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(54) **HIGH-FIDELITY AUDIO TRANSMISSION CONNECTOR USING SOFT METAL**

(57) The present disclosure concerns an improved system for plug (100) and socket (200) connectors for transmission of electrical signals representing sound data, where the sound deterioration is reduced compared to prior art. The mechanical requirements of the plug (100) and socket (200) connectors are fulfilled by a mechanically robust frame (101, 201), while the high-fidelity electrical connection is enabled by use of a soft, highconductivity metal (103, 203).

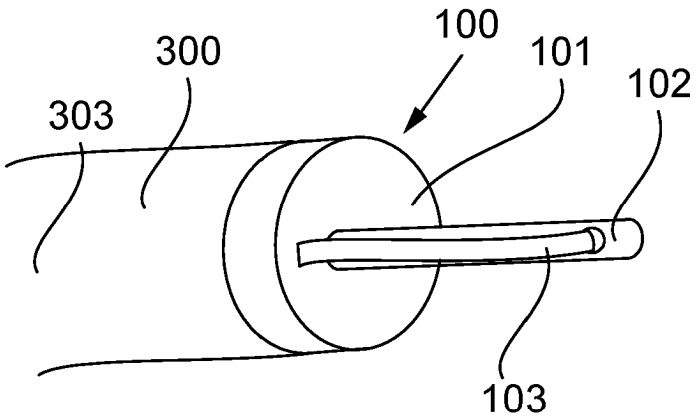


Fig. 1A

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Description

Technical field

[0001] The subject of the present disclosure is plugs and sockets for transmitting electrical signals representing sound data, in particular for extremely high fidelity audio transmission.

Background

[0002] High fidelity audio transmission relies on lossless and defect free conduction of electrical signals through cables and connections. In order to obtain as high a signal purity as possible, many high-end music equipment manufacturers use high-conductivity metals in their cables, such as copper and silver. Particularly, annealed noble metals, where the metal is heated and slowly cooled in a controlled manner in order to obtain a very high purity and defect-free crystal structure, have shown favorable conductivity properties that translate to high fidelity audio transmission. Such annealed metals are used in high-end cables but not for plugs and sockets due to their very high malleability making them difficult and infeasible to machine and process.

[0003] It is therefore common to produce plugs and sockets, where the conductor in the cable is connected to a contact element in the plug or socket by means of welding, soldering, or mechanical fastening, such as screwing. The conductor in the plug or socket is then typically a harder metal (such as hardened copper or alloys thereof) able to withstand the forces and wear associated with numerous mating cycles consisting of plugging and unplugging the connectors.

[0004] Extensive listening tests reveal that most plugs, including many expensive audiophile varieties, disturb the signal-carrying current and add coloration to the music signal. This leads many audio enthusiasts to bypass connections by "hard wiring" cables that connect audio equipment, thereby eliminating the deficiencies associated with the use of plug and socket connectors.

Summary

[0005] It is one objective of the present disclosure to provide a plug and socket that at least partially overcomes some of the challenges mentioned above.

[0006] In a first aspect of the present disclosure, a plug for transmitting electrical signals representing sound data is disclosed, configured to be connected in one end to a socket and at the other end to a cable. The plug comprises a mechanically robust frame, one or more pins configured to be received by and fit into one or more receptacles in the socket, and one or more electrical contact elements. The electrical contact elements comprise a metal having a hardness value (HV) of less than 75, such as less than 60, such as less than 45, such as less than or equal to 30, as measured using the Vickers hardness test (ISO 6507 / ASTM E384).

[0007] In a second aspect of the present disclosure, a socket for transmitting electrical signals representing sound data is disclosed, configured to be connected in one end to a plug, such as a plug described above, and at the other end to a further device, such as a cable or a panel. The socket comprises a mechanically robust frame, one or more receptacles configured to receive and hold one or more pins of the plug, and one or more electrical contact elements. The one or more electrical contact elements are comprised of a metal having a hardness value (HV) of less than or equal to 75, such as less than or equal to 60, such as less than or equal to 45, such as less than or equal to 30, as measured using the Vickers hardness test (ISO 6507 / ASTM E384).

[0008] A design that enables using soft metals as electrical contact elements opens a range of opportunities for utilizing high-conductivity metals, which are commonly excluded from electrical contacts due to their mechanical instability. In this disclosure, however, the mechanical requirements of the plug and socket connectors are fulfilled by the frame, respectively, while the high-fidelity electrical connection is enabled by the use of the high-conductivity metal, respectively.

[0009] In one or more embodiments of the present disclosure, the one or more electrical contact elements of the plug or the socket comprise a noble metal, such as copper, silver, or an alloy thereof.

[0010] In one or more embodiments of the present disclosure, the purity of the metal of the electrical contact elements of the plug or the socket is higher than 95%, such as higher than 99%, such as higher than 99.9%, such as higher than 99.99%.

[0011] In one or more embodiments of the present disclosure, the metal of the electrical contact elements of the plug or the socket has been annealed.

[0012] In one or more embodiments of the present disclosure, the one or more electrical contact elements of the plug or the socket each has a cross sectional area of less than 2 mm^2, such as less than 1 mm^2, such as less than 0.5 mm^2.

[0013] In one or more embodiments of the present disclosure, the mechanically robust frame of the plug or the socket is composed of an electrically insulating polymer, such as polyether ether ketone (PEEK).

[0014] In one or more embodiments of the present disclosure, the mechanically robust frame of the plug or the socket is manufactured by means of molding, such as by means of injection molding.

[0015] In one or more embodiments of the present disclosure, the plug or the socket is designed to be compatible with standard connector designs, such as RCA standards, Banana plug standards, such as 4 mm Banana plug standards, or XLR standards, such as XLR3 standards.

[0016] In one or more embodiments of the present disclosure, one or more of the one or more electrical contact elements of the plug or the socket are integral

parts of one or more electrical conductors of the cable.

[0017] In one or more embodiments of the present disclosure, each of the pins of the plug additionally comprise one or more elastic elements that cause the one or more electrical contact elements to reversibly bulge outwards, such that the diameter of each pin is larger when the plug is not inserted in the socket.

[0018] In one or more embodiments of the present disclosure, each of the one or more receptacles of the socket additionally comprises one or more elastic elements, which cause the one or more electrical contact elements to reversibly bulge outwards, such that the internal diameter of each receptacle is smaller when a plug is not inserted in the socket than it is when a plug is inserted in the socket.

Description of Drawings

[0019]

Fig. 1A: Schematic drawing of a general plug, where the electrical contact element is supported by a mechanically stabilizing frame in the form of a pin, in one or more embodiments of the present disclosure.

Fig. 1B: Schematic drawing of a general socket, where the electrical contact elements supported by a mechanically stabilizing frame in the form of an receptacle, in one or more embodiments of the present disclosure.

Fig. 2A: Exploded view of an RCA-type plug showing the two components of the mechanically stabilizing frame, the electrical conductor pin and ring, in one or more embodiments of the present disclosure.

Fig. 2B: Schematic drawing of an assembled RCA-type plug, in one or more embodiments of the present disclosure. Here, the electrical conductor parts have been colored gray to guide the viewer.

Fig. 3A: Exploded view of a Banana-type plug showing the mechanically stabilizing frame consisting of a base and a pin as well as two electrical conductor bands, in one or more embodiments of the present disclosure.

Fig. 3B: Schematic drawing of an assembled pin in the Banana-type plug, in one or more embodiments of the present disclosure.

Fig. 4A: Exploded view of an XLR3-type plug showing the mechanically stabilizing frame consisting of a base and three pins as well as three electrical conductor bands, in one or more embodiments of the present disclosure.

Fig. 4B: Schematic drawing of an assembled pin in the XLR3-type plug, in one or more embodiments of the present disclosure. Here, the electrical conductor parts have been colored gray to guide the viewer.

Fig. 5A: Exploded view of an XLR3-type socket showing the mechanically stabilizing frame consisting of a base and three receptacles as well as three electrical conductor bands, in one or more embodiments of the present disclosure.

Fig. 5B: Schematic drawing of an assembled pin in the XLR3-type socket, in one or more embodiments of the present disclosure. Here, the electrical conductor parts have been colored gray to guide the viewer.

Detailed description

[0020] The present disclosure concerns an improved system for plug 100 and socket 200 connectors for transmission of electrical signals representing sound data, where the sound deterioration is reduced compared to prior art. In order to overcome the disturbances of the electrical signal introduced by the mechanically stable but less conductive metals usually forming the contact elements of the connectors, the plug 100 and socket 200 of the present invention each comprises a different mechanically robust frame 101 and 201, respectively, composed of a strong and wear-resistant material, such as polyether ether ketone (PEEK) around which a high-conductivity metal 103 and 203, respectively, is wrapped in order to form the connection. Thus, the mechanical requirements of the plug 100 and socket 200 connectors are fulfilled by the frame 101 and 201, respectively, while the high-fidelity electrical connection is enabled by the use of the high-conductivity metal 103 and 203, respectively.

[0021] In one or more embodiments of the present disclosure, the electrical contact elements 103, 203 comprise a noble metal such as copper, silver, or alloys thereof. The advantage of using these metals is their high electrical conductivity. In one or more embodiments, the purity of the metal of the electrical contact elements 103, 203 is higher than 95%, such as higher than 99%, such as higher than 99.9%, such as higher than 99.99%. The absence of impurities enhances the electrical conductivity and reduces disturbances of the electrical signal, which may deteriorate the listening experience. In one or more embodiments, the metal of the electrical contact elements 103, 203 has been annealed. This is a process in which the metal is heated to an elevated temperature and subsequently cooled in order to enhance its ductility and decrease its hardness. During the heating, atoms migrate around the crystal structure to annihilate defects such as dislocations, making the metal softer even after cooling. Additionally, annealing metals, such as noble metals, increases their electrical

conductivity. In one or more embodiments, the electrical contact elements 103, 203 each has a cross sectional area of less than 2 mm^2, such as less than 1 mm^2, such as less than 0.5 mm^2. Using a very thin wire or band of metal - particularly when the metal is very soft - is challenging in terms of mechanical stability, however when using expensive metals, it is preferable to keep the amount of material as low as possible.

[0022] All the material properties mentioned in the embodiments above cause the electrical contact elements 103 and 203 to be very soft. In one or more embodiments, the metal of the electrical contact elements 103 or 203 has a hardness value (HV) of less than 75, such as less than 60, such as less than 45, such as less than or equal to 30, as measured using the Vickers hardness test (ISO 6507 / ASTM E384).

[0023] In order to enable the metal of the electrical contact elements 103 or 203 to be so soft, the connector 100 or 200 comprises a mechanically robust frame 101 or 201, respectively. In one or more embodiments, the mechanically robust frame 101 or 201 comprises an electrically insulating polymer, such as polyether ether ketone (PEEK). It is advantageous that the mechanically robust frame 101 or 201 be electrically insulating as this avoids issues with short-circuiting connections inside the connector 100 or 200. PEEK is a wear-resistant material with excellent mechanical and chemical stability well suited for providing the structural integrity of the connector and thereby supporting the soft electrical contact elements 103, 203. In one or more embodiments, the mechanically robust frame 101, 201 may be fabricated by molding, such as injection molding. This method of manufacturing is relatively inexpensive, highly industrially scalable, and lends itself well to thermoplastics such as PEEK.

[0024] Furthermore, in one or more embodiments, the mechanically robust frame 101, 201 may be elastic or include elastic elements so as to improve the physical contact between electrical contact elements 103, 203 across the intermating connection. In this regard, many polymers, including PEEK, are ideal, since they exhibit favorable elastic properties that enable the connector to protect the soft electrical contact elements 103, 203 by flexing and absorbing any impacts in the mechanically robust frame 101, 201 whilst at the same time providing a suitable pressure of electrical contact elements 103, 203 against their counterparts during intermating.

[0025] Fig. 1 shows a schematic view of a plug 100 (Fig. 1A) and a socket 200 (Fig. 1B) each of which is connected to an end of a cable 300. The plug 100 has a mechanically robust frame 101, which supports an electrical contact element 103 along the length of a pin 102. When intermating such a plug 100 with a socket (such as the socket 200 shown in Fig. 1B), the electrical contact element 103 comes into contact with the electrical contact element in the socket.

[0026] Correspondingly, the socket 200 shown in Fig. 1B has a mechanically robust frame 201, which supports an electrical contact element 203 along the inside length of an receptacle 202. When intermating such a socket 200 with a plug (such as the plug 200 shown in Fig. 1A), the electrical contact element 203 comes into contact with the electrical contact element 103 in the plug 100.

[0027] The fact that the noble metal used to obtain the high-quality connection is only a small part of the connector enables the connector 100, 200 itself it be manufactured relatively inexpensively. The main structure of the connector 100, 200 is instead formed by the inexpensive mechanically robust frame 101, 201.

[0028] In one or more embodiments of the present disclosure (such as the embodiment illustrated in Fig. 2), the plug 110 is compliant with RCA standard dimensions. Here, the mechanically robust frame 111 comprises two parts 111a and 111b fitted over two electrical contact elements 113a and 113b forming respectively a central pin 113a and a concentric ring 113b. The two parts 111a, 111b of the mechanically robust frame 111 can be held together by means of two screws on the side of 111a configured to be connected to a cable. Not shown in the figure is the electrical conductors from the cable 300, which must be fastened to the electrical contact elements 113 of the plug 110, such as by means of soldering.

[0029] In one or more embodiments of the present disclosure (such as the embodiment illustrated in Fig. 3), the plug 120 is compliant with Banana plug standard dimensions, such as 4 mm Banana plug dimensions. Here, each pin 122 comprises one or more elastic elements 126, such as grooves, protrusions, or incisions 126 extending longitudinally along the length of the pin 122, which cause the electrical contact elements 123 to reversibly bulge outwards such that the diameter of the pin 122 is larger when the plug 120 is not mated with a complementary socket 200 than when it is mated. This elastic deformation causes the electrical contact elements to press outwards when intermating with a complementary connector, thereby ensuring a good electrical contact. Since the main mechanical structure is provided by the mechanically robust frame 121, even very malleable electrical contact element material can be utilized.

[0030] In one or more embodiments of the present disclosure (such as the embodiment illustrated in Fig. 4), the plug 130 is compliant with XLR standard dimensions, such as XLR3 standard dimensions. In either case, the plug 130 comprises a number of pins 132 (in the case of XLR3, this number is three). In one or more embodiments, each pin 132 has a hole 134 towards the distal end 132a through which the electrical contact element 133 is threaded. In one or more embodiments, each pin 132 additionally comprises a longitudinal groove in which the electrical contact element 133 is arranged along the length of the pin 132.

[0031] In one or more embodiments of the present disclosure (such as the embodiment illustrated in Fig. 5), the socket 230 is compliant with XLR standard dimensions, such as XLR3 standard dimensions. In either case, the socket 230 comprises a number of receptacles 232

(in the case of XLR3, this number is three). In one or more embodiments, each receptacle 232 has a recess 234 in the distal rim 232a configured to hold the electrical contact element 233 when it is bent about the rim 232a of the receptacle 232. Importantly, the electrical contact element 233 extends longitudinally along the inside of the receptacle 232, where it may form electrical contact when the socket 230 is mated with a complimentary plug 130.

[0032] In one or more embodiments, the electrical contact elements 103, 203 of the connector 100, 200 are integral parts of one or more electrical conductors 303 of the cable 300 with which the plug 100 or socket 200 is connected. In this case, a professional music technician can assemble a cable with a connector by peeling off the protective outer coating of the cable and suitably arranging the electrical conductor 303 of the cable 300 in the mechanically robust frame 101, 201 of the connector.

Items

[0033]

1. A plug (100) for transmitting electrical signals representing sound data configured to be connected in one end to a socket (200) and at the other end to a cable (300), wherein the plug (100) comprises a mechanically robust frame (101), one or more pins (102) configured to be received by and fit into one or more receptacles (202) in the socket (200), and one or more electrical contact elements (103), wherein the electrical contact elements (103) comprise a metal having a hardness value (HV) of less than 75, such as less than 60, such as less than 45, such as less than or equal to 30, as measured using the Vickers hardness test (ISO 6507 / ASTM E384).

2. The plug (100) according to item 1, wherein the one or more electrical contact elements (103) comprise a noble metal, such as copper, silver, or an alloy thereof.

3. The plug (100) according to any of items 1-2, wherein the purity of the metal of the electrical contact elements (103) is higher than 95%, such as higher than 99%, such as higher than 99.9%, such as higher than 99.99%.

4. The plug (100) according to any of items 1-3, wherein the metal of the electrical contact elements (103) has been annealed.

5. The plug (100) according to any of the preceding items, wherein the one or more electrical contact elements (103) each has a cross sectional area of less than 2 mm^2, such as less than 1 mm^2, such as less than 0.5 mm^2.

6. The plug (100) according to any of the preceding items, wherein the mechanically robust frame (101) is composed of an electrically insulating polymer, such as polyether ether ketone (PEEK).

7. The plug (100) according to any of the preceding items, wherein the mechanically robust frame (101) is manufactured by means of molding, such as by means of injection molding.

8. The plug (110) according to any of the preceding items designed to be compatible with standard connector designs, such as RCA standards, Banana plug standards, such as 4 mm Banana plug standards, or XLR standards, such as XLR3 standards.

9. The plug (100) according to any of the preceding items, wherein one or more of the one or more electrical contact elements (123) are integral parts of one or more electrical conductors (303) of the cable (300).

10. The plug (120) according to any of the preceding items, wherein each of the pins (122) additionally comprise one or more elastic elements (126) that cause the one or more electrical contact elements (123) to reversibly bulge outwards, such that the diameter of each pin (122) is larger when the plug (120) is not inserted in the socket.

11. A socket (200) for transmitting electrical signals representing sound data configured to be connected in one end to a plug (100), such as a plug (100) according to any of items 1-10, and at the other end to a further device, such as a cable (300) or a panel, wherein the socket (200) comprises a mechanically robust frame (201), one or more receptacles (202) configured to receive and hold one or more pins (102) of the plug (100), and one or more electrical contact elements (203), wherein the one or more electrical contact elements (203) are comprised of a metal having a hardness value (HV) of less than or equal to 75, such as less than or equal to 60, such as less than or equal to 45, such as less than or equal to 30, as measured using the Vickers hardness test (ISO 6507 / ASTM E384).

12. The socket (200) according to item 11, wherein each of the one or more receptacles (202) additionally comprises one or more elastic elements (206), which cause the one or more electrical contact elements (203) to reversibly bulge outwards, such that the internal diameter of each receptacle (202) is smaller when a plug (100) is not inserted in the socket (200) than it is when a plug (100) is inserted in the socket (200).

13. The socket (200) according to any of items 11-12, wherein the one or more electrical contact elements

(203) are composed of a noble metal, such as copper, silver, or an alloy thereof.

14. The socket (200) according to any of items 11-13, wherein the purity of the metal of the electrical contact elements (203) is higher than 95%, such as higher than 99%, such as higher than 99.9%, such as higher than 99.99%.

15. The socket (200) according to any of items 11-14, wherein the metal of the electrical contact elements (203) has been annealed.

16. The socket (200) according to any of items 11-15, wherein the one or more electrical contact elements (203) each has a cross sectional area of less than 2 mm^2, such as less than 1 mm^2, such as less than 0.5 mm^2.

17. The socket (200) according to any of items 11-16, wherein the mechanically robust frame (201) is composed of an electrically insulating polymer, such as polyether ether ketone (PEEK).

18. The socket (200) according to any of items 11-17, wherein the mechanically robust frame (201) is manufactured by means of molding, such as by means of injection molding.

19. The socket (200) according to any of items 11-18, wherein one or more of the one or more electrical contact elements (203) are integral parts of one or more electrical conductors (303) of the cable (300).

20. The socket (230) according to any of items 11-19 designed to be compatible with standard connector designs, such as RCA standards, Banana plug standards, such as 4 mm Banana plug standards, or XLR standards, such as XLR3 standards.

21. The socket (230) according to any of items 11-20, wherein each of the electrical contact elements (233) is bent about the rim of one of the receptacles (232) and extends along the inside of the receptacle (232), such as in a lengthwise groove (235).

Claims

1. A plug (100) for transmitting electrical signals representing sound data configured to be connected in one end to a socket (200) and at the other end to a cable (300), wherein the plug (100) comprises a mechanically robust frame (101), one or more pins (102) configured to be received by and fit into one or more receptacles (202) in the socket (200), and one or more electrical contact elements (103), wherein the electrical contact elements (103) comprise a metal having a hardness value (HV) of less than 75, such as less than 60, such as less than 45, such as less than or equal to 30, as measured using the Vickers hardness test (ISO 6507 / ASTM E384).

2. The plug (100) according to claim 1, wherein the one or more electrical contact elements (103) comprise a noble metal, such as copper, such as silver, such as an alloy thereof.

3. The plug (100) according to any of the preceding claims, wherein the purity of the metal of the electrical contact elements (103) is higher than 95%, such as higher than 99%, such as higher than 99.9%, such as higher than 99.99%.

4. The plug (100) according to any of the preceding claims, wherein the metal of the electrical contact elements (103) has been annealed.

5. The plug (100) according to any of the preceding claims, wherein the one or more electrical contact elements (103) each has a cross sectional area of less than 2 mm^2, such as less than 1 mm^2, such as less than 0.5 mm^2.

6. The plug (100) according to any of the preceding claims, wherein the mechanically robust frame (101) is composed of an electrically insulating polymer, such as polyether ether ketone (PEEK), and wherein the mechanically robust frame (101) is manufactured by means of molding, such as by means of injection molding.

7. The plug (110) according to any of the preceding claims designed to be compatible with standard connector designs, such as RCA standards, Banana plug standards, such as 4 mm Banana plug standards, or XLR standards, such as XLR3 standards.

8. A socket (200) for transmitting electrical signals representing sound data configured to be connected in one end to a plug (100), such as a plug (100) according to any of claims 1-7, and at the other end to a further device, such as a cable (300) or a panel, wherein the socket (200) comprises a mechanically robust frame (201), one or more receptacles (202) configured to receive and hold one or more pins (102) of the plug (100), and one or more electrical contact elements (203), wherein the one or more electrical contact elements (203) are comprised of a metal having a hardness value (HV) of less than or equal to 75, such as less than or equal to 60, such as less than or equal to 45, such as less than or equal to 30, as measured using the Vickers hardness test (ISO 6507 / ASTM E384).

9. The socket (200) according to claim 8, wherein each

of the one or more receptacles (202) additionally comprises one or more elastic elements (206), which cause the one or more electrical contact elements (203) to reversibly bulge outwards, such that the internal diameter of each receptacle (202) is smaller when a plug (100) is not inserted in the socket (200) than it is when a plug (100) is inserted in the socket (200).

10. The socket (200) according to any of claims 8-9, wherein the one or more electrical contact elements (203) are composed of a noble metal, such as copper, such as silver, such as an alloy thereof.

11. The socket (200) according to any of claims 8-10, wherein the purity of the metal of the electrical contact elements (203) is higher than 95%, such as higher than 99%, such as higher than 99.9%, such as higher than 99.99%.

12. The socket (200) according to any of claims 8-11, wherein the metal of the electrical contact elements (203) has been annealed.

13. The socket (200) according to any of claims 8-12, wherein the one or more electrical contact elements (203) each has a cross sectional area of less than 2 mm^2, such as less than 1 mm^2, such as less than 0.5 mm^2.

14. The socket (200) according to any of claims 8-13, wherein the mechanically robust frame (201) is composed of an electrically insulating polymer, such as polyether ether ketone (PEEK), and wherein the mechanically robust frame (201) is manufactured by means of molding, such as by means of injection molding.

15. The socket (230) according to any of claims 8-14 designed to be compatible with standard connector designs, such as RCA standards, Banana plug standards, such as 4 mm Banana plug standards, or XLR standards, such as XLR3 standards.

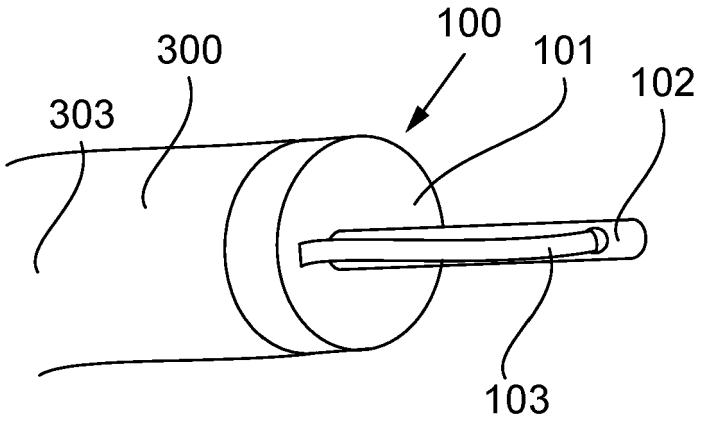


Fig. 1A

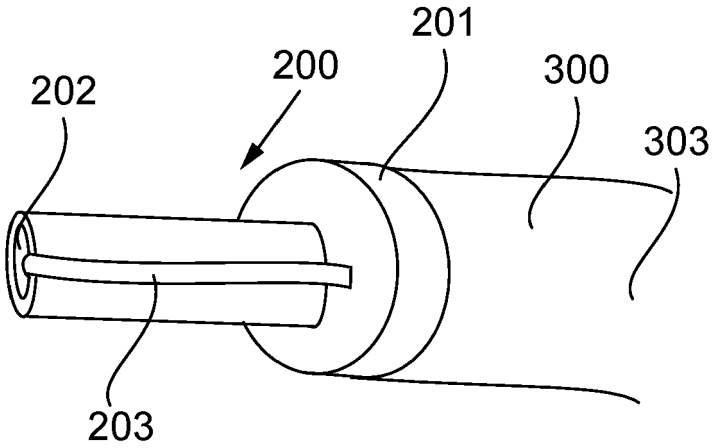


Fig. 1B

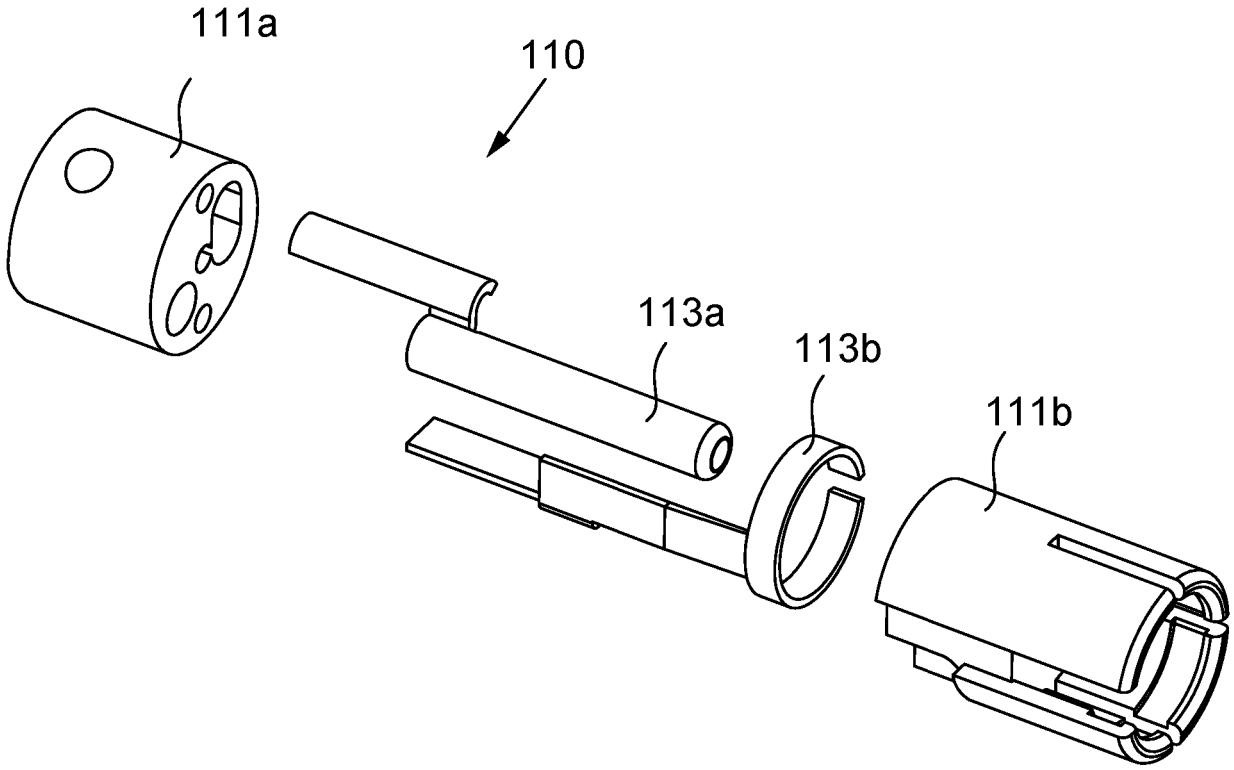


Fig. 2A

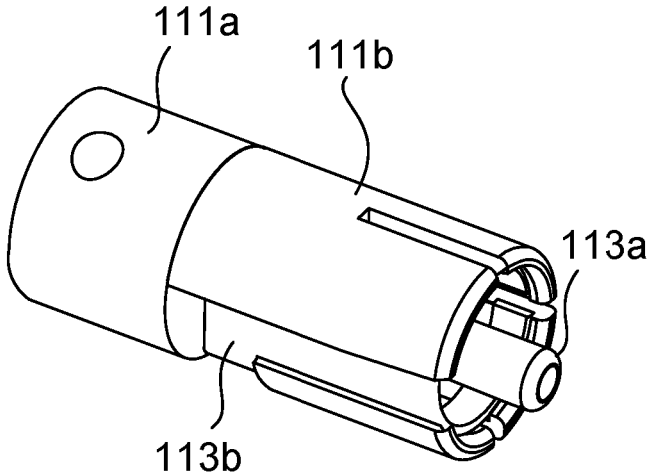


Fig. 2B

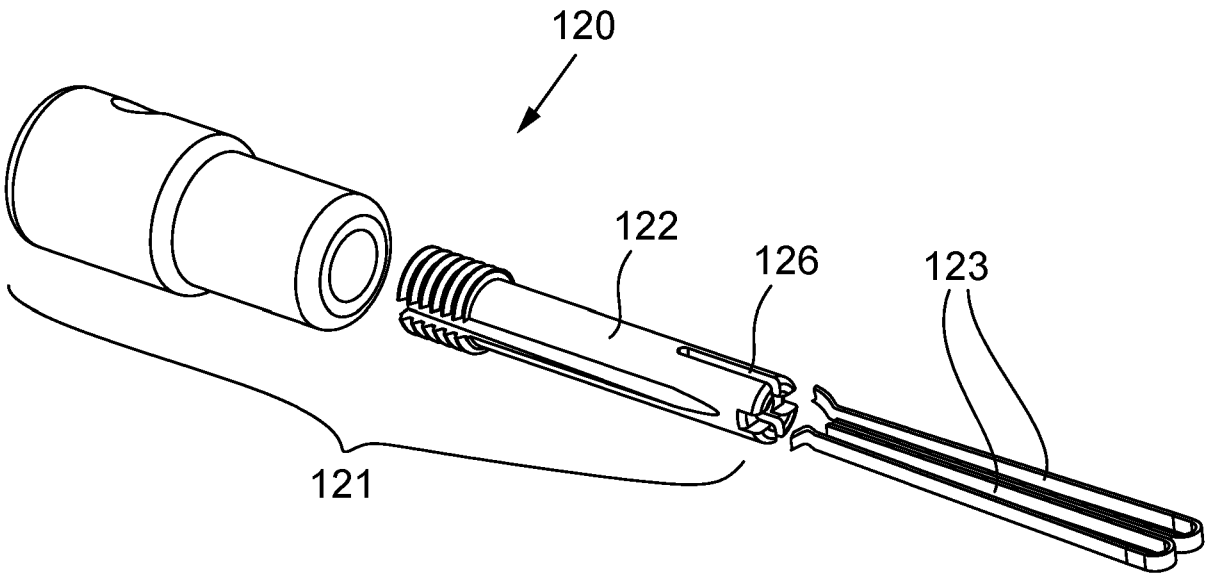


Fig. 3A

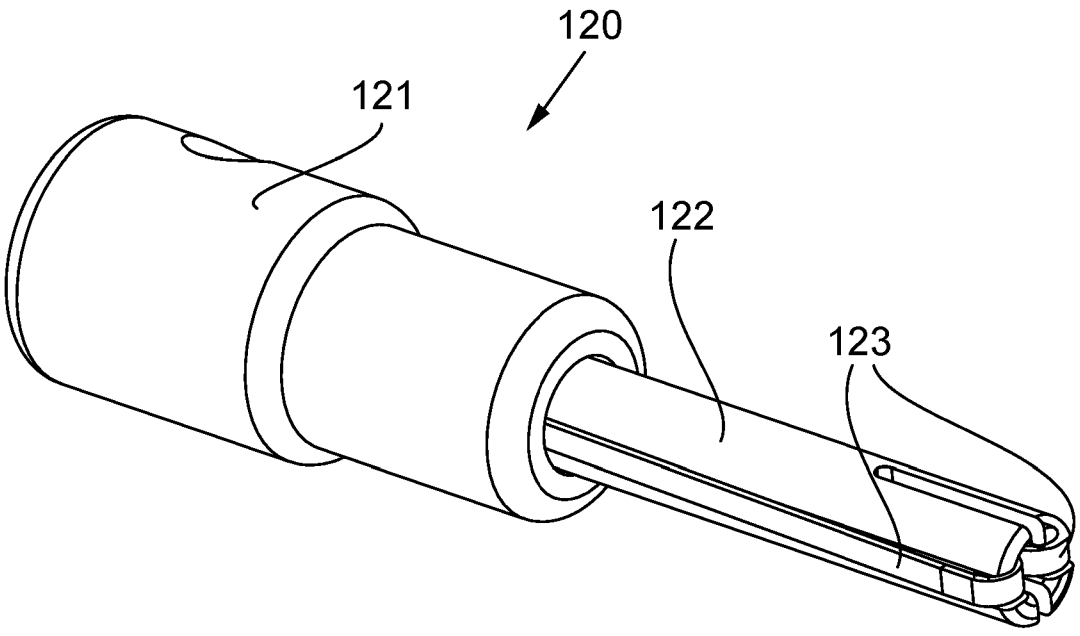


Fig. 3B

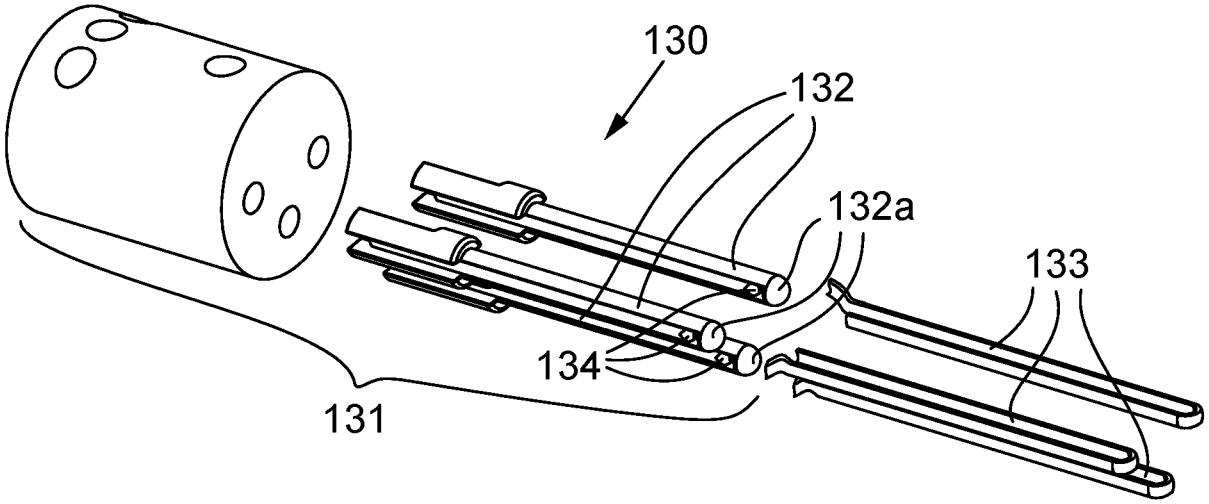


Fig. 4A

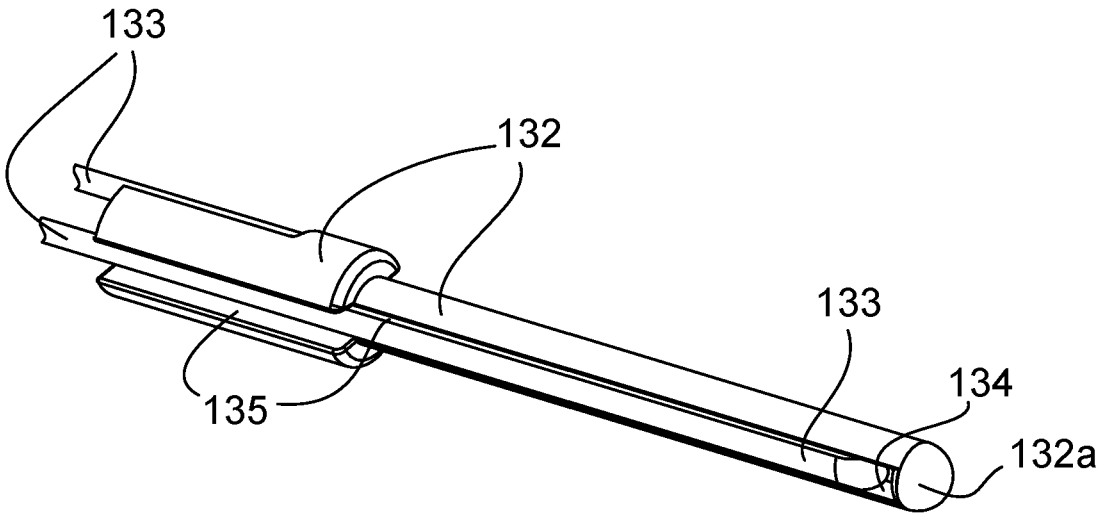


Fig. 4B

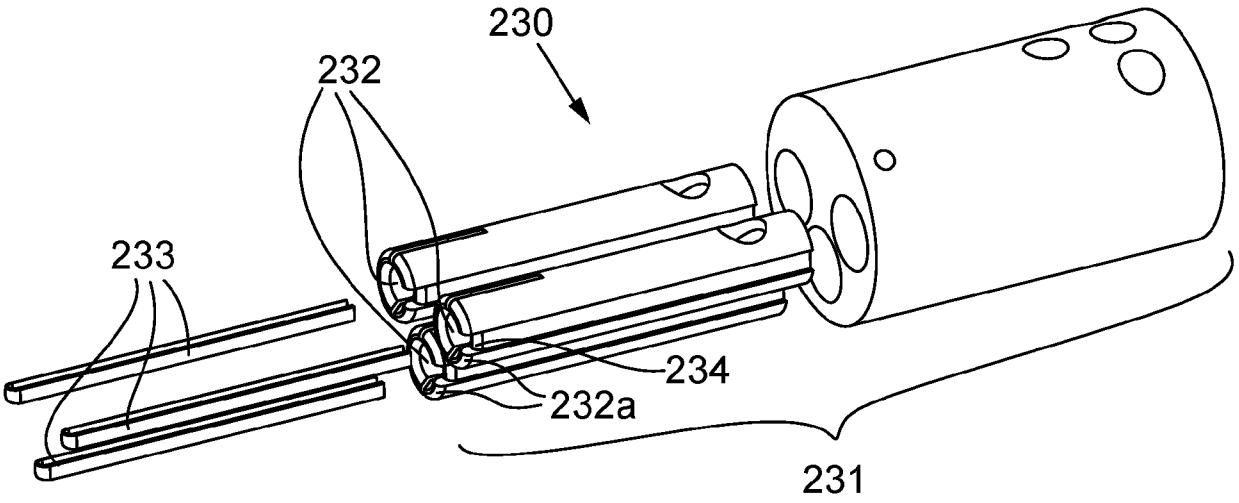


Fig. 5A

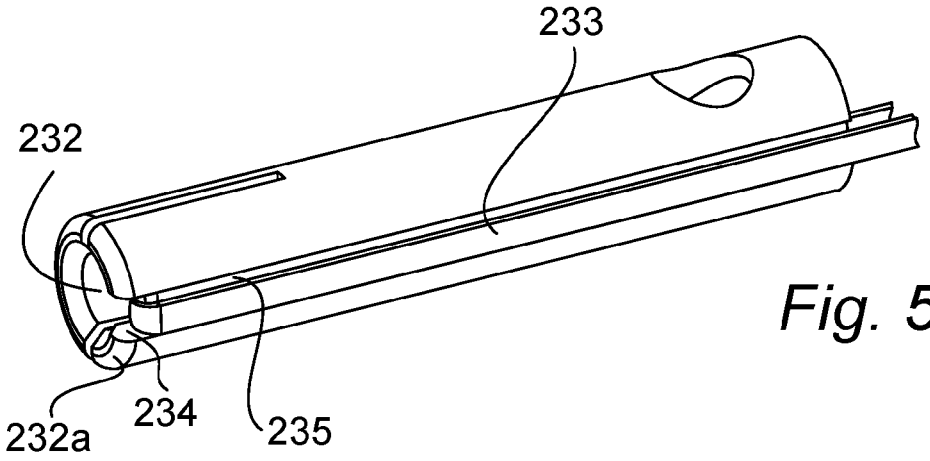


Fig. 5B

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 25 16 7751

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2020/295488 A1 (MASUDA TAKESHI [JP]) 17 September 2020 (2020-09-17) * paragraphs [0086], [0088]; figures 3,4 *	1,5-8	INV. H01R13/03
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 September 2025	Corrales, Daniel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 25 16 7751

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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