HU000035014T2

(19) **HU**

(11) Lajstromszám: **E 035 014**

(13) **T2**

MAGYARORSZÁG
Szellemi Tulajdon Nemzeti Hivatala

EURÓPAI SZABADALOM
SZÖVEGÉNEK FORDÍTÁSA

(21) Magyar ügyszám: **E 13 152448**
(22) A bejelentés napja: **2013. 01. 24.**

(51) Int. Cl.: ***H01R 43/00*** *(2006.01)*
H01R 13/405 *(2006.01)*
H01R 13/52 *(2006.01)*

(96) Az európai bejelentés bejelentési száma:
EP 20130152448
(97) Az európai bejelentés közzétételi adatai:
EP 2621026 A1 **2013. 07. 31.**
(97) Az európai szabadalom megadásának meghirdetési adatai:
EP 2621026 B1 **2017. 07. 19.**

(30) Elsőbbségi adatok:
102012100598 **2012. 01. 25.** **DE**

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(54) **Tömített dugasz és eljárás dugasz tömítésére**

Sealed plug method for sealing a plug

[0001] The invention relates to a sealed connector according to the preamble of claim 1 and a method for sealing a connector according to the preamble of claim 12. Control elements of the hydraulics, for example valves, can be actuated electromagnetically. For this purpose, the valve includes an encapsulated solenoid having a coil, and when it is energised it moves an armature that entrains a valve piston. In this way, a position of the valve piston can be precisely adjusted. To supply the coil with current, a connector which penetrates the casing, is preferably made of plastics material and is injection-moulded onto the casing is provided on the casing of the solenoid. Current paths or pins of the connector that can be connected to a power source pass through a connector bottom of the connector from an outside towards an inside of the casing, where they are connected to the coil.

[0002] It is known to pot the connector bottom of the connector with a dielectric sealing compound so as to seal the passage of the current paths against penetrating moisture. To this end, plastics materials, epoxy resin or silicone rubber are conventionally utilised.

[0003] DE 1 148 613 dating from 1963 recommends, as a sealing compound for the connector, a silicone to be potted which is intended to adhere to the contacted materials. Alternatively, tacky petroleum compounds or rubber or epoxy compounds are suggested.

[0004] It is a drawback of the suggested solutions that the substances suggested as sealing compounds are not specified. It is a drawback of the suggested epoxy compounds that, in particular in the case of temperature cycling, they are subjected to shrinkage, which may result in detachment and thus in leakage at a boundary layer between the pin and the sealing compound.

[0005] DE 44 10 455 C1 dating from 1995 takes up the recommendation of using an adherent silicone and mentions the use of a two-component UV-hardening silicone. However, the patent specification advises against this concept, because, if the silicone is mechanically stressed, in particular if the contact pins move, the adhesiveness of the silicone is lost. Instead a solution is suggested in which the impermeability is obtained by a

specific geometric design of the pins and shrinking of the plastics material surrounding the pins when said material is cooled in the manufacturing process.

[0006] It is a drawback of the solution without any sealing compound that the plastics material surrounding the pins is subjected to shrinking during its service life. Furthermore, the plastics material is only slightly elastic so that with this solution, too, the passage may not remain sealed in the case of repeated mechanical stress or in the case of temperature cycling. US-A6290239 discloses a connector according to the preamble of claim 1. Compared to this, the problem addressed by the invention is to provide a connector having improved impermeability against the penetration of moisture.

[0007] This problem is solved by a sealed connector having the features of claim 1, as well as by a method for sealing a connector having the features of claim 13.

[0008] Advantageous developments of the invention are described in the dependent claims.

[0009] The connector according to the invention for supplying power to a unit of the hydraulics can be arranged on a casing of said unit. Here, a connector bottom of the connector is penetrated by at least one current path. This passage of the at least one current path through the connector bottom is sealed with a silicone-containing compound. According to the invention, said compound is an adhesive and has high adhesion. This strong adhesion can ensure that, in detrimental operating conditions in which the current path is moved, the sealing compound continues adhering to the current path. In this way detachment from the current path, i.e. the formation of a gap between the current path and the sealing compound, is prevented. Therefore, sustained sealing of the unit against moisture can be brought about. In connection with the high adhesion of the compound and the adhesive, it is preferred for the adhesive to have high flexibility. In this way, the adhesion of the adhesive to the current path is further improved. It is another advantage of the adhesive used that, in the case of temperature cycling of the connector resulting in voltages in the area of the boundary layer between the current path and the adhesive due to different temperature expansion coefficients of the sealing compound, or the adhesive and the current path, the impermeability of the connector continues to be maintained.

[0010] The connector bottom is understood to be an area of a casing of the connector which is penetrated by a current path.

[0011] The unit is preferably connectable via the connector to a power source or an electrical control unit. In a particularly preferred manner, the unit is a coil of a solenoid or an equipment cabinet. It is preferable here for a valve, in particular a pilot valve of the mobile hydraulics, to be operable via the solenoid.

[0012] In an advantageous development of the connector, the connector bottom of the connector is potted with the adhesive at least in an area of passage of the at least one current path. Potting involves little effort in terms of manufacturing, whereby the sealing can be produced in an inexpensive manner.

[0013] In connectors having larger manufacturing tolerances and consequently having a gap between the at least one current path and the connector bottom, in particular an annular gap or a clearance, the silicone-containing adhesive proves to be very advantageous, because, due to its low surface energy, it penetrates even a very narrow gap so that said gap is potted or filled with the adhesive in a sealing manner.

[0014] In a particularly preferred development of the connector, the adhesive consists of one component, which constitutes a reduction in effort compared with the use of two-component or multi-component adhesives or adhesives including a catalyst.

[0015] An acetoxy adhesive having an acetoxy group at least in the non-hardened condition is particularly suitable for this purpose. According to the invention, the adhesive is light-hardened, particularly UV-light hardened. Alternatively or in addition, the adhesive can be humidity-hardened. Particularly preferably, the adhesive is primarily light or UV-light hardened and secondarily humidity hardened. According to the invention, the adhesive is ductile or viscous in an area close to the connector bottom, i.e. close to the passage of the current path through the connector bottom and the connector casing. As a result, the sealing adhesive has higher elasticity here, and is also more adhesive. These properties can be achieved, for example, by the fact that the adhesive is not fully hardened in this area.

[0016] In a particularly advantageous development of the connector, an insulating resistance has a value of more than 0.5 MΩ (mega-ohm) via the sealed passage of the at least one current path when a voltage of 500 volts is applied. Particularly preferably, this value is approximately 1 MΩ.

[0017] In a particularly advantageous development of the connector, a coil winding is arranged on said connector so as to enable a particularly compact and space-saving arrangement of a coil of a solenoid in terms of the device.

[0018] It proves to be particularly advantageous if the connector according to the invention is arranged, in particular injection-moulded, on a casing of a unit of the hydraulics for the electrical supply of the unit.

[0019] Here, the unit is preferably a coil of a solenoid or an equipment cabinet, a valve, in particular a pilot valve of the mobile hydraulics, preferably being operable via the solenoid. The use of the casing in mobile hydraulics is particularly advantageous if the casing is exposed to varying operating states when afloat and in particular under water. This relates, for example, to mobile machines that are used for the rescue of individuals in flood control. In this case, electrically or electro-hydraulically operated valves or the solenoids thereof may happen to get under water. The impermeability of the connectors thereof for the supply of power is then of crucial importance.

[0020] A method according to the invention for sealing a connector bottom of a connector penetrated by at least one current path and for sealing a passage of the at least one current path through the connector bottom, it being possible for a unit of the hydraulics to be electrically supplied via the connector, includes the step of: sealing the passage with a silicone-containing adhesive. Here, the sealing is preferably carried out by filling a gap formed in an area of the passage between the at least one current path and the connector bottom. This gap can in particular be in the form of a clearance or an annular gap. The sealing or filling can in particular be carried out by potting the connector bottom with the silicone-containing adhesive in the area of the passage of the at least one current path through the connector bottom.

[0021] The strong adhesion of the adhesive in particular to the current path and a surface of the connector bottom and of the passage can ensure that, in detrimental operating conditions in which the current path is moved, the sealing compound of the adhesive continues adhering to the current path. In this way, the adhesive is prevented from detaching from the current path and a gap is prevented from forming between the current path and the sealing compound. Therefore, the unit can be sealed in the area of the current path against

penetration of moisture in a sustained manner. In connection with the high adhesion of the adhesive, it is preferable for the adhesive to exhibit high flexibility and elasticity. In this manner, the adhesion of the adhesive to the current path is further improved. Another advantage of the adhesive used is that, in the case of thermal cycling of the connector resulting in voltages in the area of the boundary layer between the current path and the adhesive due to different temperature expansion coefficients of the sealing compound or of the adhesive and the current path, the impermeability of the connector continues to be maintained.

[0022] Advantageously, silicones are used as an adhesive, as in the liquid state they have a low surface energy and therefore can optimally wet the connector bottom to be sealed and the current path to be sealed. Potting the connector bottom of the connector constitutes a step which can be controlled very well as part of a process. It has to be ensured here, however, that the components of the current path and of the connector bottom to be bonded or sealed are clean. The silicone-containing adhesive preferably consists of one component so as to keep procedural complexity low. The adhesive preferably includes an acetoxy group in this case.

[0023] It is particularly advantageous if, after sealing the passage of the at least one current path through the connector bottom with the silicone-containing adhesive, the silicone-containing adhesive is hardened by light, in particular by ultraviolet light as a further step.

[0024] Alternatively or in addition, the method according to the invention includes, after or during the step of hardening the silicone-containing adhesive by light, hardening the silicone-containing adhesive by humidity, in particular by air humidity or water vapour, as a further step. This ensures that areas that cannot or could not be reached during light-hardening are hardened by the air humidity naturally occurring in the ambient air.

[0025] In the following, an embodiment of a connector according to the invention is explained in greater detail with reference to the figures, in which

Fig. 1 is a front view of a connector;

Fig. 2 is a longitudinal section through the connector according to Fig. 1;

Fig. 3 and 4 show the connector according to Fig. 1 and 2 with a device for introducing the adhesive; and

Fig. 5 and 6 show the connector according to Fig. 1 and 2 with a device for hardening the adhesive.

[0026] Fig. 1 is a front view of a connector 1 for the power supply of a coil of a solenoid (not shown) by means of which a pilot valve of the mobile hydraulics can be actuated. The connector 1 is made of plastics material in the form of an injection-moulded part. It has a substantially circular-cylindrical connector casing 2 provided for arrangement in a corresponding cut-out in a casing of the solenoid (not shown). The connector casing 2 has an end face 4 from which a connector device 6 extends towards the viewer of Fig. 1. The connector device 6 has an approximately rectangular connector collar 8 with rounded corners. The connector collar 8 borders a connector bottom 10 of the connector 1 in this figure. In the area of the connector bottom 10, two current paths 12 in the form of pins and four smaller spacers 14 are arranged symmetrically with respect to a vertical axis 16 of the connector 1. Above a transverse axis 18 extending through centre points of the two current paths 12, a latching support 20 is arranged on the connector collar 8. At its open side at the bottom of Fig. 1, the latching support 20 includes a guide groove 22 which is further deepened on both sides of the vertical axis 16 in the direction of an upper side in Fig. 1 of the connector 1, and in this way forms a latching groove 24. The connector bottom 10 of the connector 1 is filled with an adhesive 26 so that each of the spacers 14 and the current paths 12 is bonded to the adhesive 26 by its radial outer lateral surface.

[0027] Fig. 2 is a longitudinal section through the embodiment of the connector according to Fig. 1.

[0028] In Fig. 2, the connector 1 extends from the connector collar 8 on the right to the connector casing 2 arranged on the left. The connector bottom 10 is arranged approximately centrally therebetween. At the radial periphery of the connector bottom 10, an O-ring groove 28 is formed which is provided for receiving an O-ring or sealing ring (not shown). In a mounted state, i.e. when the connector 1 is fastened to a casing of the coil or of the solenoid (not shown), said connector is arranged level with the connector bottom 10 and level with the O-ring groove 28 on the casing. The casing is sealed to the connector 1 in a water-tight or moisture-tight manner via the O-ring.

[0029] The two current paths 12 penetrate the connector 1 and the connector bottom 10 thereof in Fig. 2 from the right to the left. The current paths 12 extend into a winding body 30 by a left end portion thereof (not shown in Fig. 2). Said winding body 30 has a radially outwardly open winding groove 32 in which a coil winding 34 is received. This coil winding 34 is connected to and contacted by the end portions of the current paths 12 pressed into the plastics material of the winding body 30. In this way, a power supply to the coil winding 37 is established via the current paths 12.

[0030] A pole disc 36 serving as a magnetic return sheet for closing the magnetic circuit is arranged radially on the inside on the connector casing 2.

[0031] At the top right in Fig. 2, the latching support 20 is arranged by means of which a connector of the power source (not shown) can be detachably connected to the connector 1 and the connector device 6. To this end, the connector of the power source has to be introduced approximately coaxially into a connector receptacle 44 bordered by the connector collar 8. This is done until one end face of the connector (not shown) abuts the spacers 14 of the connector 1. The spacers 14 of the connector 1 are resiliently deformable in the axial direction so that the connector (not shown) can penetrate farther and more deeply into the connector receptacle 44 by applying a particular force. In conjunction with a latching lug of the connector (not shown), the latching takes place when the latching lug engages behind a latching edge 38 of a latching recess 40 of the latching support 20. In this way, the connector (not shown) can be fixed in position in the connector receptacle 44 using a particular initial load. In the case of radial movements, for instance, of the connector (not shown), a transverse movement of the current paths 12 can occur due to transverse forces transmitted to the current paths 12. In order to limit this movement of the current paths 12, the connector bottom 10 of the connector 1 is extended by a base rib 42 on the right in Fig. 2. Said base rib has the function of clamping the penetrating current paths 12. Therefore, movement of the current paths 12 is inhibited to a certain extent.

[0032] In order to prevent moisture, for instance water or water vapour, that acts from the outside (on the right in Fig. 2) from passing from the connector receptacle 44 through the connector bottom 10 penetrated by the current paths 12 to the coil winding 34, the connector bottom 10 enclosed by the connector collar 8 is filled with a silicone-containing adhesive 26. Here, this is a one-component acetoxy silicone adhesive LOCTITE® 5091™ (Technical Data

Sheet December 2007). The one-component form proves to be advantageous during filling of the connector bottom 10, because it does not need to be mixed with a second component or with a catalyst. The adhesive 26 hardens by UV light during the manufacturing process and after filling. In normal processing conditions, the adhesive 26 is exposed to sufficient UV radiation in order to completely harden at least on the surface. The adhesive 26 has another positive and advantageous property, because it hardens by surface humidity or air humidity, even in shadowy areas into which no UV radiation can reach. The adhesive completely hardens after approximately 72 hours at ambient temperature. The adhesive 26 used is highly flexible, meaning that the point of adhesion has a shock-absorbing property and a good loading capacity. A transverse movement of the current paths 12 can thus be compensated well not only due to the adhesion of the adhesive 26 but also due to the elasticity of the adhesive 26. In this way, the formation of a gap is effectively prevented at the boundary faces between the current paths 12 and the adhesive 26.

[0033] Fig. 3 and 4 schematically show a dosing device 50 that is preferably designed as a dosing tip for the dosed and precisely positioned introduction of the liquid adhesive 26 into the passage area of the current paths 12 in the area of the connector bottom 10. The dosing device 50 is introduced into the area of the connector receptacle 44 with respect to its position such that the clearance in the passage area of the current paths 12 is uniformly filled due to the amount and the flow properties of the adhesive 26 and a homogenous, smooth surface of the adhesive 26 is formed towards the outside.

[0034] Fig. 5 and 6 schematically show a hardening device 51 that is preferably formed as a UV light source for hardening the liquid adhesive 26. The formation of a homogenous outer surface of the adhesive 26 is assisted by an appropriate dosed supply of energy to the hardening device 51 so that the area filled by means of the adhesive 26 also perfectly seals the connector 1 to the outside and forms no gaps for water to later penetrate during operation.

[0035] The adhesive 26 used has advantageous and positive properties not only under the aforementioned mechanical stresses, but also during temperature cycling on the connector 1. This is demonstrated by stress tests having the function of testing the impermeability of the passage of the current paths 12 through the connector bottom 10. Here, the connectors 1 heated to 140 °C in a climate-testing chamber over two hours' storage are abruptly immersed in cold water having a temperature of 20 °C. There they were retained at a depth

of one meter for a period of one hour. When subsequently storing the specimens in a climate-testing chamber and at 20°C, the extent to which water had passed from the connector receptacle 44 to the other side of the connector 1 in the area of the winding body 30 was tested. Even after 20 cycles, no leakage occurred. In each case, an insulation resistance of the sealing adhesive 26 was higher than 1 MΩ. A leakage current was lower than 10 µA at an applied voltage of 500 volts.

[0036] Deviating from the use of the connector 1 for a coil of a solenoid of a pilot valve of the mobile hydraulics, the connector 1 according to the invention can advantageously be used wherever a water-tight feed-through of electric current paths or pins is required. The connector according to the invention proves to be particularly advantageous when it is used with pilot valves for mobile control blocks. In contrast to conventionally potted bases of connectors sealed with epoxy resin or Silopren compound, the connector according to the invention has significantly better sealing characteristics in the event of temperature variations and under mechanical stress.

[0037] A connector for electrical supply of a unit of the hydraulics is disclosed which can be arranged or is arranged on a casing of such a unit. Here, a current path penetrates a connector bottom of the connector and in an area of this passage the connector bottom is sealed against penetrating moisture using a silicone-containing compound. According to the invention, this compound is an adhesive having high adhesive forces.

[0038] A casing of a unit of the hydraulics comprising such a connector is also disclosed.

[0039] A method for sealing a connector bottom of a connector penetrated by a current path by means of which connector a unit of the hydraulics can be electrically supplied is also disclosed. According to the invention, the method includes a step of "sealing a passage of the current path through the connector bottom with a silicone-containing adhesive".

List of reference signs

1	connector
2	connector casing
4	end face
6	connector device
8	connector collar
10	connector bottom
12	current path
14	spacer
16	vertical axis
18	transverse axis
20	latching support
22	guide groove
24	latching groove
26	adhesive
28	O-ring groove
30	winding body
32	winding groove
34	coil winding
36	pole disc
38	latching edge
40	latching
42	base rib
44	connector receptacle
50	dosing device
51	hardening device

TÖMÍTETT DUGASZ ÉS ELJÁRÁS DUGASZ TÖMÍTÉSÉRE

SZABADALMI IGÉNYPONTOK

1. Dugasz hidraulikus aggregát árammal történő ellátásához, ami az aggregát házán lehet elrendezve, ahol a dugasz (1) fenekén (10) legalább egy áramvezető (12) van átvezetve, és a legalább egy áramvezető (12) átvezetése egy szilikon tartalmú masszával van tömítve, ahol a massza egy ragasztóanyag (26),
   azzal jellemezve, hogy
   a ragasztóanyag (26) úgy van fénnyel kikeményítve, hogy egy, a fenék (10) közelében lévő tartományban ne legyen teljesen kikeményedve és ezért szívós vagy sűrűnfolyós legyen.
2. Az 1. a fenék (10) a legalább egy áramvezető (12) átvezetésének legalább egy részén a átvezetése egy szilikon tartalmú masszával van kiöntve.
3. Az 1. vagy 2. igénypont szerinti dugasz, ahol egy, a fenék (10) és a legalább egy áramvezető (12) közötti rés a ragasztóanyaggal (26) van kiöntve.
4. Az 1 – 3. igénypontok bármelyike szerinti dugasz, ahol a ragasztóanyag (26) egykomponensű.
5. Az előző igénypontok bármelyike szerinti dugasz, ahol a ragasztóanyag (26) egy acetoxi ragasztó.
6. Az előző igénypontok bármelyike szerinti dugasz, ahol a ragasztóanyag (26) járulékosan nedvességgel van kikeményítve.
7. Az előző igénypontok bármelyike szerinti dugasz, ahol a legalább egy áramvezető (12) tömített átvezetésének szigetelési ellenállása nagyobb, mint 0,5 Megaohm (0,5 MΩ).
8. Az előző igénypontok bármelyike szerinti dugasz, ahol az aggregát egy elektromágnes tekercse vagy egy kapcsolószekrény.
9. A 8. igénypont szerinti dugasz, ahol az elektromágnessel egy szelep működtethető.
10. Az előző igénypontok bármelyike szerinti dugasz, ahol a dugaszon (1) tekercselés (34) van elrendezve.
11. Aggregát ház hidraulikához, **azzal jellemezve,** hogy a dugasz (1) a házon az előző igénypontok bármelyike szerint van elrendezve.
12. Eljárás legalább egy áramvezető (12) átvezetésének tömítésére egy dugasz (1) fenekén (10), ahol a dugasszal (1) hidraulikus aggregát árammal történő ellátása végezhető, aminek során:
    - az átvezetést egy szilikon tartalmú ragasztóanyaggal (26) tömítjük,

    azzal jellemezve, hogy az eljárás során még:
    - a ragasztóanyagot (26) fénnyel keményítjük ki úgy, hogy egy, az egy, a fenék (10) közelében lévő tartományban ne legyen teljesen kikeményedve és ezért szívós vagy sűrűnfolyós legyen.
13. A 12. igénypont szerinti eljárás, ahol a szilikon tartalmú ragasztóanyag (26) fénnyel történő kikeményítése alatt vagy után egy lépésben
    - a szilikon tartalmú ragasztóanyagot (26) nedvességgel keményítjük ki.

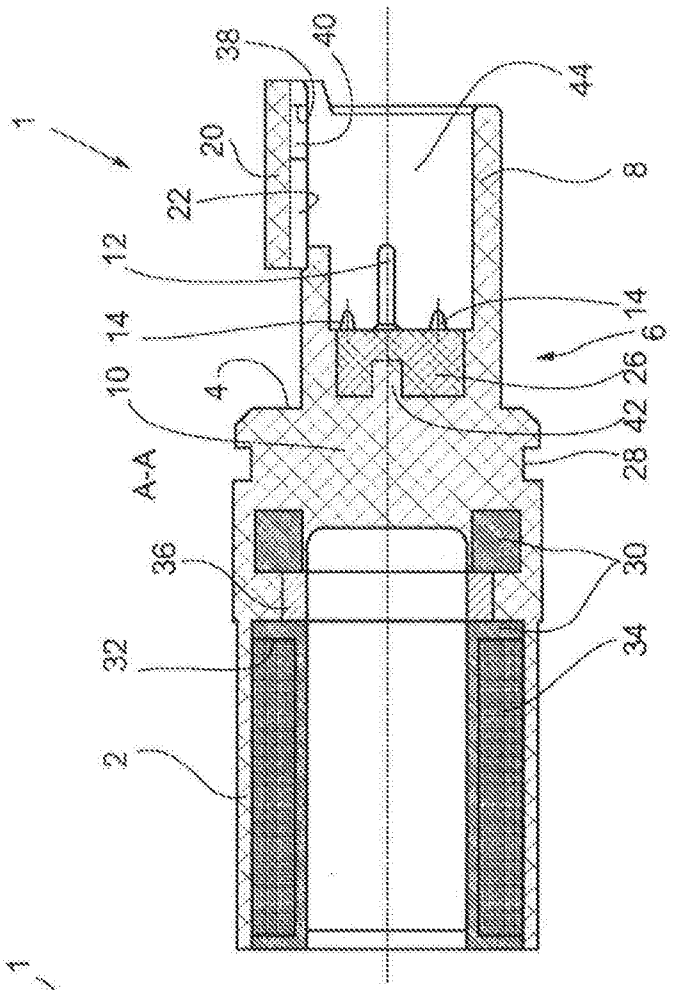

Fig. 2

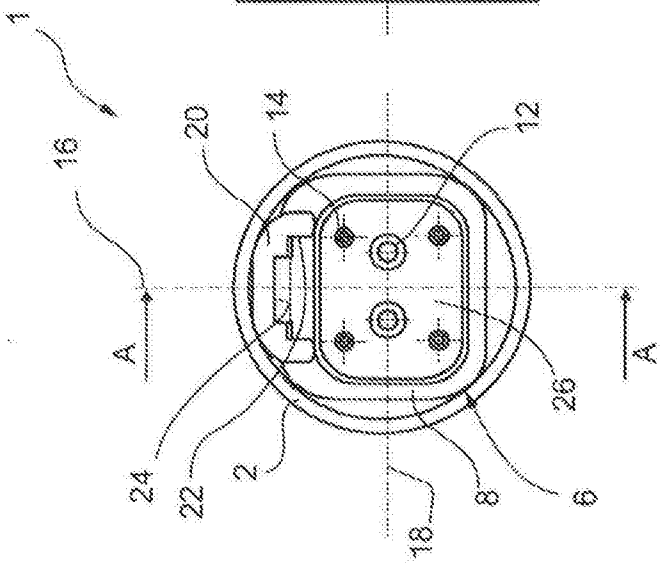

Fig. 1

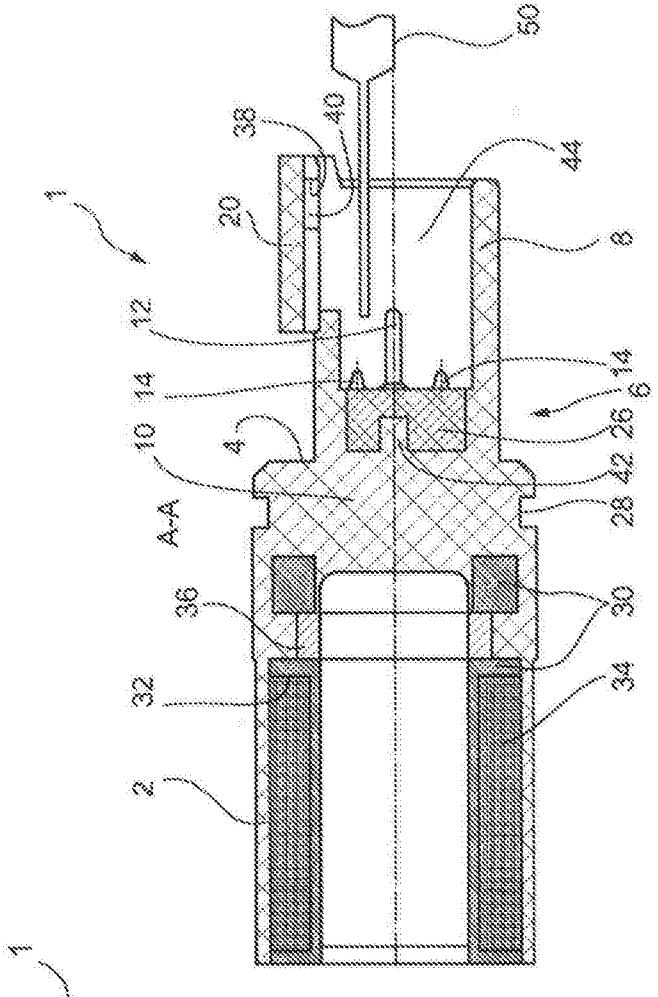
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Fig. 4

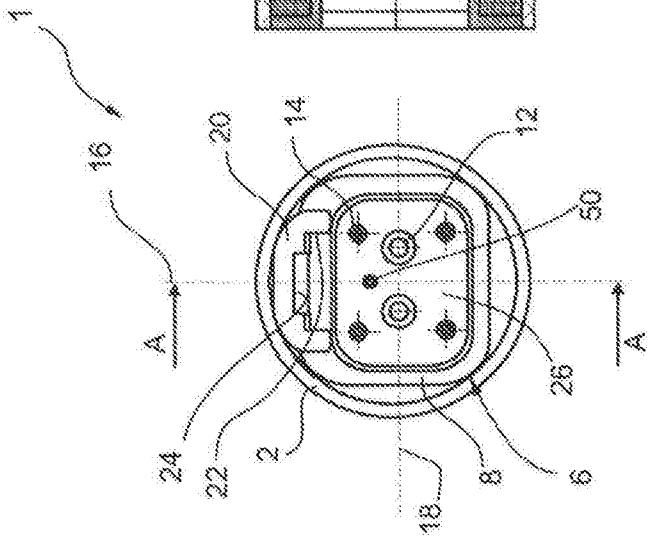
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Fig. 3

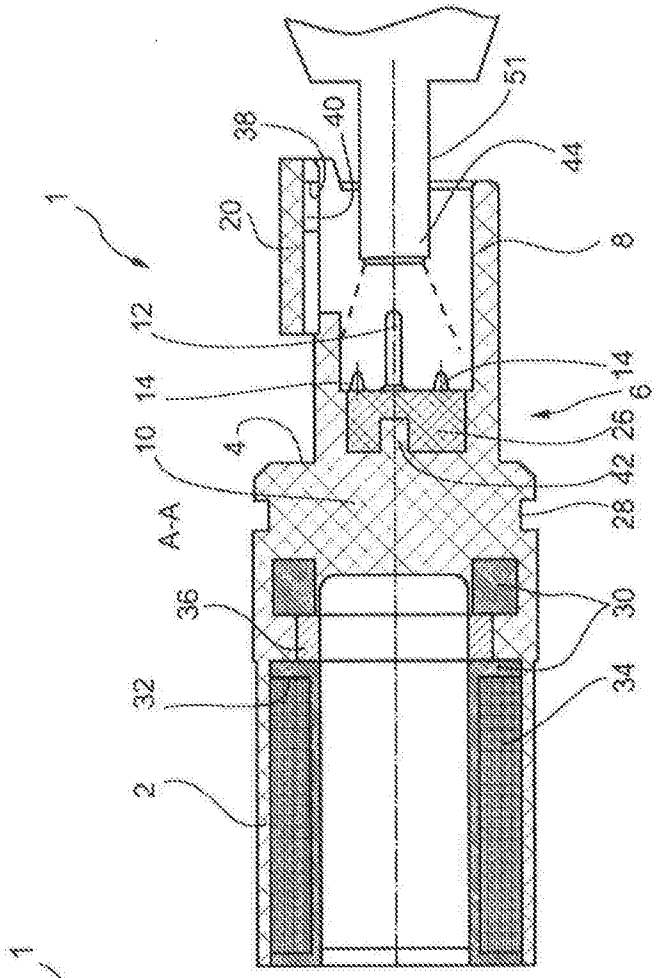
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Fig. 6

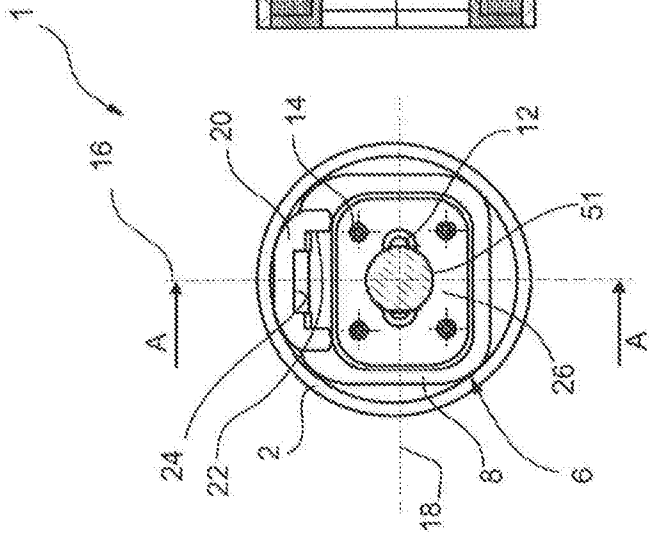
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Fig. 5