerted on the heat-shrink tube engaged between opposing heating shells to continuously contact at least part of the heat-shrink tube as the heat-shrink tube shrinks; and

an actuation device configured to move the holders of the heating devices between the open and closed positions; and

a power source configured to provide power to the loading tray assembly and the heating assembly.

12. The apparatus according to claim 11, further comprising a cooling device configured to cool the heat-shrink tube.

13. The apparatus according to claim 11 or 12, wherein the power source includes one or more batteries disposed within the body.

14. The apparatus according to any of claims 11-13, wherein the contact surface of the heating shell has a length configured to be substantially the same as a length of the heat-shrink tube such that the contact surface only contacts the heat-shrink tube.

15. The apparatus according to any of claims 1-14, wherein the contact surface is configured to provide different contact areas for the heat-shrink tube as the heat-shrink tube shrinks.

16. The apparatus according to any of claims 11-15, wherein the contact surface is shaped to be rounded or eye-shaped.

17. The apparatus according to any of claims 11-16, wherein the contact surface has a coating configured to provide nonstick finish.

18. The apparatus according to claim 17, wherein the coating includes a material selected from at least one of polytetrafluoroethylene (PTFE), anodized aluminum, ceramics, silicone, enameled cast iron, and seasoned cast iron.

19. The apparatus according to any of claims 11-18, wherein the heating shell is made of aluminum.

20. The apparatus according to any of claims 11-19, wherein the actuation device includes a motor.

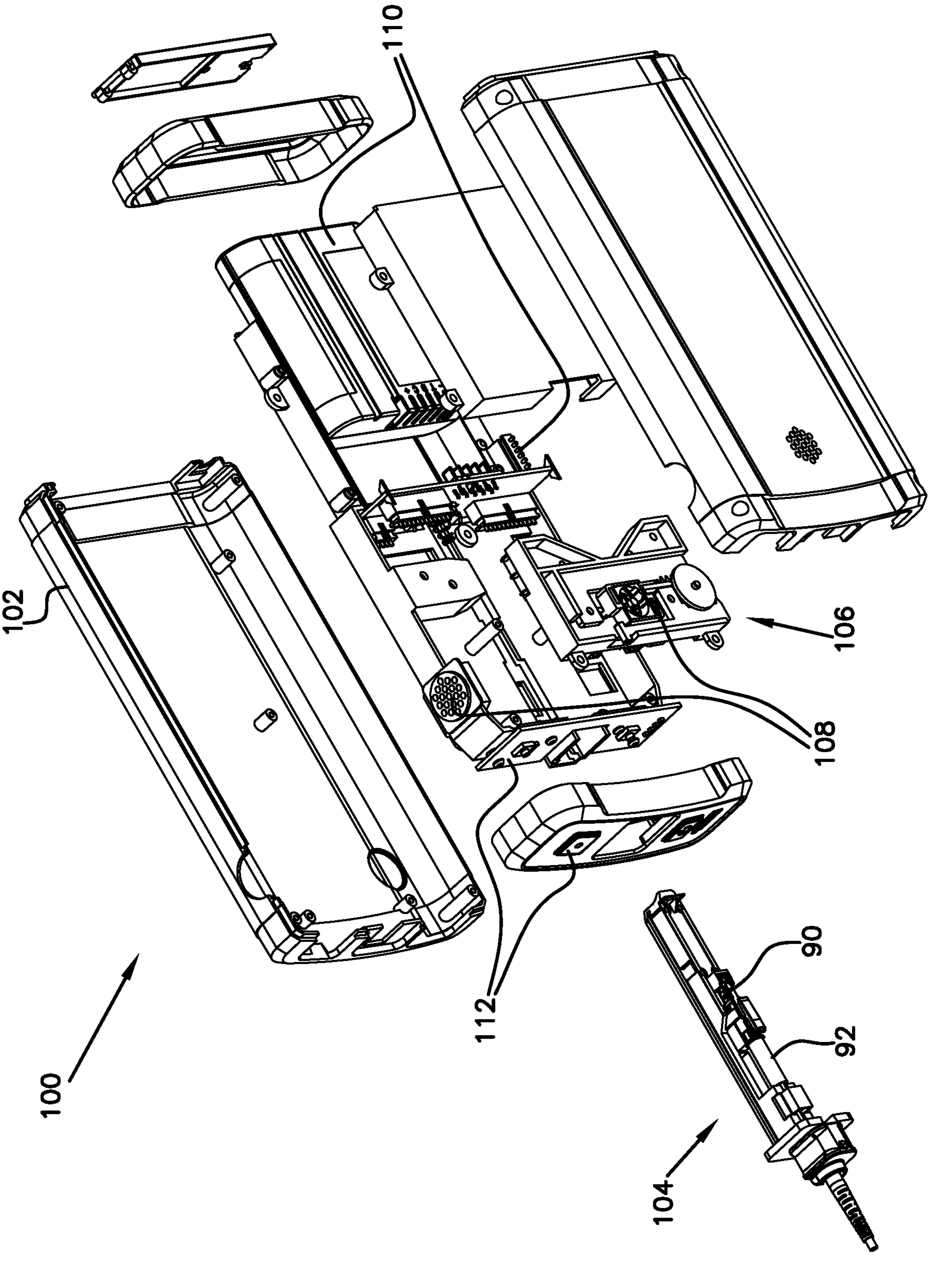

FIG. 1

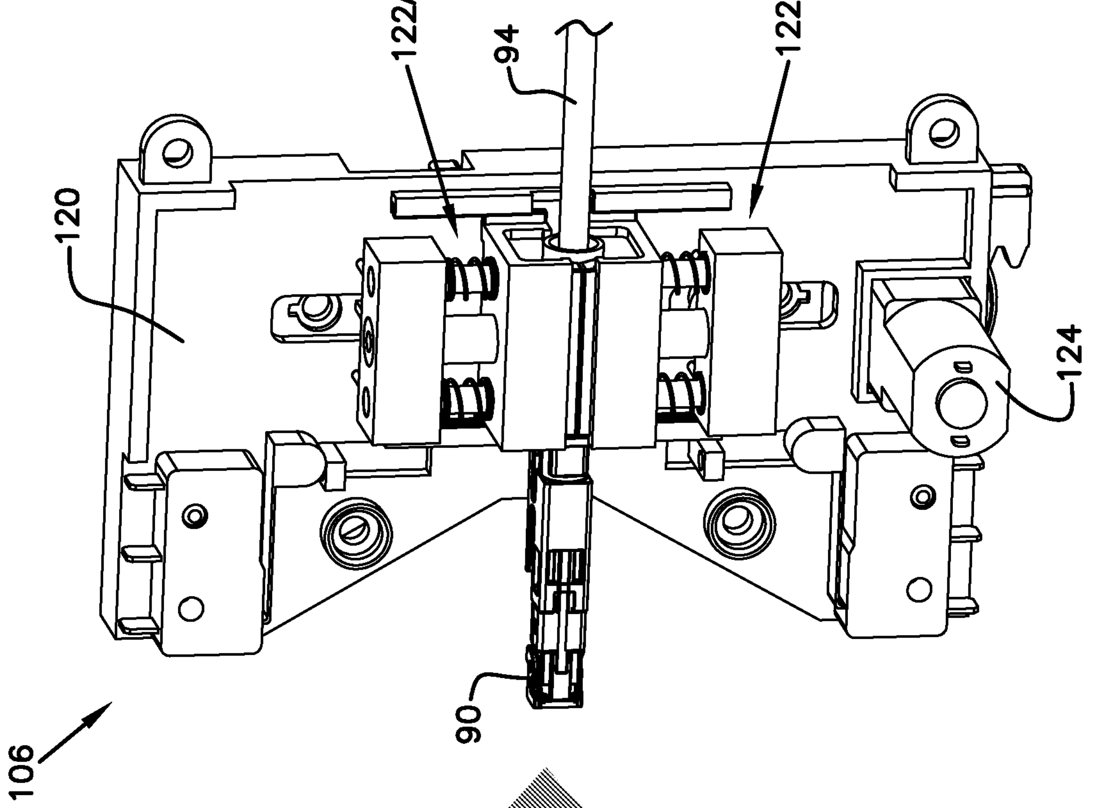

FIG. 2B

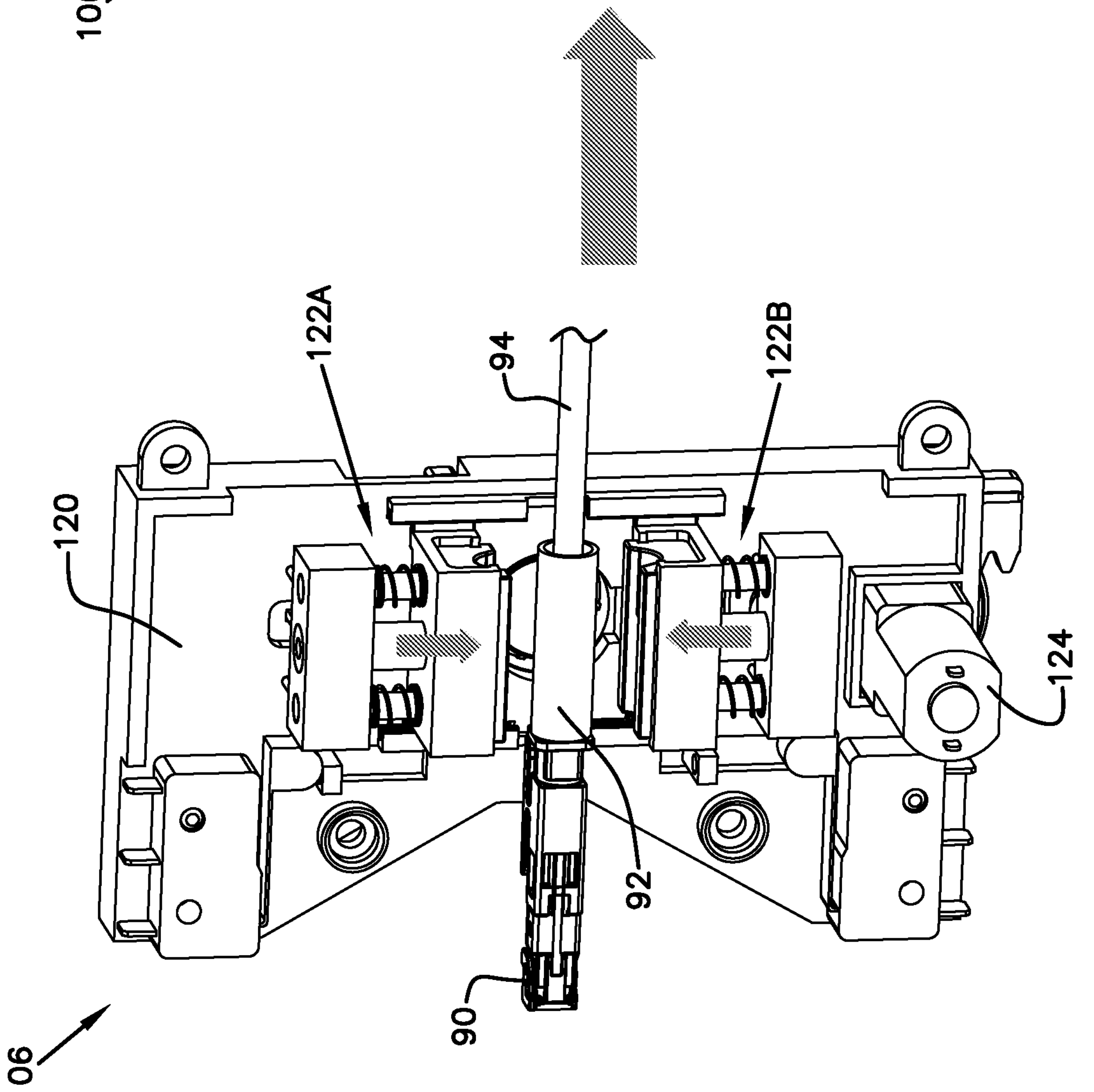

FIG. 2A

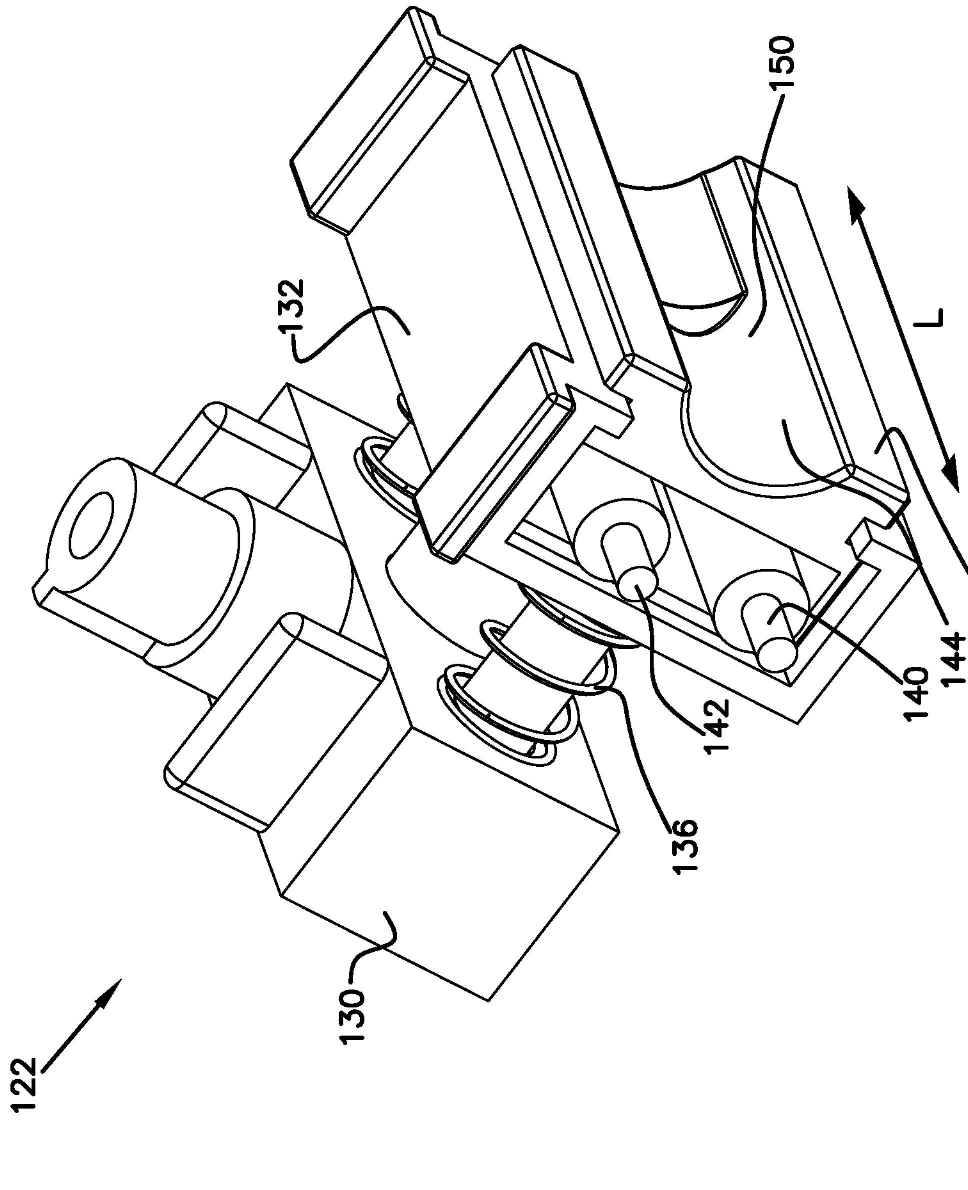

FIG. 3

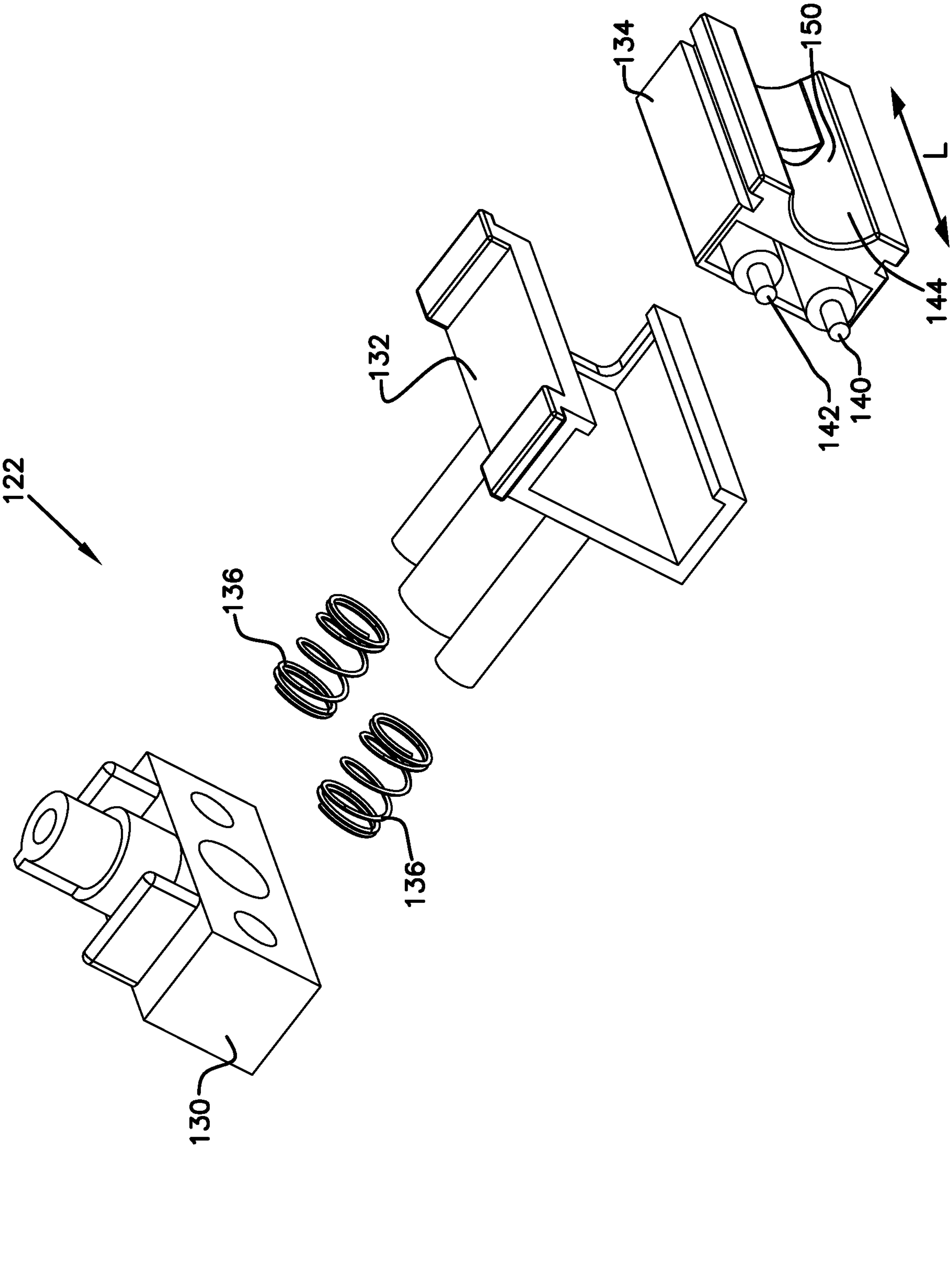

FIG. 4

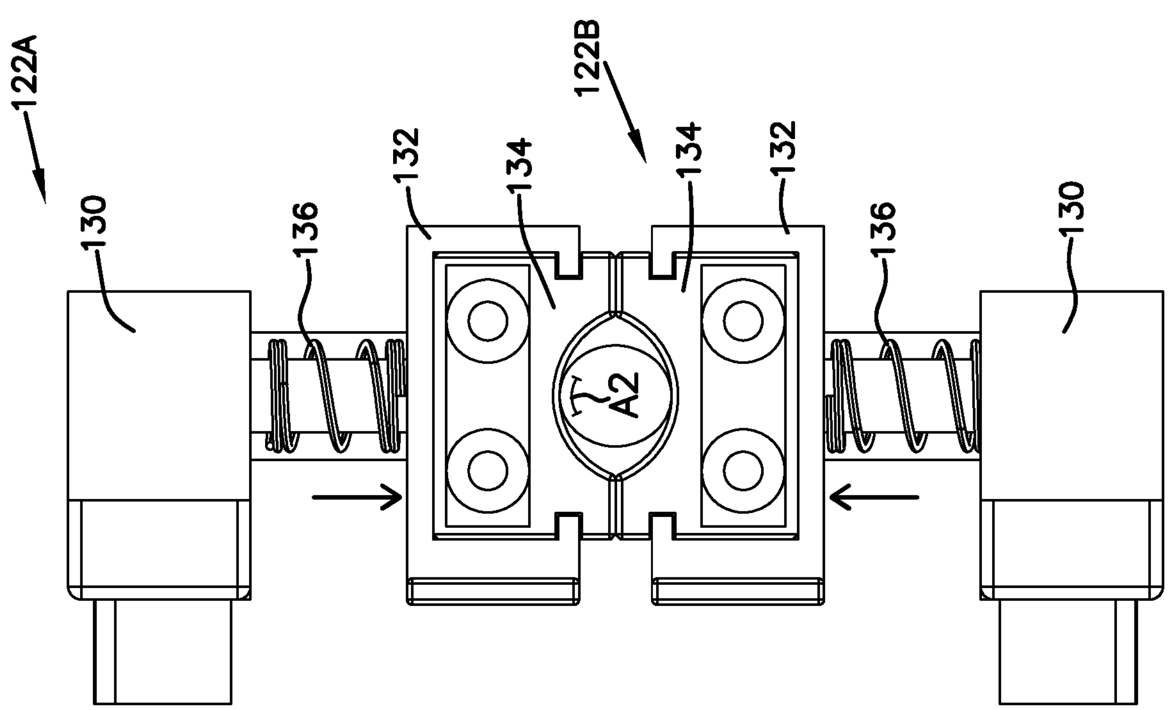
122A
122B
130
136
132
134
134
132
136
130
A2

FIG. 5B

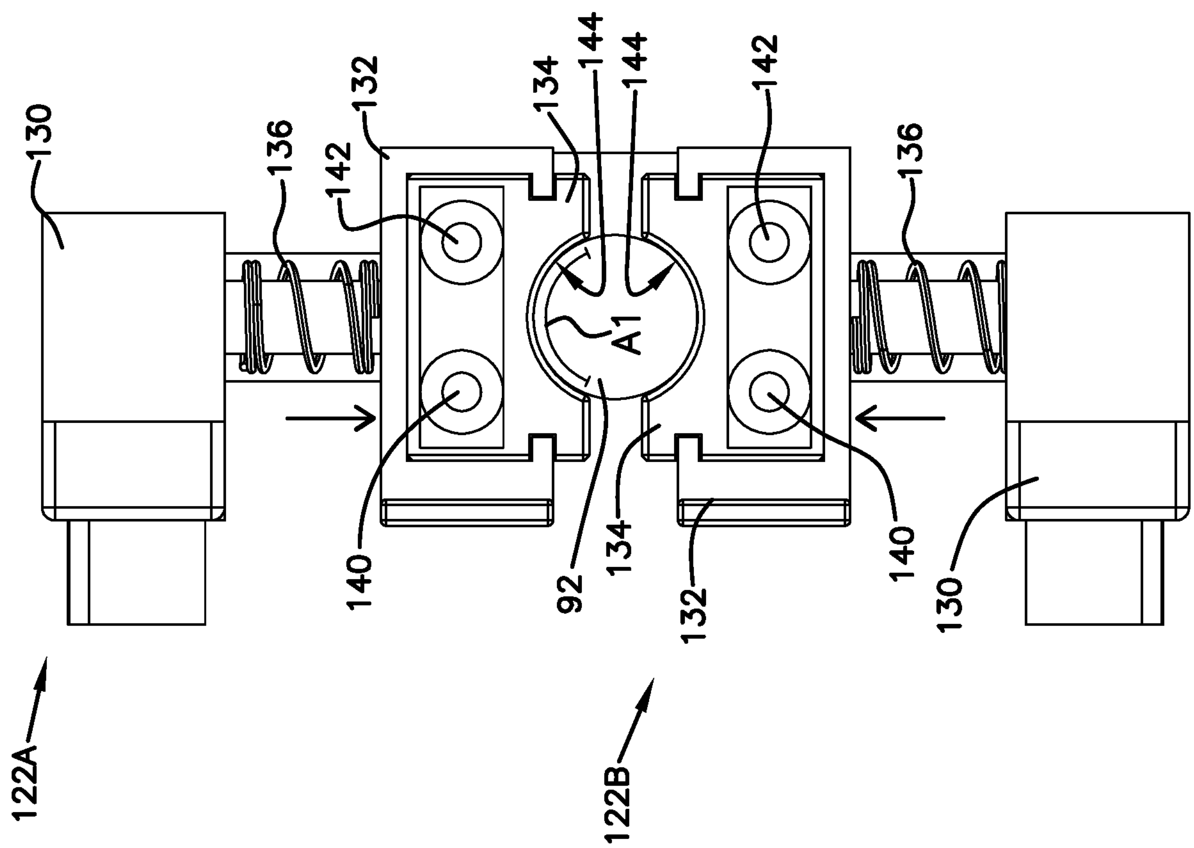
130
136
142
132
134
144
144
142
136
A1
140
92
134
132
140
130
122A
122B

FIG. 5A

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/093842

A. CLASSIFICATION OF SUBJECT MATTER

G02B 6/255(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

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)

CNPAT,CNKI,WPI,EPODOC:tyco electronics heat+ connector, fib?? cable bias+ shrink+ contract+ hold?? actuat+ motor mov+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004042317 A (FUJIKURA LTD.) 12 February 2004 (2004-02-12) paragraphs 0011-0019, figures 1-3	1-20
Y	CN 203275701 U (ELOIK COMM. EQUIPMENT TECHNOLOGY CO., LTD.) 06 November 2013 (2013-11-06) paragraphs 0024-0028, figure 2	1-20
A	CN 204248389 U (OUYANG, QINGFENG ET AL.) 08 April 2015 (2015-04-08) the whole document	1-20
A	US 2012080419 A1 (BUSH SIMON PETER ET AL.) 05 April 2012 (2012-04-05) the whole document	1-20
A	CN 201936031 U (UNIV. BEIJING UNION) 17 August 2011 (2011-08-17) the whole document	1-20

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

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 July 2016	**22 July 2016**

Name and mailing address of the ISA/CN	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2015/093842

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP	2004042317	A	12 February 2004	None	
CN	203275701	U	06 November 2013	None	
CN	204248389	U	08 April 2015	None	
US	2012080419	A1	05 April 2012	None	
CN	201936031	U	17 August 2011	None	