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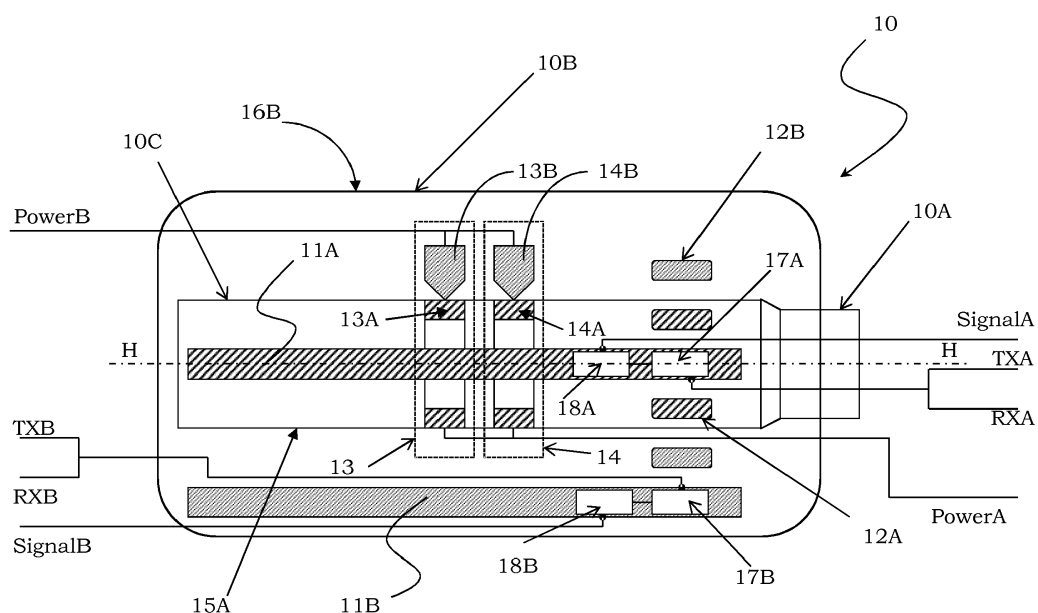
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(54) SLIP RING AND CORRESPONDING TRANSMISSION METHOD

(57) It is described a slip ring (10) comprising at least one movable portion (10A) and one fixed portion (10B), at least one interface surface (10C) being defined therebetween, the slip ring (10) further comprising contactless transmission elements (12A, 12B) for a signal transmission, which are associated with the movable portion and fixed portion (10A, 10B), respectively, as well as at

least one contact transmission element (13, 14) arranged at the interface surface (10C) and used only for a power transmission. Conveniently, the contactless transmission elements (12A, 12B) comprise respective inductive coupling elements for a signal transmission by magnetic induction.



Fixed portion
Movable portion

FIG. 1

Description

Field of application

[0001] The present invention refers to a slip ring, as well as to a power and signal transmission method by means of such a slip ring.

[0002] Particularly but not exclusively, the invention regards a slip ring comprising a fixed portion and a movable portion for the power and signal transmission from a sensor, for example a thermocouple, and the following description is made with reference to this application field with the only purpose to simplify its exposition.

Prior art

[0003] As it is well known, the slip rings are devices used in many electromechanical systems that require a free continuous rotation with the purpose of transferring electrical power and/or data from a fixed portion to a rotating portion, continuously over 360°.

[0004] It is possible to consider the operation of a slip ring similar to that of a crane, which comprises a fixed frame portion and a rotating arm or head, indeed.

[0005] The use of such slip rings essentially occurs in order to be able to eliminate the connection metal wires, which are susceptible to be damaged when hanging from movable joints.

[0006] In particular, a slip ring therefore comprises at least one ring connection structure, which includes brushes and related brush-holder for the sliding contact between a fixed portion and a movable portion of the slip ring, such a connection structure being usually protected by a cover made of aluminum, steel or other materials so as to guarantee the proper protection based on the required application requirements.

[0007] Therefore, from the structural point of view, a slip ring essentially comprises the fixed portion, also called stator, including the brushes and the movable portion, in particular rotating, also called rotor, comprising the rings, both elements, brushes and rings, being made of conductive materials and being in contact, in particular in a sliding contact, on at least one interface surface between stator and rotor.

[0008] Normally, all the mechanical parts are protected with antioxidant treatments, electrochemical treatments or particular paintings in order to guarantee a long useful working life. Particularly, conductive materials such as aluminum and steel, but also stainless steel or special plastic materials, as well as metals such as, for example, copper, silver-plated copper, golden copper or brass can be used.

[0009] Therefore, the slip ring is a passive element, in particular an electromechanical component formed by sliding contacts realized by ring-brush pairs, each brush exclusively assuring the contact with an external surface of a related ring, at an interface surface between the fixed portion and the movable or rotating portion of the slip ring.

[0010] Such sliding contacts allow a transmission of analog voltage or current signals and currently the so obtained slip rings are mainly employed in the industrial robotics and are used to improve the efficiency of an electromechanical system that comprises them, by simplifying the operation and eliminating the problem related to the wear and damaging of wires and/or cables exiting the slip ring itself.

[0011] The slip rings made according to the above-described known solutions, although meeting the purpose, have several drawbacks and limitations, of which the main are the following ones:

- a mechanical wear of the components occurs, in particular due to the brushes-rings contact, which reduces the useful working life of the slip ring including them;
- moreover, such brushes-rings sliding contact can cause a variation of the impedance value as generated by the contact itself; and
- in case of a temperature variation of the mechanical support forming the case of the slip ring, undesired variations of the analog signals to be transmitted from the fixed portion to the movable or rotating portion thereof occur.

[0012] US patent granted with number US 6,434,293 on August 13, 2002 discloses a slip ring comprising light emitters and receivers that are arranged on both the rotating portion and the fixed portion, in order to transmit information by means of optical communication without physical contact between the two portions; it is also provided the transmission of the power supply by means of a system composed by rings and brushes, the rings being integral with the rotating shaft.

[0013] Although being advantageous under several aspects, this solution has the drawback of needing a precise alignment of the light emitters and receivers, and such alignment should be always guaranteed.

[0014] The technical problem of the present invention is to devise a slip ring, having such structural and functional characteristics to allow a proper signals transfer without an excessive wear of the elements forming it, and without the need of aligning the elements adapted to transmit and receive those signals, in that way overcoming the limitations and the drawbacks that still affect the slip rings made according to the prior art.

Summary of the invention

[0015] The solution idea at the basis of the present invention is to separate the signal and power transmission, the signal transmission being realized according to a contactless (wireless) transmission mode, in particular through magnetic induction, by means of inductive coupling elements such as magnetic induction coils, also us-

ing suitable analog-to-digital (A/D) conversions and digital-to-analog (D/A) reconversions.

[0016] Based on that solution idea, the technical problem is solved by a slip ring comprising at least one movable portion and one fixed portion, at least one interface surface being defined therebetween, that slip ring further comprising contactless transmission elements for a signal transmission, which are associated with those movable portion and fixed portion, respectively, as well as at least one contact transmission element arranged at the interface surface and used only for a power transmission, that slip ring being characterized in that the contactless transmission elements comprise respective inductive coupling elements for a signal transmission by magnetic induction.

[0017] More in particular, the invention comprises the following additional and optional characteristics, taken individually or in combination, if necessary.

[0018] According to an aspect of the invention, the inductive coupling elements are magnetic induction coils, such coils being mutually concentric and arranged within the movable portion and fixed portion, respectively.

[0019] According to another aspect of the invention, the movable portion and fixed portion can comprise respective printed circuit boards, associated with the contactless transmission elements, comprising respective transmission/reception units being connected to respective signal converters and respective signal transmission terminals.

[0020] Furthermore, the contact transmission element can comprise at least one ring integral with the movable portion, arranged at the interface surface and in contact with at least one brush integral with the fixed portion, so as to form a sliding contact at the interface surface, that contact transmission element being connected to respective power transmission terminals of the movable and fixed portions.

[0021] More in particular, the signal converters can be an analog-to-digital converter and a digital-to-analog converter, respectively.

[0022] According to another aspect of the invention, the movable portion can comprise a printed circuit board, a contactless transmission element and the ring of the contact transmission element, inserted in a suitable case whose outer surface forms the interface surface; in a similar way, the fixed portion can comprise a printed circuit board, a contactless transmission element and the brush of the contact transmission element, inserted in a further case.

[0023] More in particular, the cases of the movable portion and the fixed portion, respectively, can be made of aluminum.

[0024] According to another aspect of the invention, the movable portion and fixed portion can be mutually coaxial with a predetermined longitudinal axis thereof, the movable portion being pivotable around that longitudinal axis.

[0025] The technical problem is also solved by a power

and signal transmission method comprising the steps of:

- providing at least one slip ring comprising a movable portion and a fixed portion, as well as an interface surface between the movable portion and the fixed portion;
- separating a power transmission from a signal transmission;
- performing the power transmission by means of a sliding contact realized between the movable portion and the fixed portion at the interface surface; and
- performing the signal transmission by means of a contactless transmission between the movable portion and the fixed portion, that contactless transmission occurring by magnetic induction through respective contactless transmission elements that include inductive coupling elements.

[0026] It is underlined that those inductive coupling elements preferably are magnetic induction coils.

[0027] Furthermore, according to another aspect of the invention, the contactless signal transmission can comprise a conversion of an input analog signal received on a signal transmission terminal into a received digital signal, which is contactlessly transmitted between the movable portion and the fixed portion, and a subsequent reconversion of the transmitted digital signal into an output signal to a further signal transmission terminal.

[0028] More particularly, the contactless transmission of the received digital signal can occur according to the mutual induction principle between the inductive coupling elements of the movable portion and the fixed portion, by supplying at least one of those inductive coupling elements with a signal having a constant amplitude and variable frequency.

[0029] According to another aspect of the invention, the signal conversion, reconversion and transmission steps can be realized by means of transmission/reception units, signal converters and contactless transmission elements included in the movable portion and the fixed portion of the slip ring.

[0030] According to yet another aspect of the invention, the power transmission can be realized by means of a sliding contact realized by means of at least one brushing pair of at least one contact transmission element, included into the slip ring, the ring being integral with the movable portion and the brush being integral with the fixed portion.

[0031] Finally, according to a further aspect of the invention, the contactless signal transmission can occur by means of at least one first coil arranged within the movable portion and at least one second coil arranged within the fixed portion, the coils being mutually concentric.

[0032] The characteristics and the advantages of the

slip ring and the transmission method according to the invention will be apparent from the description, made herein below, of one exemplary embodiment thereof given by way of indicative but non-limitative example with reference to the attached drawings.

Brief description of the drawings

[0033] In those drawings:

Figure 1 schematically shows a slip ring that is realized according to the present invention; and

Figure 2 schematically shows A/D and D/A conversions used by the slip ring of Figure 1.

Detailed description

[0034] With reference to those figures, and in particular to Figure 1, a slip ring realized according to the present invention is globally indicated with 10.

[0035] It should be noticed that the figures represent schematic views of the device according to the invention and they are not drawn to scale, but instead they are drawn in order to emphasize the important characteristics of the invention. In the figures, the different pieces are represented in a schematic way, their shape being able to vary according to the desired application.

[0036] As seen in relation to the prior art, the slip ring 10 comprises at least one movable portion 10A, also called rotor, and one fixed portion 10B, also called stator. It is also defined at least one interface surface 10C between the movable portion 10A and the fixed portion 10B.

[0037] In a preferred embodiment, the movable portion 10A and the fixed portion 10B are mutually coaxial, extending along a longitudinal axis HH, the movable portion 10A in particular being rotatable about that longitudinal axis HH, and they are mutually fastened in a known way by means of a ball bearing system that allows the movement, in particular the rotation, of the movable portion 10A.

[0038] The movable portion 10A and the fixed portion 10B are provided with respective printed circuit boards, 11A and 11B, associated with respective contactless transmission elements, 12A and 12B.

[0039] Advantageously according to the present invention, the contactless transmission elements, 12A and 12B, include respective inductive coupling elements for the signal transmission by magnetic induction. In a preferred embodiment of the present invention, those inductive coupling elements are in the form of magnetic induction coils.

[0040] In particular, at least two coils are included in the slip ring 10, those coils being mutually concentric. Specifically, at least one first coil, always shown as 12A, is arranged inside the movable portion 10A, while at least one second coil, always shown as 12B, is arranged inside the fixed portion 10B, those coils being mutually concentric.

tric.

[0041] The signal transmission between the concentric coils occurs according to the mutual induction principle, namely by feeding them with a signal having a constant amplitude and variable frequency proportional to an input signal, that signal being suitably converted, as it will be described in details in the following.

[0042] Particularly, the transmission occurs through a signal whose frequency is variable in a range from about 2 kHz to about 11 kHz; that signal can possibly be divided in suitable time slots and that frequency can possibly be adjustable based on the physical characteristics of the coils and/or their supports.

[0043] The slip ring 10 also comprises further contact transmission elements, which are two in the example shown in the figure and are shown as 13 and 14. As in the known solutions, the contact transmission elements, 13 and 14, comprise respective rings 13A and 14A that are arranged at the interface surface 10C between the movable portion 10A and the fixed portion 10B and contacting respective brushes 13B and 14B, in order to realize a sliding contact at that interface surface 10C. It is underlined that the rings 13A and 14A are integral with the movable portion 10A and therefore they rotate therewith, while the brushes 13B and 14B are integral with the fixed portion 10B.

[0044] In other words, the movable portion 10A comprises the printed circuit board 11A, the contactless transmission element 12A and the rings 13A and 14A of the contact transmission elements 13 and 14, which are inserted in a suitable case 15A, whose external surface realizes the interface surface 10C between the movable portion 10A and fixed portion 10B. In a similar way, the fixed portion 10B comprises the printed circuit board 11B, the contactless transmission element 12B and the brushes 13B and 14B of the contact transmission elements 13 and 14, which are inserted in a suitable case 16B too.

[0045] In a preferred embodiment, the cases 15A and 16B are made of aluminum, in particular having an IP65 degree of protection, while the rings 13A and 14A and the brushes 13B and 14B are made of copper, silver-plated copper, gold-plated copper or brass, preferably gold-plated copper so that the sliding contact occurs between gold and gold.

[0046] More in particular, the printed circuit boards 11A and 11B comprise respective transmission/reception units 17A and 17B, provided with respective reception terminals, RXA and RXB, and transmission terminals, TXA and TXB, as well as respective signal converters, 18A and 18B, connected to such transmission/reception units, 17A and 17B.

[0047] Therefore, the slip ring 10 of the present invention separately transmits power and signals. In particular, the slip ring 10 is therefore provided with respective power transmission terminals, PowerA and PowerB, as well as respective signal transmission terminals, SignalA and SignalB, connected to the movable portion 10A and the fixed portion 10B, respectively.

[0048] In particular, a first power transmission terminal PowerA is connected to the brushes 13B and 14B of the contact transmission elements, 13 and 14, while a second power transmission terminal PowerB is connected to rings 13A and 14A of the contact transmission elements, 13 and 14; in that way, the power transmission inside the slip ring 10 occurs by contact, thanks to the contact transmission elements, 13 and 14, and in particular to the sliding contact between the respective brushing pairs.

[0049] In a similar way, a first signal transmission terminal SignalA is connected to the printed circuit board 11A of the movable portion 10A and a second signal transmission terminal SignalB is connected to the printed circuit board 11B of the fixed portion 10B.

[0050] More in particular, as schematically shown in Figure 2, in case of a signal transmission from the movable portion 10A to the fixed portion 10B, at the integrated circuit board 11A of the movable portion 10A, the signal transmission terminal SignalA is connected to the signal converter 18A, in particular an analog-to-digital converter (ADC), which is in turn connected to the transmission/reception unit 17A.

[0051] The ADC converter is an electronic circuit able to convert a continuous analog signal (e.g. a voltage) into a series of discrete values, indeed. Particularly, the continuous-time analog signal is sampled at a frequency indicated as "sampling rate" or sampling frequency.

[0052] In that way, an input analog signal, received on the signal transmission terminal SignalA, for example from a sensor connected to the slip ring 10, is converted in a received digital signal, in turn transmitted by means of the transmission/reception unit 17A, in particular by contactless transmission thanks to the interaction between the contactless transmission elements 12A and 12B, namely thanks to the magnetically coupled concentric coils, which are comprised in the movable and fixed portions, 10A and 10B.

[0053] Further, the received digital signal, as converted by the signal converter 18A of the movable portion 10A, is transmitted to the fixed portion 10B, in particular to its integrated circuit board 11B and more in particular to the transmission/reception unit 17B included therein.

[0054] That transmitted digital signal therefore is converted by the signal converter 18B, in particular a digital-to-analog converter (DAC), connected to the transmission/reception unit 17B and provided as output analog signal to the signal transmission terminal SignalB.

[0055] The DAC converter in particular is able to generate a certain voltage or current level on its output terminal, according to a numerical value that is present at its input, based on a conversion table that is named LUT ("Look-Up Table"), which can have proportional characteristics in the relationship between digital values and the corresponding values of the analog signal to be generated, or it can follow a totally arbitrary trend, according to its usage.

[0056] In that way, the signal transmission inside the

slip ring 10 occurs contactlessly, thanks to the contactless transmission elements 12A and 12B, namely the magnetic induction coils, and in particular thanks to their interaction with the transmission/reception units, 17A and 17B, of the movable portion 10A and the fixed portion 10B, namely by magnetic induction.

[0057] The slip ring 10 therefore has been provided with an electronic portion comprising the transmission/reception units, 17A and 17B, and the signal converters, 18A and 18B, housed in the integrated circuit boards, 11A and 11B, which allow a contactless transmission of digital signals, thanks also to the contactless transmission elements 12A and 12B. Therefore, advantageously it is possible to eliminate, for the signal transmission, the noise due to the sliding contact realized by the brushing pairs. Suitably, for the slip ring 10 according to the present invention, that sliding coupling is maintained only for the power transmission, where the noise effects are not important.

[0058] The present invention also refers to a power and signal transmission method by means of a slip ring of the above-described type.

[0059] In particular, the transmission method essentially comprises the steps of:

- providing at least one slip ring 10 comprising a movable portion 10A and a fixed portion 10B, as well as an interface surface 10C between the movable portion 10A and the fixed portion 10B;
- separating a power transmission from a signal transmission;
- performing the power transmission by means of a sliding contact realized between the movable portion 10A and the fixed portion 10B at the interface surface 10C; and
- performing the signal transmission by means of a contactless transmission between the movable portion 10A and the fixed portion 10B, that contactless transmission occurring by magnetic induction through respective contactless transmission elements that include inductive coupling elements.

[0060] Furthermore, the step of contactless signal transmission comprises a conversion of an input analog signal, for example received from a sensor connected to the slip ring 10, into a received digital signal, which is transmitted contactlessly, and a following reconversion of that transmitted digital signal into an output signal. The signal conversion, reconversion and transmission operations are performed by means of suitable transmission/reception units, 17A and 17B, signal converters, 18A and 18B, as well as contactless transmission elements, 12A and 12B, namely the coils, included in the slip ring 10.

[0061] The power transmission instead is realized by means of a sliding contact obtained, for example, by

means of brush-ring pairs of suitable contact transmission elements, 13 and 14, included in the slip ring 10.

[0062] In conclusion, the slip ring and the transmission method according to the present invention allow to carry out a simple and effective power and signal transmission, reducing the problems connected to the wear of the sliding components, which are reduced in their number, as well as reducing the noise, which is eliminated from the signal transmission, which is the one mainly affected by the same.

[0063] The present invention solves the above-mentioned technical problem and has several advantages.

[0064] In particular, advantageously according to the present invention, the signal transmission through the coils does not need a precise alignment, as it is instead the case of optical signal transmission systems.

[0065] It is also underlined that the use of two mutually concentric coils allows the generation of a magnetic field able to allow a variation of the relative positioning of those coils along the slip ring longitudinal axis up to about 90% of the amplitude of those coils, that amplitude being always measured along the slip ring longitudinal axis.

[0066] In other words, the presence of concentric coils allows the slip ring of the present invention to tolerate remarkable mechanical deviations during its operation.

[0067] Moreover, thanks to the mutual induction coupling, the present invention allows a remarkable stability of the signal that is transmitted/received from the coils, that signal being immune to both the axial vibrations and the radial vibrations and being immune also to the rotational speed, which is only limited by the rotational speed of the movable portion.

[0068] Suitably, the signal transmitted between the coils by mutual induction is not influenced by the generation of dust due to the wear of the slip ring, in particular due to the contact between brushes and rings, as instead it is the case of the optical transmission systems, whose efficiency is limited by the presence of that dust.

[0069] The slip ring of the invention is apt to perform bidirectional transmissions of the CAN-bus type, as well as to transfer multiple signals that are converted through the ADC and DAC system.

[0070] Moreover, the adoption of concentric coils allows the elimination of sliding contacts for the signal transmission. Therefore, this allows to eliminate a dynamic resistance related thereto and therefore to eliminate the related electrical noise generated by the sliding between brushes and rings during the rotation of the movable portion of the slip ring, noise that can cause signal transmission errors also when the contacts are not worn-out.

[0071] Furthermore, the absence of a contact between metallic portions for the signal transmission eliminates the dependency thereof from the so-called Seebeck effect, which occurs every time there is a contact between metals of a different nature, generating a voltage proportional to the temperature of those metals. Significant temperature differences are involved for example in case of

thermocouple sensors, which can distort a reading carried out by them in the presence of contacts between metals.

[0072] In fact, the slip ring of the described type finds a useful application in case of temperature sensors, such as thermistor sensors or RTD ("Resistance Temperature Detector"), such as the so-called PT100 and PT1000 including resistors made of platinum (which have resistivity values equal to 100Ω and 1000Ω at 0°, actually), thermocouple sensors, but also in case of analog or digital signal transmission, for example for field bus in the so-called Controller Area Network, also named CAN-bus and in particular used in the automotive field as a serial transmission standard, specifically designed to work also in environments that are strongly disturbed by the presence of electromagnetic waves.

[0073] It is also underlined that the slip ring according to the present invention does not suffer from the rotational speed variations of the movable portion thereof because the transmission, in particular the signal one, does not depend on sliding contacts, but occurs by magnetic induction through two concentric coils.

[0074] Essentially, it is possible to state that the proposed slip ring and transmission method allow managing the power and signal transfer both mechanically and electronically, thanks to at least one contactless transmission, in particular a signal one, and thanks to a suitable signal processing that is obtained from components that are integrated in integrated circuit boards inserted in the slip ring.

[0075] Clearly, one skilled in the art, in order to meet contingent and specific requirements, will be able to make several modifications and variations to the above-described slip ring and transmission method, all included within the protection scope of the invention as defined from the following claims.

Claims

1. A slip ring (10) comprising at least one movable portion (10A) and one fixed portion (10B), at least one interface surface (10C) being defined therebetween, said slip ring (10) further comprising contactless transmission elements (12A, 12B) for a signal transmission, which are associated with said movable portion and fixed portion (10A, 10B), respectively, as well as at least one contact transmission element (13, 14) arranged at said interface surface (10C) and used only for a power transmission, said slip ring (10) being **characterized in that** said contactless transmission elements (12A, 12B) comprise respective inductive coupling elements for a signal transmission by magnetic induction.
2. The slip ring (10) according to claim 1, **characterized in that** said inductive coupling elements are magnetic induction coils.

3. The slip ring (10) according to claim 2, **characterized in that** said magnetic induction coils are mutually concentric and are arranged inside said movable portion and fixed portion (10A, 10B), respectively.
4. The slip ring (10) according to claim 1, **characterized in that** said movable portion and fixed portion (10A, 10B) comprise respective printed circuit boards (11A, 11B), associated with said contactless transmission elements (12A, 12B), comprising respective transmission/reception units (17A, 17B) that are connected to respective signal converters (18A, 18B) and respective signal transmission terminals (SignalA, SignalB).
5. The slip ring (10) according to claim 4, **characterized in that** said signal converters (18A, 18B) are an analog-to-digital converter and a digital-to-analog converter, respectively.
6. The slip ring (10) according to any one of the preceding claims, **characterized in that** said at least one contact transmission element (13, 14) comprises at least one ring (13A, 14A) that is integral with said movable portion (10A), arranged at said interface surface (10C) and in contact with at least one brush (13B, 14B) that is integral with said fixed portion (10B), so as to form a sliding contact at said interface surface (10C), said contact transmission element (13, 14) being connected to respective power transmission terminals (PowerA, PowerB) of said movable portion and fixed portion (10A, 10B).
7. The slip ring (10) according to claim 6, **characterized in that** said movable portion (10A) comprises a printed circuit board (11A), a contactless transmission element (12A) and said ring (13A, 14A) of said contact transmission element (13, 14), inserted in a suitable case (15A) whose outer surface forms said interface surface (10C), and said fixed portion (10B) comprises a printed circuit board (11B), a contactless transmission element (12B) and said brush (13B, 14B) of said contact transmission element (13, 14), inserted in a further case (16B).
8. The slip ring (10) according to claim 7, **characterized in that** said cases (15A, 16B) of said movable portion (10A) and said fixed portion (10B), respectively, are made of aluminum.
9. The slip ring (10) according to any one of the preceding claims, **characterized in that** said movable portion and fixed portion (10A, 10B) are mutually coaxial with a predetermined longitudinal axis (HH) thereof, said movable portion (10A) being pivotable around said longitudinal axis (HH).
10. A power and signal transmission method, compris-

ing the steps of:

- providing at least one slip ring (10) comprising a movable portion (10A) and a fixed portion (10B), as well as an interface surface (10C) between said movable portion and fixed portion (10A, 10B);
 - separating a power transmission from a signal transmission;
 - performing said power transmission by means of a sliding contact realized between said movable portion (10A) and said fixed portion (10B) at said interface surface (10C); and
 - performing said signal transmission by means of a contactless transmission between said movable portion (10A) and said fixed portion (10B), said contactless transmission occurring by magnetic induction through respective contactless transmission elements (12A, 12B) that include inductive coupling elements.
11. The transmission method according to claim 10, wherein said contactless signal transmission comprises a conversion of an input analog signal received on a signal transmission terminal into a received digital signal, which is contactlessly transmitted between said movable portion and fixed portion (10A, 10B), and a subsequent reconversion of said transmitted digital signal into an output signal to a further signal transmission terminal.
 12. The transmission method according to claim 11, wherein said contactless transmission of said received digital signal occurs according to the mutual induction principle between said inductive coupling elements of said movable portion and fixed portion (10A, 10B), by supplying at least one of said inductive coupling elements with a signal having a constant amplitude and variable frequency.
 13. The transmission method according to claim 11 or 12, wherein said signal conversion, re-conversion and transmission operations are realized by means of transmission/reception units (17A, 17B), signal converters (18A, 18B) and said contactless transmission elements (12A, 12B) included in said movable portion and said fixed portion (10A, 10B) of said slip ring (10).
 14. The transmission method according to any one of the claims from 10 to 13, wherein said power transmission is realized by means of a sliding contact realized by means of at least one brush-ring pair (13A, 14A; 13B, 14B) of at least one contact transmission element (13, 14), included into said slip ring (10), said ring (13A, 14A) being integral with said movable portion (10A), and said brush (13B, 14B) being integral with said fixed portion (10B).

15. The transmission method according to any one of the claims from 10 to 14, wherein said contactless signal transmission occurs by means of at least one first coil arranged within said movable portion (10A) and at least one second coil arranged within said fixed portion (10B), said coils being mutually concentric.

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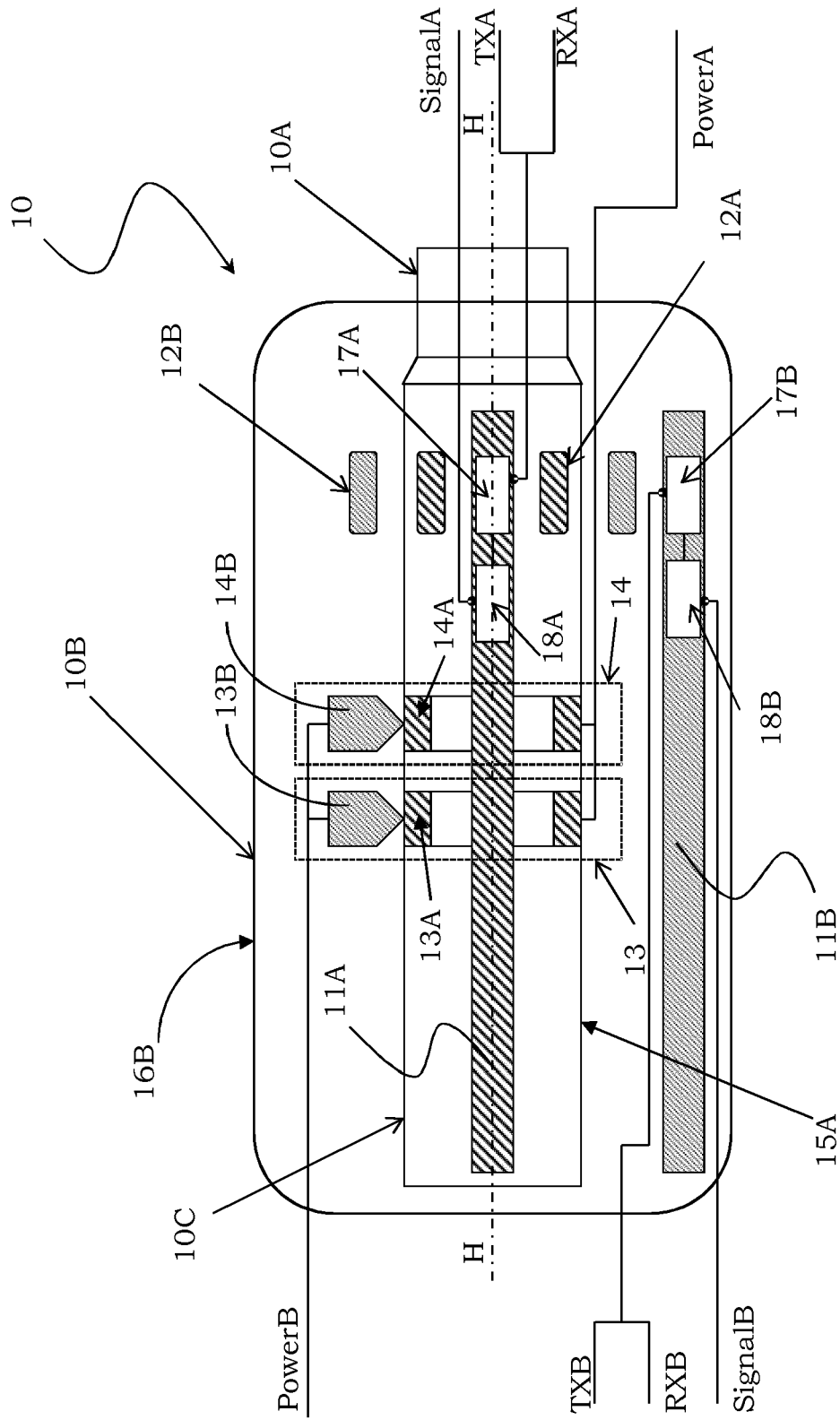


FIG. 1

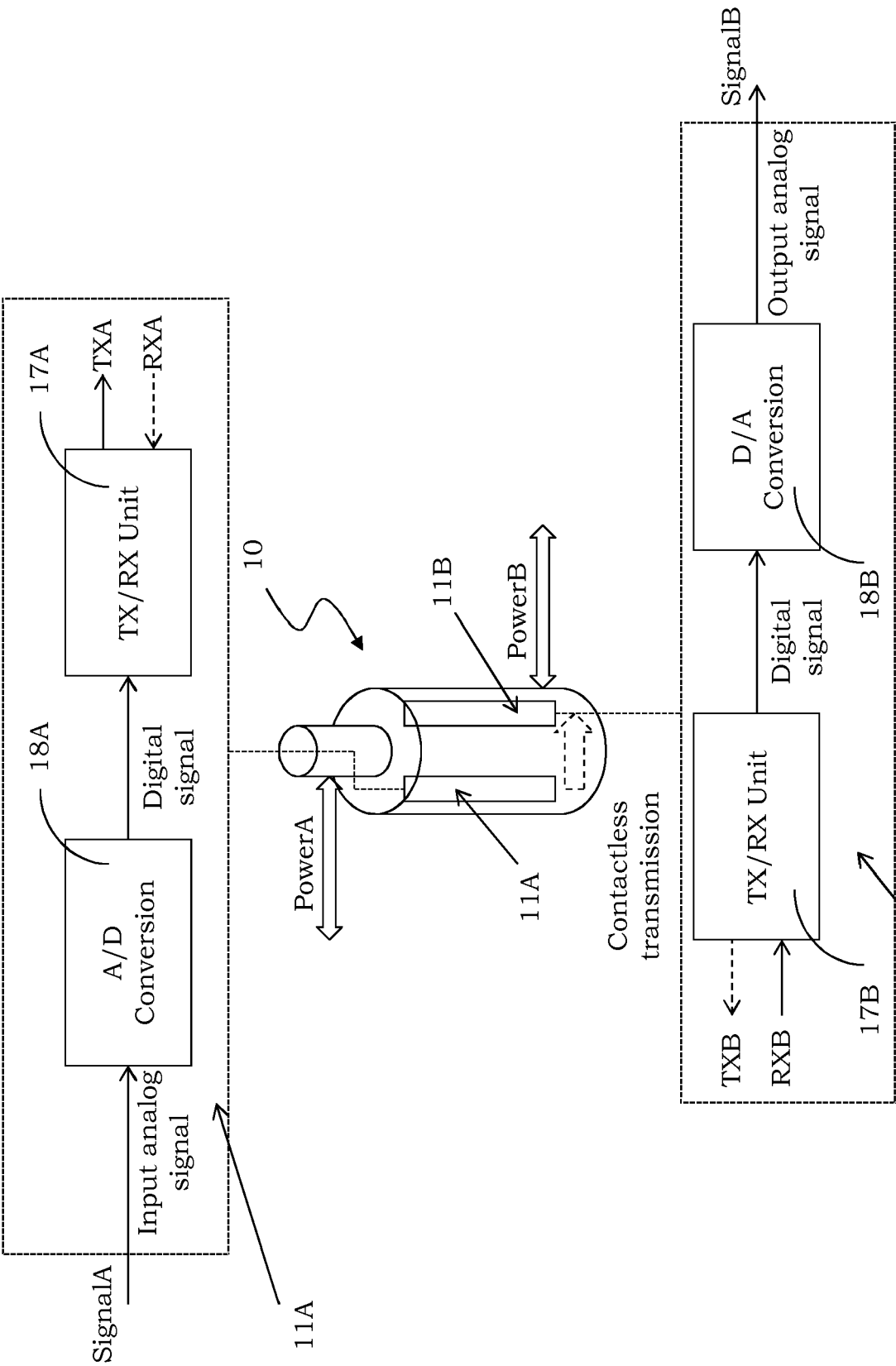


FIG. 2



EUROPEAN SEARCH REPORT

Application Number
EP 16 17 0256

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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	DE 10 2013 220205 A1 (SIEMENS AG [DE]) 9 April 2015 (2015-04-09) * abstract *	1,2,4-14	INV. H01R39/18 H01R39/08 H01F38/18
A	* figure 2 *	3,15	
A	----- US 6 434 293 B1 (IGETA KENICHIRO [JP] ET AL) 13 August 2002 (2002-08-13) * abstract * * column 5, line 66 - column 6, line 31 * * figures 4-5 *	1-15	
A	----- EP 2 704 267 A2 (CANON KK [JP]) 5 March 2014 (2014-03-05) * abstract * * figures 1A - 6B *	1-15	

			TECHNICAL FIELDS SEARCHED (IPC)
			H01R H01F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 12 September 2016	Examiner Pugliese, Sandro
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 16 17 0256

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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