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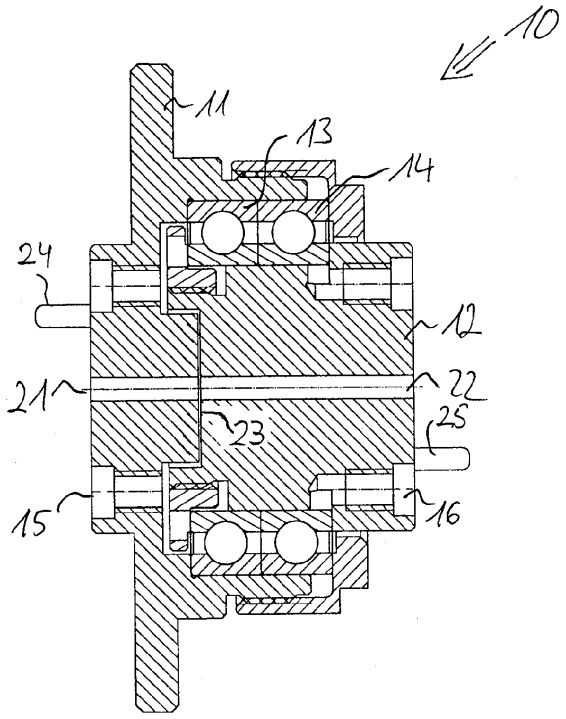
(54) Rotary joint for millimeter wave scanning systems

(57) A rotary joint system is provided for coupling millimeter wave signals or other radio frequency signals from a stationary transmitter to a rotating antenna. The rotary joint system comprises a rotary joint and a mode converter. An input signal to the rotary joint system is a signal from a transmitter, being guided in a rectangular waveguide, propagating in H_{10} mode. This input signal is converted by the mode converter into a H_{11} mode in a circular waveguide. This signal is further forwarded to a circular H_{11} rotary joint coupling the signal to the rotating side into a further circular waveguide and the antenna. The orientation (or polarization) of the electromagnetic field in this circular waveguide is identical with respect to the stationary transmitter. It does not rotate with rotation and therefore allows the antenna to radiate a signal with a constant polarization independent of the rotation angle.

Fig. 1



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Description

Field of the invention

[0001] The invention relates to a rotary joint for millimeter wave scanning imaging systems for generating images of objects by using electromagnetic waves with wavelengths in the millimeter range.

Description of the related art

[0002] A food scanning device using electromagnetic RF radiation is disclosed in DE 10 2009 047300 A1. It has a source for generation for RF radiation and directing this radiation to a food article. The reflected radiation is received by a receiver and analyzed to obtain information about the composition of the food.

[0003] A scanning imaging system using millimeter waves is disclosed in US 2002/0044276 A1. Herein, a scanning reflector is used to sweep through a periodic scan pattern to redirect millimeter wave energy from a target object to a detector.

Summary of the invention

[0004] The problem to be solved by the invention is to provide a rotary joint system for a millimeter wave scanner for continuous scanning of objects. A further object is to provide a comparatively simple, cost-efficient, and maintenance-free rotary joint. Another object of the invention is to provide a rotary joint, which transfers electromagnetic waves with a constant and scanning angle independent polarization.

[0005] Solutions of the problem are described in the independent claims. The dependent claims relate to further improvements of the invention.

[0006] In a first embodiment, a rotary joint system is provided for coupling millimeter wave signals or other radio frequency signals from a stationary transmitter to a rotating antenna. The rotary joint system comprises a rotary joint and a mode converter. An input signal to the rotary joint system is a signal from a transmitter, being guided in a rectangular waveguide, propagating in H_{10} mode. This input signal is converted by the mode converter into a H_{11} mode in a circular waveguide. This signal is further forwarded to a circular H_{11} rotary joint coupling the signal to the rotating side into a further circular waveguide and the antenna. The orientation (or polarization) of the electromagnetic field in this circular waveguide is identical with respect to the stationary transmitter. It does not rotate with rotation and therefore allows the antenna to radiate a signal with a constant polarization independent of the rotation angle. The mode converter may be omitted, if the transmitter is able to generate a H_{11} mode signal in a circular waveguide.

[0007] It is preferred, if the antenna is a circular antenna. Herein, the terms "circular waveguide" and "circular antenna" relate to waveguides and antennas having an approximately circular cross section. Such antennas may further have a conical shape.

Description of Drawings

[0008] In the following, the invention will be described by way of example, without limitation of the general inventive concept, on examples of embodiment with reference to the drawings.

Fig. 1 shows a first embodiment of a rotary joint in a sectional view.

Fig. 2 shows the first embodiment of a rotary joint in a top view.

Fig. 3 shows the first embodiment of a rotary joint in a bottom view.

Fig. 4 shows a schematic diagram of a rotary joint system.

[0009] In Fig. 1, a first embodiment of a rotary joint 10 is shown in a sectional view. The rotary joint 10 comprises a first body section 11 and a second body section 12 rotatably mounted together by a first bearing 13 and a second bearing 14. Threaded holes 15 and 16 are provided for flange screws. For transferring millimeter waves or any other kind of RF signals, a first waveguide section 21 and a second waveguide section 22 separated by a narrow gap 23 are provided. For electrically closing the gap, at least one choke (not shown here) may be provided. There may be at least one alignment pin 24, 25 for aligning an external waveguide with the rotary joint.

[0010] In Fig. 2, the first embodiment of a rotary joint is shown in a top view as seen from the left side in figure 1.

[0011] In Fig. 3, the first embodiment of a rotary joint is shown in a bottom view as seen from the right side in figure 1. Here, further mounting holes (26) for mounting the flange of the rotary joint can be seen.

[0012] In Fig. 4, a schematic diagram of a rotary joint system is shown. The electromagnetic waves generated by transmitter 39 are coupled by means of a first stationary rectangular waveguide 36 to a mode converter 35. In this figure, a cross-section of each waveguide together with the preferred transmission mode is shown. Accordingly, the first stationary rectangular waveguide 36 has a rectangular cross-section, and its preferred propagation mode is H_{10}. The mode converter 35 converts the H_{10} mode received by the rectangular waveguide 36 into an H_{11} mode in a stationary circular waveguide 34. The H_{11} mode signal from the circular waveguide is coupled by the rotary joint 33 to another H_{11} mode in rotating circular waveguide 32. The signal propagating there through is emitted by antenna 31. Instead of the mode converter 35 and the first stationary rectangular waveguide 36, there may be a transmitter 39, which directly may generate H_{11} mode signals into a circular

waveguide.

List of reference numerals

10	rotary joint
11	first body section
12	second body section
13	first bearing
14	second bearing
15	first threaded hole
16	second threaded hole
21	first waveguide section
22	second waveguide section
23	gap
24	first alignment pins
25	second alignment pins
26	mounting holes
31	antenna
32	circular waveguide
33	rotary joint
34	stationary circular waveguide
35	mode converter
36	stationary rectangular waveguide
39	transmitter

Claims

1. A rotary joint system for coupling millimeter wave signals from a stationary transmitter (39) to a rotating antenna (31) comprising:

   - a mode converter (35) for converting the signals of the transmitter into a H_{11} mode signal in a circular waveguide, and
   - a rotary joint (10, 33) for coupling the signals in H_{11} mode from the mode converter to the rotating antenna.

2. Scanning imaging system according to claim 1, **characterized in that** the rotating antenna (31) is a circular cross sectioned antenna.

Fig. 1

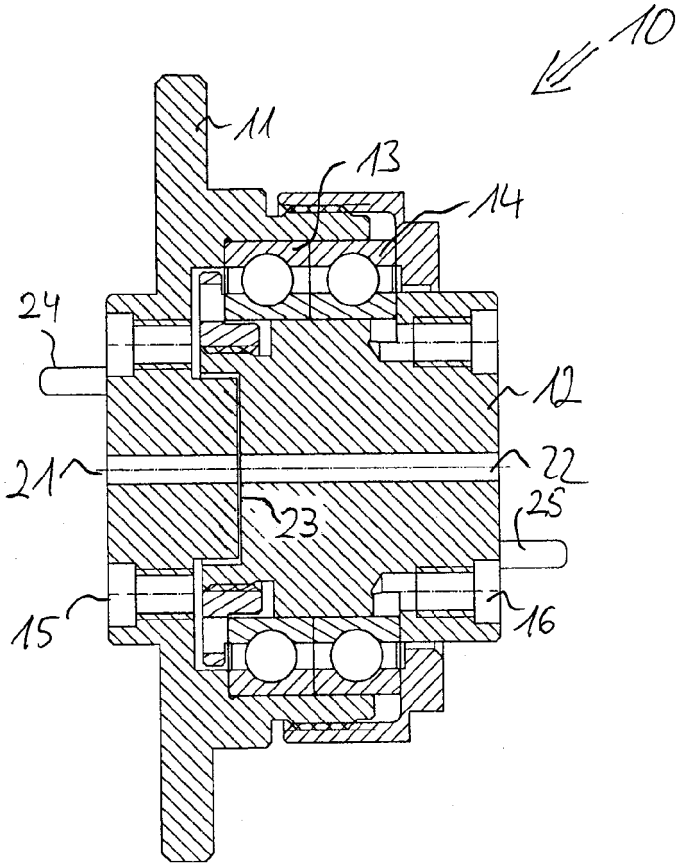


Fig. 2

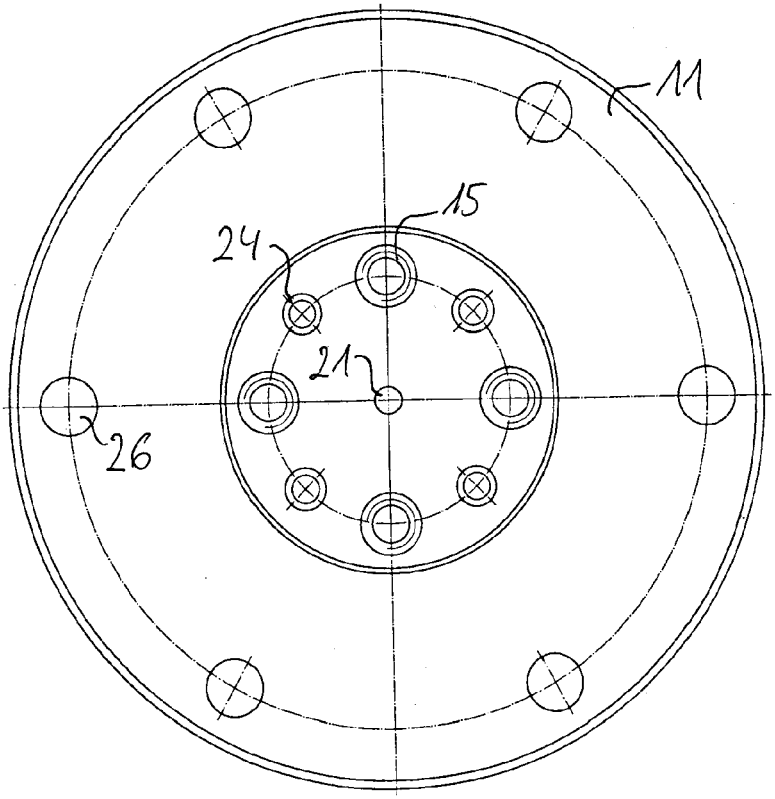


Fig. 3

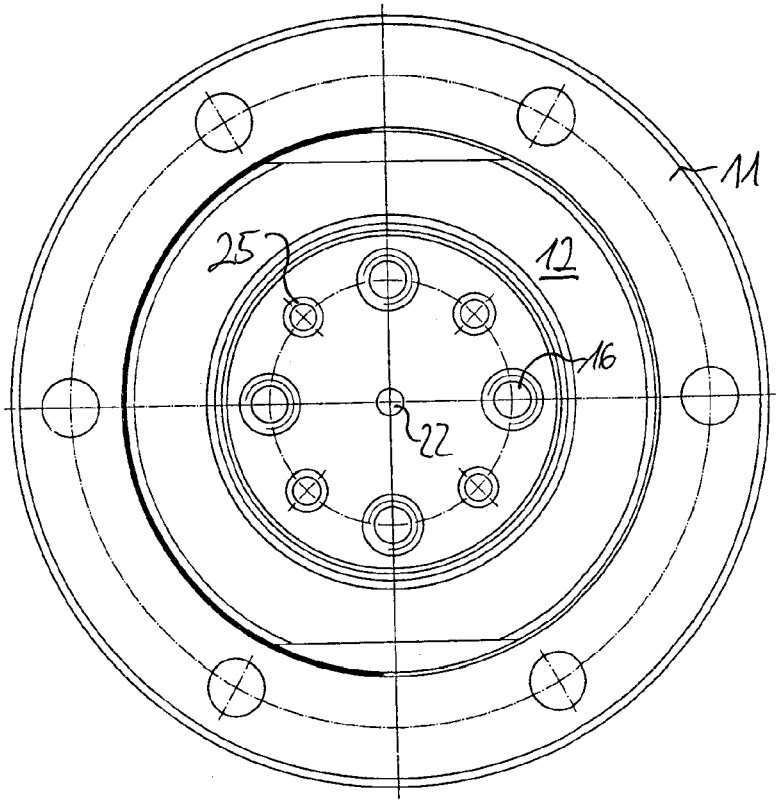
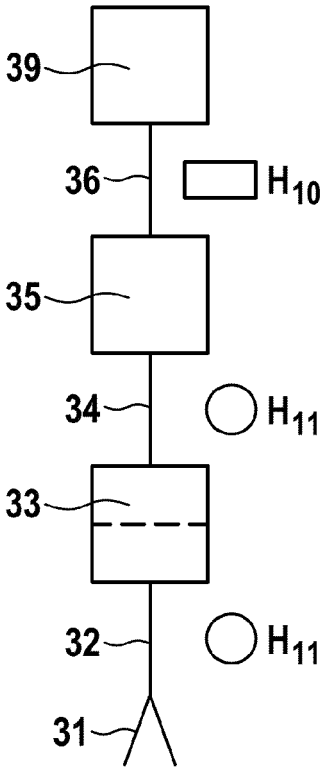


Fig. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 13 16 5015

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	EP 1 291 965 A1 (MITSUBISHI ELECTRIC CORP [JP]) 12 March 2003 (2003-03-12) * paragraph [0125] - paragraph [0128]; figures 22,23 * * paragraph [0089] - paragraph [0100]; figures 12,13 *	1,2	INV. H01P1/06
X	US 2004/135657 A1 (ARAMAKI YOJI [JP] ET AL) 15 July 2004 (2004-07-15) * paragraph [0028] - paragraph [0029]; figures 1,5 *	1,2	
X	JP S63 9301 A (NEC CORP) 16 January 1988 (1988-01-16) * abstract *	1,2	
A,D	US 2002/044276 A1 (STONER PAUL D [US] ET AL) 18 April 2002 (2002-04-18) * abstract *	1,2	
			TECHNICAL FIELDS SEARCHED (IPC) H01P H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 September 2013	Kaleve, Abraham

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 16 5015

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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13-09-2013

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- DE 102009047300 A1 **[0002]**
- US 20020044276 A1 **[0003]**