

Data Transmission Device and Device for Conductive Transmission of Electrical Energy

The present invention relates to a data transfer device according to the preamble of Claim 1
5 and a device for conductively transferring electrical power between a charging station and an
electrical consumer capable of moving relative to the charging station according to the
preamble of Claim 12.

WO 2015/018888 A1 discloses a contact device and a charging contact unit for a rapid
10 charging system for use in electrically powered vehicles, such as electric buses. The contact
device serves to establish an electrically conductive connection between the vehicle and the
stationary charging station by means of a charging contact unit, with the contact device being
disposed on the vehicle and having a contact device for contacting the charging contact unit.
The contact device or the charging contact unit comprises a positioning device with a
15 pantograph or a swing arm, by means of which the contact device can be positioned in the
vertical direction relative to the charging contact unit. The contact device also comprises
contact elements that can make contact with the charging contact elements of the charging
contact unit, so as to form contact pairs. The positioning device also comprises a transverse
guide that is disposed on the far end of the pantograph or swing arm and by means of which
20 the contact element support can be positioned transversely relative to the charging contact
unit. Also disposed on the charging contact unit are conductor strips for a control line, which
conductor strips can be conductively connected to control contact elements of the contact device.

DE 10 2013 007 646 B3 discloses a system with a railway vehicle, which can move along a
25 railway line, with a slotted waveguide being disposed on the railway line. Disposed on a
frame of the railway vehicle is a U-shaped leg section, the legs of which extend around a side
wall of the slotted waveguide, with one of the legs, to which an antenna is attached, engaging
the slotted waveguide. Although the leg section is spring-mounted relative to the slotted
waveguide, it is possible to insert the antenna into a side wall of the slotted waveguide only
30 through a threaded area especially provided for this purpose.

This conductive connection has the disadvantage that the contact surface can oxidize
relatively quickly and become dirty. Especially in environments where the air is very humid,
for example, in transshipment ports, or in areas at risk of pollution, the contact surfaces very

quickly become dirty and oxidize. This means that the contact surfaces have to be periodically cleaned and serviced, which is time- and cost-intensive. If this is neglected, disruptions in the data transfer will increase and occur relatively frequently, which will markedly reduce the reliability of the system. Since such units are also used in autonomous driving vehicles, it is necessary for cleaning personnel to periodically inspect the charging stations and contact devices of the vehicles, which are in part disposed across large surface areas or long driving distances, and to clean the contacts.

Thus, the problem to be solved by the present invention is to make available a data transfer device and a device for conductively transferring electrical power between a charging station and an electrical consumer that moves relative to the charging station, which devices overcome the disadvantages mentioned above and ensure that the data transfer between the charging station and the electrical consumer requires little maintenance, is resistant to external environmental influences and, at the same time, is easy and safe to use, highly reliable and as free as possible from disruptions.

The problem is solved by the invention by a data transfer device with the features of Claim 1 and a device for conductively transferring electrical power between a charging station and an electrical consumer that moves relative to the charging station with the features of Claim 12.

According to the present invention, the data transfer device referred to above is characterized in that the hollow profile and/or the transmitting and/or receiving unit can be moved relative to each other in at least one positioning direction by means of a positioning device so as to make it possible to retract and extend the transmitting and/or receiving unit, respectively, into or from, the longitudinal slot of the hollow profile. This ensures that the transmitting and/or receiving unit can be quickly retracted into the longitudinal slot for charging. Advantageously, the transmitting and/or receiving unit may also project through the longitudinal slot into the hollow chamber of the hollow profile. In this case, the positioning direction preferably passes through the longitudinal slot in the direction of a hollow chamber of the hollow profile, i.e., the transmitting and/or receiving unit first moves into the longitudinal slot and subsequently moves in the direction of the hollow chamber. The longitudinal direction is preferably oriented across a plane which passes through the longitudinal slot and from the longitudinal slot toward the hollow chamber and is,

specifically, at right angles relative to the longitudinal slot. Thus, the transmitting and/or receiving unit can advantageously be moved at least partially into the hollow chamber.

5 In a preferred embodiment, the elongated hollow profile is a slotted waveguide, and the transmitting and/or receiving unit is an antenna which transfers data to and from the slotted waveguide. Alternatively, an additional transmitting and/or receiving unit can be disposed on the hollow profile and, more specifically, in the hollow chamber of said hollow profile, which transmitting and/or receiving unit, for the purpose of data transfer, can be connected to the transmitting and/or receiving unit that is retracted into the longitudinal slot and/or the hollow
10 chamber. The data transfer can advantageously take place optically.

The positioning device preferably has a drive [sic; guide], in particular a linear drive [sic; guide], for moving the transmitting and/or receiving unit and/or the hollow profile in the positioning direction.
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In a useful embodiment, the converging guide walls of an insertion cone end in the longitudinal slot of the hollow profile. This makes it easier to insert the transmitting and/or receiving unit into the longitudinal slot.

20 It may be advantageous to provide a return mechanism which, on deflection of the transmitting and/or receiving unit from a predefined position at rest in the positioning direction away from the longitudinal slot, exerts a return force on the transmitting and/or receiving unit in the direction of the longitudinal slot. This allows the transmitting and/or receiving unit to move slightly rearward in order to avoid damage. To this end, the
25 transmitting and/or receiving unit can be mounted by means of a bearing on a support, in particular, a contact support of a charging head, so as to be able to move in the positioning direction, with at least one return element, in particular, a return spring of the return mechanism, being disposed between the transmitting and/or receiving unit and the support. To this end, the bearing can advantageously comprise sliding contact bearings that are disposed
30 on the support and guide elements that move in said bearings and are disposed on the transmitting and/or receiving unit.

The transmitting and/or receiving unit and the hollow profile are preferably disposed so as to be able to move relative to each other in a transverse direction extending transversely relative

to the positioning direction so as to be able to compensate for a lateral offset between the transmitting and/or receiving unit and the hollow profile in the transverse direction. To this end, it may be beneficial to provide a return mechanism, which, on deviation of the transmitting and/or receiving unit and/or the hollow profile in the transverse direction away from a predefined center position, exerts a return force in the direction of the center position on the transmitting and/or receiving unit and/or the hollow profile.

In an advantageous embodiment, the transmitting and/or receiving unit, at least in the area in which it engages the longitudinal slot, can be enclosed in a protective sleeve. This can reduce or completely eliminate damage to the transmitting and/or receiving unit. To ensure that the data transfer is not impaired, the protective sleeve can be electrically insulating. In an advantageous embodiment, the longitudinal slot can be configured to be longer than, preferably at least twice as long as, the width of the transmitting and/or receiving unit extending in the longitudinal direction of the longitudinal slot. This can advantageously compensate for a certain offset of the transmitting and/or receiving unit relative to the longitudinal slot.

According to the present invention, the above-mentioned device for conductively transferring electrical power between a charging station and an electrical consumer that moves relative to the charging station is characterized in that a data transfer device, as described above and in greater detail below, is used.

The charging head is preferably disposed on the charging station and the hollow profile on the electrical consumer or vice versa, depending on the usage requirements. On automated guided vehicles, so-called AGVs, which drive autonomously and which drive to the charging station only for the purpose of recharging their batteries, the hollow profile can be advantageously disposed on the AGV, preferably in a charging chamber, which is accessible to the charging head from the outside. Optionally, the charging chamber can be closed with a protective cover to protect it from external influences, particularly the effects of weather and mechanical influences. The longitudinal slot of the hollow profile preferably extends substantially in the vertical or horizontal direction.

In an advantageous embodiment, the transmitting and/or receiving unit is disposed on a contact support of the charging head. To this end, the transmitting and/or receiving unit is

preferably disposed on an insertion tip of the contact support which, in the positioning direction, faces the hollow profile. To reduce the risk of damage during retraction of the transmitting and/or receiving unit, the transmitting and/or receiving unit can be at least partially recessed in the insertion tip. The contact support can have a wedge-shaped cross section so as to be able, if desired, to insert it into a complementarily shaped insertion cone.

The present invention will subsequently be described by detailed embodiment examples with reference to the accompanying drawings. These drawings show:

- 10 **Fig. 1** a top plan view of a device with an integrated data transfer device according to the present invention in a first detached position;
- Fig. 2** the top plan view of the device shown in Figure 1 with the data transfer device in a second connected position;
- 15 **Fig. 3** a schematic three-dimensional view of an insertion device of the device shown in Figures 1 and 2;
- Fig. 4** a schematic three-dimensional view of a charging head of the device of Figures 1 and 2 as seen obliquely from the top;
- 20 **Fig. 5** a schematic three-dimensional view of a charging head of Figure 4 as seen obliquely from the bottom;
- Fig. 6** a schematic three-dimensional detail view of a portion of the data transfer device;
- 25 **Fig. 7** a schematic three-dimensional view of the device according of the present invention in use with an automated guided vehicle, with the data transfer device in the first detached configuration as shown in Figure 1;
- 30 **Fig. 8** the schematic three-dimensional view of Figure 7, with the data transfer device in the second connected configuration as seen in Figure 2.

Figure 1 shows a device 1 according to the present invention for conductively transferring electrical power between a charging head 2 of a mobile electrical consumer as seen in Figures 7 and 8 in the form of an automated guided vehicle AGV and a stationary charging station 3. Instead of an AGV, the device 1 can also be used in combination with other vehicles.

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As clearly shown in Figures 3, 7 and 8, the AGV vehicle comprises an insertion cone 4 which has substantially vertically extending guide walls 5, 5'. The guide walls 5, 5' are configured identically but as mirror images of each other.

10 To conductively transfer electrical power to the charging head 2, the guide walls 5, 5' have electrically conductive first contact elements in the form of charging contact strips 6, 6' extending in the vertical direction as well as ground contact surfaces in the form ground contact strips 7, 7' which also extend in the vertical direction.

15 The two guide walls 5, 5' converge in the shape of a cone and their rearward ends, as seen in Figure 3, end in a longitudinal slot 8 of a slotted waveguide 9. The slotted waveguide 9 has the form of a cross section, which can be seen especially well in Figures 1 and 2, which is generally known in the art. The longitudinal slot 8 extends along the entire height of the insertion cone 4 in the vertical direction as well. The longitudinal slot 8 subsequently widens,
20 as is known in the art, to form a hollow chamber 10 in the T-shaped slotted waveguide 9. The slotted waveguide 9 can also have different cross sections to ensure the best possible data transfer and, at the same time, the lowest possible transmission to the outside.

The charging head 2 is attached to the charging station 3 so as to be able to actively move in a
25 positioning direction Z and can travel back and forth in the positioning direction Z between a retracted detached position (Figure 7) and an extended connected position (Figure 8) by means of a linear positioning device 11 shown in Figures 7 and 8. The positioning device 11 and its working principles will be explained in greater detail below. The positioning direction Z extends through the longitudinal slot 8 in the direction of the hollow chamber 10 of the
30 slotted waveguide 9, i.e., it preferably passes across a plane extending through the longitudinal slot 8 from the longitudinal slot 8 toward the hollow chamber 10.

A contact support 12 with vertical side walls 13, 13' has a wedge-shaped cross section complementary to the cross section of the insertion cone 4, with the shape of the side walls

13, 13' conforming to the shape of the guide walls 5, 5'. A plurality of contact elements 14, 14' for the electrical transmission of power as well as ground contacts 15, 15' for connecting the ground of the AGV vehicle to the charging station 2 are disposed along the side walls 13, 13'.

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The number, spatial configuration and width of the charging contact strips 6, 6', the ground contact strips 7, 7', the contact elements 14, 14' and the ground contacts 15, 15' can differ as a function of use and available space.

10 The three identically configured contact elements 14, 14' are disposed along the side walls 13 and 13' in the vertical direction one on top of another, so that they make electrically conductive contact with the charging contact strips 6, 6' and the ground contact strips 7, 7' when the charging head 2 and the insertion cone 4 are connected as shown in Figure 2. A vertical offset between the contact support 12 of the charging head 2 and the insertion cone 4
15 of the AGV vehicle can be compensated for in that the height of the insertion cone 4 is greater than that of the contact support 12, wherein, for the transfer of data, it is generally sufficient to ensure that the longitudinal slot 8 is longer than the antenna 16 in the longitudinal direction of the longitudinal slot, in this case, measured in the vertical direction. A vertical offset of this type can be caused, inter alia, by uneven loads or by the tire pressure of the vehicle.

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An antenna 16 projects from a conically tapered insertion tip of the contact support 12 on the front, as shown in Figure 4. The antenna 16 is enclosed by a protective sleeve, which is not specifically shown in the drawings. This protective sleeve is preferably made of an electrically insulating material in order to prevent the antenna 16 from coming into
25 electrically conductive contact with the walls of the slotted waveguide 9 and thus to avoid a short circuit between the slotted waveguide 9 and the antenna 16, which is disadvantageous for the contactless data transfer. To this end, the width of the longitudinal slot 8 is dimensioned such that when positioned exactly in the center, the antenna 9 [sic; 16], even when enclosed by the protective sleeve, does not strike the side walls of the longitudinal slot
30 8. However, if positioned exactly in the center, the antenna 16 does not touch the walls of the longitudinal slot 8.

To transmit a signal by means of the slotted waveguide 9, the antenna 16 can be inserted into the longitudinal slot 8. To this end, the antenna 16 is moved by the positioning device 11,

shown in Figures 7 and 8, of the charging head 2 from the detached position shown in Figure 1 in the positioning direction Z into connected position as shown in Figure 2. To this end, the positioning device 11 comprises a carriage 24 which can move in the positioning direction Z along a stationary guide 23, with the charging head 2 being disposed on the right end, as seen in Figures 7 and 8, of said carriage.

Both an antenna connection 25 disposed on the rear face of the antenna 16 as well as the contact elements 14, 14' and the ground contacts 15, 15' are connected as is known in the art to a stationary power supply and signal transmission unit 27 by means of cables 26 shown in Figures 1, 2, 7 and 8. To allow the cables 26 to be taken up together with the carriage 24, sections of the cables 26 are run in mobile cable guides 28 known in the art.

As a general rule, the wedge-shaped and conical configuration of the contact support 12 and the insertion cone 4, respectively, makes it possible to position, as precisely as possible, the antenna 16 in the longitudinal slot 8 and the charging contact strips 6, 6' and the ground contact strips 7, 7' along the contact elements 14, 14' and the ground contacts 15, 15', respectively.

Positioning is preferably achieved using the antenna 16 which is already precisely oriented relative to the longitudinal slot 8, so that a movement in a transverse direction Q transversely with respect to the positioning direction Z is not required.

However, since in practical applications, this cannot always be ensured due to imprecise positioning, the charging head 2 is disposed on the front end of the carriage 24 of the positioning device 11 so as to be able to move in the transverse direction Q via a linear guide 29 that extends in the transverse direction Q, so that during insertion of the contact support 12 into the insertion cone 4, an offset extending in the transverse direction Q between the insertion cone 4 and the contact support 12 is additionally compensated for in the horizontal direction. To this end, the centering springs 30, 31 as clearly shown in Figure 5, ensure, on the one hand, that the charging head 2, upon deviation from the position at rest, which is centered relative to the transverse direction Q shown in Figure 1, is pushed back into said position at rest. On the other hand, the centering springs 30, 31 make it possible for the contact support 12 to be moved from an eccentric position into the center position as shown in Figure 2. The centering springs 30, 31 are disposed so as to pull in opposite direction so that one of the

springs pulls the charging head 2 into a direction extending parallel to the transverse direction Q while the other spring pulls in the opposite direction. This is schematically illustrated in Figure 5 by the arrows in the springs.

- 5 To ensure that, in case the contact support 12 is in an eccentric position, damage to the antenna 16 is prevented while the charging head 2 is positioned in the positioning direction Z toward the insertion cone 4, in the course of which the antenna can be damaged by potentially striking the antenna guide walls 5, 5', the antenna 16 is disposed in the positioning direction Z so as to be able to move into the contact support 12.

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To this end, on the rear face of the antenna 16, facing away from the slotted waveguide 9, two cylindrical guide bars 17, 17' are disposed in sliding contact bearings 18, 18' so as to be able to move in the positioning direction Z, as illustrated in the detail drawing of Figure 6. The sliding contact bearings 18, 18' are rigidly connected to the charging head 2. In addition, two
15 elongated mounting struts 19, 19' extending parallel to the guide bars 17, 17' are disposed on the antenna 16. On the rearward end, in Figure 6 on the right side, the mounting struts 19, 19' have two mounting points 20, 20' for mounting the return springs 21, 21'. On the other end, the return springs 21, 21' are rigidly mounted on the charging head 2 by means of mounting screws 22, 22' and maintain the antenna 16 in a predefined rest position, as shown in Figure
20 1, i.e., in Figure 6, the return springs 21, 21' are unloaded. If the antenna 16, during insertion of the contact support 12 into the insertion cone 4, strikes the guide walls 5, 5' or any other areas, the antenna 16 moves against the spring force of the return springs 21, 21' rearwardly in the positioning direction Z. This prevents damage to the antenna 16 and, at the same time, ensures that the antenna 16 is smoothly and reliably 16 inserted into the longitudinal slot 8.

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In the embodiments above, the insertion cone 3 with the slotted waveguide 9, the contact support 12 with the antenna 16, the positioning device 11 in the positioning direction Z and the linear guide 29, including the centering springs 30, 31, form a data transfer device according to the present invention. However, different practical implementations of the
30 invention disclosed in the claims are also possible. More specifically, the longitudinal slot 8 can principally be oriented in any direction, for example, instead of in the vertical direction, as shown in the drawings, in the horizontal direction, in which case the configuration would have to be rotated by 90°.

List of reference characters

	1	Device
	2	Charging head
5	3	Charging station
	4	Insertion cone
	5, 5'	Guide walls
	6, 6'	Charging contact strips
	7, 7'	Ground contact strips
10	8	Longitudinal slot
	9	Slotted waveguide (hollow profile)
	10	Hollow chamber in the slotted waveguide
	11	Positioning device
	12	Contact support
15	12a	Insertion tip
	13	Side walls
	14, 14'	Contact elements for the transmission of power
	15, 15'	Ground contacts
	16	Antenna (transmitting and/or receiving unit)
20	17, 17'	Guide bars
	18, 18'	Sliding contact bearings for the guide bars
	19, 19'	Mounting struts
	20, 20'	Mounting screws for the return springs on the antenna side
	21, 21'	Return springs
25	22, 22'	Mounting screws for the return springs on the charging head side
	23	Carriage
	24	Carriage guide
	25	Antenna connection
	26	Cables
30	27	Power supply and signal transmission unit
	28	Cable guide
	29	Linear guide in the direction Q
	30	First centering spring
	31	Second centering spring

AGV	Automated Guided Vehicle
Z	Positioning direction of the charging head
Q	Transverse direction at right angles to the positioning direction of the charging head

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Claims

1. Data transfer device with an elongated hollow profile (9) with a hollow chamber (10) extending in a longitudinal direction (L) of the hollow profile (9) and a longitudinal slot (8) extending in the longitudinal direction (L) and a transmitting and/or receiving unit (16), **characterized in** that the hollow profile (9) and/or the transmitting and/or receiving unit (16) for retracting or extending the transmitting and/or receiving unit (16) into the longitudinal slot (9) [sic; 8] of the hollow profile (9) can be moved relative to one another in at least one positioning direction (Z) by means of a positioning device (11).
2. The data transfer device as in Claim 1, **characterized in** that the elongated hollow profile is a slotted hollow conductor (9) and the transmitting and/or receiving unit is an antenna (16) for transferring data to and from the slotted hollow conductor (9).
3. The data transfer device as in Claim 1 or 2, **characterized in** that the positioning device (11) comprises a drive [sic; guide], in particular a linear drive [sic; guide] (23, 24) for moving the transmitting and/or receiving unit (16) and/or the hollow profile (9) in the positioning direction (Z).
4. The data transfer device as in Claim 1, 2 or 3, **characterized in** that the converging guide walls (5, 5') of an insertion cone (4) end in the longitudinal slot (8) of the hollow profile (9).
5. The data transfer device as in Claim 4, **characterized in** that a return mechanism (21, 21') is provided, which, upon deviation of the transmitting and/or receiving unit (16) from a predefined position at rest in the positioning direction (Z) away from the longitudinal slot (8), exerts a return force on the

- 5 transmitting and/or receiving unit (16) in in the direction of the longitudinal slot (8).
6. The data transfer device as in Claim 5, **characterized in** that the transmitting and/or receiving unit (16) is mounted by means of a bearing (18, 18') on a support (12) so as to be able to move in the positioning direction (Z), with at least one return element, in particular a return spring (21, 21') of the return mechanism, is disposed between the transmitting and/or receiving unit (16) and the support (12).
7. The data transfer device as in Claim 6, **characterized in** that the bearing comprises sliding contact bearings (18, 18') disposed on the support (12) and guide elements (17, 17') moving in said bearings and disposed on the transmitting and/or receiving unit (16).
8. The data transfer device as in any one of the preceding claims, **characterized in** that the transmitting and/or receiving unit (16) and the hollow profile (9) are disposed so as to be able to move relative to one another in a transverse direction (Q) extending transversely relative to the positioning direction (Z).
9. The data transfer device as in Claim 8, **characterized in** that a return mechanism (30, 31) [sic; 21, 21'] is provided, which, upon deviation of the transmitting and/or receiving unit (16) and/or the hollow profile (9) in the transverse direction (Q) from a predefined center position, exerts a return force in the direction of the center position on the transmitting and/or receiving unit (16) and/or the hollow profile (9).
10. The data transfer device as in any one of the preceding claims, **characterized in** that the transmitting and/or receiving unit (16), at least in the area in which it engages the longitudinal slot (8), is enclosed by a protective sleeve, in particular by an electrically insulating protective sleeve.

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11. The data transfer device as in any one of the preceding claims, **characterized in** that the longitudinal slot (8) is longer than, preferably at least twice as long as, the width of the transmitting and/or receiving unit (16) in the longitudinal direction of the longitudinal slot (8).

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12. A device (1) for conductively transferring electrical power between a charging station (3) and an electrical consumer (AGV) that moves relative to the charging station (3), with the device (1) comprising a charging head (2) with contact elements (14, 14') for establishing an electrical connection between the electrical consumer (AGV) and the charging station (3), **characterized in** that a data transfer device as in any one of the preceding claims is provided.

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13. The device (1) as in Claim 12, **characterized in** that the charging head (2) is disposed on the charging station (3) and the hollow profile (9) is disposed on the electrical consumer (AGV) or vice versa.

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14. The device (1) as in Claim 12 or 13, **characterized in** that the longitudinal slot (8) of the hollow profile (9) extends substantially in the vertical or horizontal direction.

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15. The device (1) as in Claim 12, 13 or 14, **characterized in** that the transmitting and/or receiving unit (16) is disposed on a contact support (12) of the charging head (2).

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16. The device (1) as in Claim 15, **characterized in** that the transmitting and/or receiving unit (16) is disposed on an insertion tip (12a) of the contact support (12) facing in the positioning direction (Z).

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17. The device (1) as in Claim 16, **characterized in** that the transmitting and/or receiving unit (16) can be at least partially recessed in the insertion tip (12a).

- 5 18. The device (1) as in one of Claims 15 to 17, **characterized in** that the contact support (12) has a conical cross section.