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(71) Applicant: **SIAE Microelettronica S.p.A.**
20093 Cologno Monzese (MI) (IT)

(72) Inventor: **OLDONI, Matteo**
20093 Cologno Monzese (MI) (IT)

(74) Representative: **Raimondi, Margherita et al**
Dott. Ing. Prof. Alfredo Raimondi S.r.l.,
Piazzale Cadorna, 15
20123 Milano (IT)

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(54) **CONNECTING STRUCTURE AND EMISSION/RECEPTION SYSTEM OF THE DUAL-BAND TYPE WITH DUAL POLARIZATION PER FREQUENCY BAND**

(57) Connecting structure for transporting a signal SLBH with a first polarization (H) in a frequency band LB and a signal SLBV with a second polarization (V) in said frequency band LB to/from a coaxial guide (100), comprising for transportation of each signal:

-) a Y-shaped waveguide junction (H210) with two coplanar rectangular guide output/input ports (H212,H213) for each component of the transported signal; each of the two rectangular output/input ports (H212,H213) of the Y junction (H210) having, connected thereto:

-) a respective waveguide transition section (H220;H230) which has a curve (H225;H235) in a plane orthogonal to the plane of the respective downstream rectangular guide output/input port of the Y junction (H210) and parallel to the larger dimension of the said port; the curves (H225;H235) of the two transition sections (H220;H230) for transporting a respective signal of the two signals being identical, parallel and directed in a same direction and each having a same angle of between 20° and 180°; wherein the curved transition sections (V220;V230) for transporting the components of the signal SLBV with second polarization have downstream output/input ports axially offset in a longitudinal/axial direction (X-X), orthogonal to the plane of the said output/input ports, with respect to the downstream output/input ports of the curved transition sections (H220;H230) for transporting the components of the signals SLBH with first polarization.

allel to the larger dimension of the said port; the curves (H225;H235) of the two transition sections (H220;H230) for transporting a respective signal of the two signals being identical, parallel and directed in a same direction and each having a same angle of between 20° and 180°; wherein the curved transition sections (V220;V230) for transporting the components of the signal SLBV with second polarization have downstream output/input ports axially offset in a longitudinal/axial direction (X-X), orthogonal to the plane of the said output/input ports, with respect to the downstream output/input ports of the curved transition sections (H220;H230) for transporting the components of the signals SLBH with first polarization.

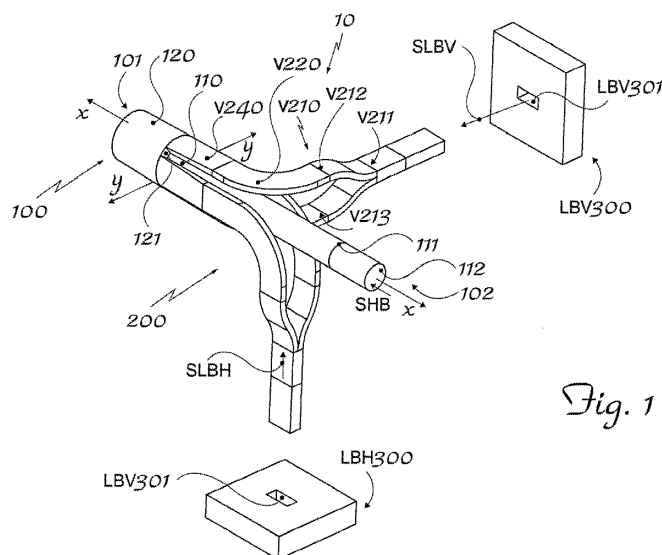


Fig. 1

Description

[0001] The present invention relates to a connecting structure for transporting a pair of orthogonal polarization signals in a frequency band to/from a coaxial guide, and a system for emitting and/or receiving orthogonal polarization signals in two frequency bands comprising such a connecting structure and a coaxial guide.

[0002] It is known in the technical sector of telecommunications and, in particular, radio links, that there is a need to transmit an increasingly larger amount of information/data. The constraints imposed by the physical characteristics of the transmission medium (air) and the costs of the equipment, which must be kept low, have resulted in the development of various transmission optimization techniques able to double the amount of information transmitted via a radio link on the same frequency channel; one of these techniques consists in transmitting simultaneously on the same frequency channel two signals with mutually orthogonal polarization (e.g. vertical polarization V and horizontal polarization H).

[0003] A further development designed to optimize the efficiency of radio link transmission has resulted in the development of so-called "dual-band" antennas able to transmit simultaneously two different frequency channels, each characterized by a different frequency band within which two orthogonal polarization signals are preferably transported.

[0004] One of the difficulties of implementing such a radio link transmission consists in the need to perform multiplexing/demultiplexing on two frequency bands, both with dual polarization, upstream and downstream of the dual-band antenna.

[0005] In greater detail, during transmission, each polarized signal V,H of each of the two frequency bands originates from a respective transceiver which has an interface port usually with a rectangular cross-section from which the single-mode signal with polarization V, H is emitted at the respective transmission frequency; this signal must then be combined with the orthogonal polarization signal H, V at the same frequency and with the orthogonal polarization signals V,H of the other frequency band so as to supply the antenna with the final composite signal comprising two frequency bands with dual polarization.

[0006] At the interface port of each transceiver it is possible to connect a rectangular cross-section waveguide which transports a single signal with single polarization and/or an orthomode transducer OMT, namely a device with two input/output ports for the single signals with single polarization, to which two single-mode waveguides are connected, and with a third common output/input port connected to a third dual-mode waveguide on which the combined signal of the two single polarization input/output signals is transmitted/received, said signals being combined/separated with mutually orthogonal polarizations when passing through the transducer. The input/output ports for the single-mode signals generally have a rectangular cross-section, while the input/output port of the combined dual-mode signal generally has a circular or square cross-section.

[0007] An example of dual-band dual polarization multiplexing is illustrated in US 3,500,419 in which two rectangular input/output ports are connected to a Y-shaped waveguide section which divides up each signal entering a rectangular port into two corresponding signal portions which are each fed to a respective right-angled curve, in turn each connected to a respective port of a pair of diametrically opposite rectangular ports of a square horn for emission towards the antenna. Since the horn is square and the ports are rectangular there are no adaptation problems.

[0008] The most widely used known technique for implementing such dual-band dual-polarization multiplexing/demultiplexing is based however on the use of a coaxial guide connected to the antenna: the signals of a respective frequency band are fed to each (internal or external) conductor of the coaxial guide by exciting the two TE₁₁ modes of the coaxial guide (the TEM mode, which is supported by the coaxial guide, must not be excited since it is not useful for the purpose of antenna radiation and is a source of interference between the ports).

[0009] The present invention relates precisely to this type of multiplexing/demultiplexing which requires adaptation to a coaxial guide.

[0010] US 6031434 describes a known method of multiplexing towards a coaxial guide based on the emission of:

- a combined dual-polarization signal of a first frequency band via a circular guide directly connected to the circular conductor inside the coaxial guide;
- individual single-mode signals of the second frequency band, via respective rectangular guides connected transversely (orthogonally) to the external conductor of the coaxial guide.

[0011] The structures which use this type of transverse emission, however, are intrinsically subject to reflections owing to mismatch at the rectangular ports and therefore require an accurate design of the adapter structures.

[0012] The main causes of mismatch include in particular: the presence of a marked transition between the transverse emission structure and the coaxial guide; and the need for a short-circuit at the rear end of the coaxial guide in order to avoid dispersing or irradiating power from the wrong side. This end point gives rise to an extremely selective frequency behaviour since typically the entry point of the first rectangular guide is chosen at a quarter of a wavelength from the end short-circuit.

[0013] The presence of mismatch therefore requires adapter structures normally obtained passively by means of

cavities and/or calibration screws which enable the reflections to be kept to a minimum within a specific and typically limited frequency range, but which nevertheless require manual or semi-automatic calibration of the screws in order to comply with specifications.

[0014] GP 2,103,021 offers a partial solution to the adaptation problems, obtained by gradually curving the direction of propagation from the rectangular guides until it becomes parallel to the axis of the coaxial guide and thus feeding to the external conductor of the coaxial guide single polarization signals from the end of the coaxial guide.

[0015] This solution, however, intrinsically poses implementation difficulties in view of the complexity of the curved connection which includes corrugations and a crest inside the rectangular guide curved section.

[0016] This solution teaches moreover providing curves which diverge relative to each other from the axis of the coaxial guide, thus resulting in four diverging rectangular ports uniformly arranged around the circular guide. It is not known how these four rectangular ports may be connected together in pairs, without intersections, numerous additional connections and without occupying the space intended for the internal circular guide of the coaxial guide so as to convey the four signal portions back to only two rectangular ports to be connected to the respective transceivers, while ensuring that the TE₁₁ modes of the coaxial guide are correctly excited without making the device more sensitive to errors and manufacturing tolerances.

[0017] A different solution is provided in US 5,818,396 and US 5,635,944 which propose a connection structure which connects two rectangular ports for input/output of orthogonal polarization signals within a same band to/from the external guide of a coaxial guide, which comprises two so-called "Magic Tees" designed to divide up the signal of each polarization on two branches of the Tee and a following right-angled curve connected to each branch of the Tee and which comprises an adapter for adaptation from a rectangular guide to a ridge guide. The four signal output ports are therefore in a ridge guide and are connected to corresponding four ports in a ridge guide of a launcher which comprises four ridge guides, the form of which gradually varies and tapers from a rectangular cross-section with ridges to a "truncated-pie" with ridges. This launcher is rigidly connected to a coaxial guide inside which the ridges of the four guides of the launcher extend over a considerable distance until they gradually disappear.

[0018] Both the documents teach that the presence of these ridges is fundamental for correct adaptation between the rectangular upstream guides and the external guide of the downstream coaxial guide. The problem of the solution disclosed in US 5,818,396 and US 5,635,944 is that this structure is very complex, in particular owing to the complicated ridge structures which must extend as far as the inside of the coaxial guide, the need to manufacture curves which also perform adaptation from a rectangular guide to a ridge guide and the use of the Magic Tees which require a projecting adapter load as well as a large amount of space to accommodate also the central circular guide which must feed the internal guide of the coaxial guide.

[0019] The technical problem which is posed therefore is that of realizing a connecting structure for connecting together rectangular input/output ports for single-mode signals and a coaxial guide, which is able to solve or at least partly overcome the aforementioned problems of the prior art; one problem dealt with by the present invention is in particular that of simplifying the structures of this type known from US 5,818,396 and US 5,635,944.

[0020] In connection with this problem it is also in particular desirable that the connecting structure should be able to carry to the external circular guide of a coaxial guide a dual-mode signal, i.e. a combination of single-mode signals, in particular for use in a transmission/reception system of the dual-band type with dual polarization per frequency band, where a circular guide inside the coaxial guide is also present.

[0021] In connection with this problem it is also preferably required that the connecting structure should be inexpensive to produce, simple to assemble and able to be easily integrated with the coaxial emission guides for dual-band antennas and with the original transceivers of the signals to be transmitted/received.

[0022] It would also be desirable for the dual-band emission system to be able to make the connection with the said transmission/reception devices as simple and direct as possible, while providing at the same time a wide band and without deterioration of the transported signals.

[0023] These results are obtained according to the present invention by a connecting structure according to Claim 1 and by an emission/reception system according to the characteristic features of Claim 10.

[0024] The Applicant has in fact surprisingly discovered that a connecting structure with rectangular input/output ports connected to a respective Y-shaped guide section which divides up the signal on two rectangular guides having a short side which is halved, each followed by a curved transition section, the rectangular output/input port of which is connected to a respective ridgeless adapter guide section, the cross-sectional form of which varies gradually from a rectangular waveguide to a waveguide with the cross-sectional form of an annular segment and which has an upstream rectangular port and a downstream annular segment port for output/input of the respective signal component, represents a structure which makes connection, production and assembly simple and direct, allowing at the same time isolation of the polarizations and the absence of undesirable modes when the signals output from the adapter sections are fed to a downstream coaxial guide.

[0025] Further details may be obtained from the following description of non-limiting examples of embodiment of the subject of the present invention, provided with reference to the accompanying drawings, in which:

Figure 1: shows a rear, schematic, perspective view of an example of embodiment of a dual-band dual polarization transmission/reception combiner system according to the invention;

Figure 2: shows a partially exploded, perspective, side view of a transmission/reception combiner system with the part of a first embodiment of the connecting structure according to the invention relating to a first polarization;

Figure 3: shows a plan view from the rear side of the system according to Figure 2;

Figure 4: shows a partially exploded, perspective, side view of a transmission/reception combiner system with the part of a second embodiment of the connecting structure according to the invention relating to the first polarization;

Figure 5: shows a view similar to that of Figure 4 with a variation of embodiment of the connecting structure according to Fig. 4;

Figure 6: shows a perspective view of a variation of embodiment of the dual-band transmission/reception combiner system according to Figure 1;

Figure 7: shows a perspective side view of a transmission/reception combiner system with the part of a third embodiment of the connecting structure according to the invention relating to the first polarization;

Figure 8: shows an illustration in a Cartesian plane of the modelled form of an example of a guide section for adaptation from a rectangular guide to an annular segment of a structure according to the invention;

Figure 9: shows a perspective view of a variation of embodiment of the dual-band emission/reception combiner system according to Figure 6;

Figure 10: shows a perspective view of a dual-band transmission/reception combiner system with a further embodiment of the connecting structure according to the invention; and

Figure 11: shows a perspective view of a dual-band transmission/reception combiner system with a further embodiment of the connecting structure according to the invention.

[0026] With reference to Fig. 1 the general structure of an example of a combiner system 10 for dual-band transmission/reception with dual orthogonal polarization according to the invention is illustrated. The combiner system 10 comprises a coaxial guide 100 extending widthwise in a radial direction Y-Y and longitudinally in an axial direction X-X for propagation of the signals between a front end 101 for connection to the following: a dual-band transmission/reception antenna (not shown) and a rear part 102 for connection to a transceiver device for transmission/reception of a dual polarization signal in a first frequency band (not shown); a first device LBV300 for transmission/reception of a signal SLBV with a first polarization (V) in a second frequency band LB; and a second device LBH300 for transmission/reception of a signal SLBH with a second polarization (H) in said second frequency band LB.

[0027] The coaxial guide 100 comprises:

- an inner circular guide 110 for transporting said dual-polarization signal in said first frequency band;
- an outer circular conductor 120, coaxial with the inner circular conductor 110 for forming an outer guide for transporting a dual-polarization signal which is a combination of said first signal SLBH and second signal SLBV in said second frequency band LB. The outer guide 120 extends axially between the front end 101 of the coaxial guide and a rear end opposite to the front end in the axial direction X-X where, in the example shown, there is a rear annular wall 21 lying in a plane parallel to the radial direction Y-Y and orthogonal to the longitudinal axis X-X.

[0028] The inner cylindrical conductor 110 is connected to a rear extension extending in the axial direction X-X beyond the rear wall 121 of the outer conductor 120 so as to form a circular guide 111 for transporting said dual orthogonal polarization signal SHB of the first frequency band. The signal SHB of the first frequency band (for example higher frequency band) may originate from a pair of orthogonal polarization signals emitted by corresponding transceivers with rectangular output port, connected to an orthomode transducer (OMT) with output on a circular guide conventional per se, or from a dual-polarization radio transceiver with integrated OMT. The combined signal SHB thus obtained at the output of the OMT is then input to a rear port 112 of the extension 111 of the inner circular guide 110 and may propagate in an axial direction X-X inside the inner circular guide 110 as far as the antenna connected to the front end 101 of the coaxial guide 100. The rear extension 111 has preferably an inner diameter the same as the inner diameter of the inner conductor 110 in order to be transparent to the propagation of the signal inside the extension 111.

[0029] The outer diameters of the conductors 111 and 110 are also preferably the same. According to a further embodiment, the said outer diameters are different; this is advantageous in the case where an outer diameter of the inner conductor 110 of the coaxial guide 120 which is different from the standard diameter of the circular extension guide 111 is required in order to obtain better propagation in the coaxial guide 120 of the signals in the respective frequency band in terms of losses, adaptation and cut-off frequency.

[0030] As will become clearer below the rear annular wall 121 of the outer circular guide 120 has two diametrically opposite input/output ports 121a for respective in-phase components of the first-polarization signal SLBH in said second frequency band LB, and two diametrically opposite input/output ports 121b for respective in-phase components of the second-polarization signal SLBV in said second frequency band LB; the two signals are combined/separated by the

coaxial guide 100 with/from a dual orthogonal polarization signal in said second frequency band LB to be sent/received with the dual-band antenna to which the coaxial guide 100 is connected.

[0031] The four ports 121a; 121b are arranged angularly equidistant on the annular extension of the part 121. This diametrically opposite and angularly equidistant arrangement ensures the symmetry of the excitation in the outer guide of the coaxial guide 100, which allows only the TE₁₁ mode of the coaxial guide 100 to be excited, and not other undesirable modes such as TEM mode, and ensures the orthogonal arrangement of the two polarizations propagated in the said guide.

[0032] A first aspect of the present invention is that of providing a connecting structure 200 able to carry the said two signals SLBH;SLBV with orthogonal polarizations of said second frequency band LB (for example the band with lower nominal frequency) from the respective upstream transceiver apparatus LBH300;LBV300 which generate them to respective input/output ports 121a;121b (Fig. 2) on the rear wall 121 of an outer circular guide, such as the outer circular guide 120 of the downstream coaxial guide 100.

[0033] The two signals SLBV, SLBH of the second frequency band LB, which originate from respective transceiver apparatus LBH300;LBV300 with output/input port LBH301;LBV301 for the respective signal SLBH;SLBV having a rectangular cross-section, must in fact be fed to the outer conductor 120 in phase and preferably minimizing the signal power losses.

[0034] The connecting structure 200 of the invention is able to carry the two signals SLBV, SLBH with orthogonal polarizations of the second frequency band LB, each emitted from a respective port with rectangular cross-section LBV301;LBH301, to ports 121a,121b formed in an annular wall of a coaxial guide, for example in the rear end walls 121 of the coaxial guide 100, and vice versa.

[0035] Figs. 2 and 3 show a partially exploded view of the example of a connecting structure 200 according to the invention schematically shown in Figure 1, in which, for easier illustration, only the parts relating to a single transmission/reception polarization, assumed as being horizontal H, for connection to the rectangular guide port LBH301 of the transceiver LBH300 are shown.

[0036] With reference to Figs. 1-3 the example of the connecting structure 200 comprises:

FIRST POLARIZATION (H) IN THE SECOND FREQUENCY BAND (LB)

[0037]

-) a rectangular guide input/output port H211 for the first signal SLBH of said second frequency band LB, with smaller dimension H211b and larger dimension H211a orthogonal thereto; the first input/output signal SLBH to/from the port H211, which is assumed to propagate with TE₁₀ mode, propagates in a direction LBHz of propagation orthogonal to the plane E_{SLBH} of the rectangular input/output port H211 of the first signal SLBH.

[0038] As shown in Figure 1, the input/output port H211 may be directed parallel to the input/output port LBH301 of the upstream transceiver LBH300, to which it is connected by means of a per se conventional rectangular guide. In the downstream direction the port H211 is instead connected to:

-) a Y-shaped coupling/dividing junction section H210 lying in a cross-sectional plane orthogonal to the plane E_{SLBH} of the input/output port H211 and parallel to the smaller dimension H211b of the said input/output port H211 (Fig. 3); the Y-shaped section H210 joins the first rectangular guide port H211 for input/output of the first-polarization signal SLBH, which is connected to the shank of the Y, together with two rectangular guide output/input ports H212,213 arranged at the upstream end of a respective branch of the Y. The two output/input ports H212,H213 of the Y-shaped section H210 are coplanar and arranged spaced apart at a distance greater than the outer diameter of the rear section 111 of the circular guide, forming a rear extension of the inner conductor 110. Each of said ports H212,H213 has a larger inner dimension equal to the larger dimension H211a of the input/output port H211 and smaller inner dimension equal to half the smaller dimension H211b of the said port H211 and lies in a plane parallel to the plane E_{SLBH} of the port H211 for input/output of the signal SLBH (Fig. 3); such a Y-shaped coupling/dividing section H210 of a rectangular guide operating in TE₁₀ fundamental mode towards two rectangular guide ports H212,H213 with halved smaller inner dimension is known per se and substantially transparent to the electromagnetic field transported which therefore is not affected by reflections during propagation inside the Y-shaped section H210.

-) Each of the two rectangular output/input ports H212,H213 of the Y-shaped section H210 has, connected thereto, a corresponding rectangular input/output port H221;H231 of a respective waveguide transition section H220;H230 which has a curve H225;H235 in a plane H_{SLBH} orthogonal to the plane E_{SLBH} of the respective rectangular guide input/output port H221;H231 and parallel to the larger dimension of the said port H221;H231 (which lies in a parallel plane and has dimensions the same as the corresponding output/input port H212;H213 of the Y-shaped section H210) and terminates in a rectangular port H222;H232 for output/input of the signal SLBH, lying in a plane parallel to the radial plane of the rear end annular wall 121 of the outer conductor 120 of the coaxial guide 100 for emission

towards the downstream dual-band antenna and, in the example shown, orthogonal to the plane of the respective input/output port H221 ;H231.

-) The curves H225;H235 of the two transition sections H220;H230 are identical, parallel to each other and directed in the same sense in the direction of the rear annular wall 121 of the outer circular guide 120 of the coaxial guide 100 and therefore the output/input mouths H222;H232 of the transition sections H220;H230 with curve H225;H235 correctly lie in a plane parallel to the radial plane of the rear annular wall 121 of the outer circular guide 120 of the coaxial guide 100 for connection to the antenna and may be connected to a respective pair of diametrically opposite input/output ports 121a on the said annular end wall 121.

[0039] In the preferred embodiment shown in Figs. 2, 3, each rectangular-guide transition section H220;H230 has a continuous curve H225;H235 in the plane H_{SLBH} . Preferably, the inner radius of curvature of each curved transition section H220;H230 is equal to two or three times the nominal wavelength of the said second frequency band. Such dimensions are optimum for minimizing the transmission reflections; as will become clearer below, smaller radii or in some cases a 90° angle are possible, although they worsen adaptation. In such cases methods known per se may be used to reduce the reflections, such as chamfering of the corners and/or the introduction of metal teeth or posts in the plane of the curve. The curved rectangular waveguide transition section may be for example formed by means of milling in the plane of the curve and covered with a flat cover.

-) As shown in Figs. 2,3, for ideal adaptation, conveniently the input/output ports 121a;121b on the rear end wall 121 of the outer conductor 120 of the coaxial guide have the cross-sectional form of an annular segment, for adaptation with these ports; the structure of the invention comprises a respective guide adapter section H240;H250, the cross-sectional form varies from a rectangular guide to a cross-section in the form of annular segment, which has at the rear a rectangular port H241;H251 connected to the rectangular output/input port H222;H232 of a respective curved transition section H220;H230 and at the front an annular segment port H242;H252 connected to the respective annular segment port 121a on the rear wall 121. The annular segment and rectangular guide ports, as well as all the waveguides described hitherto are ridgeless, thus making it possible to eliminate problematic sections required for adaptation from a rectangular guide to a ridge guide.

[0040] The adapter section H240;H250 is necessary for optimum matching, since a direct connection between the rectangular guide output/input port H222;H232 and the corresponding opening 121a on the bottom 121 of the coaxial guide 120 would result in major reflections owing to the impedance and form mismatch of the field transported to the two sections.

[0041] The form of the inner surfaces of a rectangular guide/annular segment adapter guide section varies gradually from a rectangular cross-section to an annular segment cross-section and may for example be defined by a linear interpolation, relative to the axis of propagation of the adapter guide (parallel to the longitudinal axis X-X for example shown in Figs. 1-2), between the two (rectangular and annular segment) sections which have dimensions which are known/defined at the upstream rectangular port and downstream annular segment port of the respective adapter section.

[0042] The junction between the different ports to be joined together may be performed by means of corresponding connecting flanges and screws which are conventional per se and not described in detail. It is also possible to form the Y junction and the curved transition sections connected thereto as one piece instead of as separate parts which are joined together.

[0043] The overall length of the waveguide connections H220,H240; H230,H250 for the first polarization H of the second band LB, between the output/input ports H212;H213 of the Y junction H210 and the input/output ports 121a on the rear end wall 121 of the outer circular guide 120 of the coaxial guide 100 is identical so as to avoid excitation of unwanted modes in the coaxial guide (such as the TEM mode).

SECOND POLARIZATION (V) IN THE SECOND FREQUENCY BAND (LB)

[0044] For transmission of the second-polarization signal SLBV in the second frequency band, the connecting structure 200 of the invention has a form (schematically shown in Fig. 1) similar to the form designed for transmission of the first polarization signal SLBH:

-) a rectangular guide input/output port V211 for the signal SLBV with second polarization in said second frequency band, with smaller dimension and larger dimension, orthogonal thereto, connected to the shank of:

-) a Y-shaped coupling/dividing junction section V210 lying in a cross-sectional plane orthogonal to the plane E_{SLBV} in which the input/output port V211 lies and parallel to the smaller dimension of the said port V211; the Y-shaped section V210 joins the rectangular guide input/output port V211 for the second polarization signal SLBV to two rectangular guide output/input ports V212,V213 arranged at the upstream end of a respective branch of the Y-shape.

The two ports V212,V213 of the Y-shaped section V210 are coplanar and arranged spaced apart at a distance greater than the outer diameter of the rear section 111 of the circular guide, forming an extension of the inner conductor 110.

[0045] Each of said ports has a larger inner dimension equal to the larger inner dimension of the input/output port, and smaller inner dimension equal to half the smaller inner dimension of the said port, and lies in a plane parallel to the plane of the input/output port V211 of the Y-shaped section V210.

-) Each of the two rectangular output/input ports V212,V213 of the Y-shaped section V210 has, connected thereto, a respective waveguide transition section V220;V230 which has a curve V225;V235 in a plane H_{SLBV} orthogonal to the plane of the respective rectangular guide input/output port and parallel to the larger dimension of the said port and terminates in a rectangular output/input port H222;H232 which lies in a plane parallel to the plane of the rear annular closing wall 121 of the coaxial guide 100.

-) The curves V225;V235 of the two transition sections V220;V230 are identical, positioned parallel and directed in the same sense in the direction of the rear wall 121 of the outer circular guide 120 of the coaxial guide 100 and therefore the output/input mouths V222;V232 of the curved transition sections V220;V230 correctly lie in a plane parallel to the plane of the rear annular wall 121 of the outer circular guide 120. so as to be connected to a respective pair of diametrically opposite input/output ports 121b thereof.

[0046] Also in the case of the second polarization V in the second frequency band LB the preferred connecting structure has a respective adapter guide section V240;V250 with cross-section varying from rectangular guide to guide with a cross-sectional form of an annular segment, having at the rear a rectangular port connected to the respective curved transition section V220;V230 and at the front an annular segment port connected to the respective annular segment port 121b on the rear wall 121.

[0047] The adapter guide sections V240;V250 are also advantageously ridgeless.

[0048] In order to prevent the structure part for propagation of the second-polarization signal SLBV in the second band LB from intersecting the structure part already described for the signal SLBH with first polarization H, the curved transition sections V220,V230 must start at a height (distance from the plane of the output/input ports H242;H252, V242,V252 from/towards the end wall 121 of the coaxial guide 100) which is different in the longitudinal/axial direction X-X from the starting point of the curved sections H220,H230 for transporting the first-polarization signal SLBH (Fig. 1); for sections with 90° curves a difference equal to the larger outer dimension of the rectangular ports H211; V211 is sufficient. Since the adapter sections H240;H250 are present, this may be advantageously obtained by forming those sections for one of the two polarizations so that it is longer than the adapter sections for the other polarization. Alternatively or in addition two identical short annular segment guide sections may be arranged between the ports 121b and the curved transition sections V220;V230, or rectangular sections may be arranged between the latter and the adjacent adapter section V240;V250.

[0049] With the configuration of the connecting device described, the mode of operation of the dual-band transmission/reception system is for example as follows:

--> During transmission, the dual polarization signal SHB in the first frequency band HB is fed through the port 112 to the rear extension 111 of the circular guide inside which it propagates. The propagation inside the guide extension 111 is not altered by the presence of the low band signal SLBH, SLBV since they are physically separate and exist on different surfaces and in different spaces.

--> The signal SHB therefore reaches the inner circular guide 110 and passes through this dual-band antenna without being altered by the presence of the outer conductor 120 and the signals transported in it. The signal SHB is not affected by additional reflections owing to the dual-band multiplexing system on the coaxial guide 100.

--> The first-polarization signal SLBH in the second frequency band LB, which is generated by the respective transmitter LBH301, is fed in TE₁₀ mode to the input/output port H211 of the connecting structure and is divided into two identical components by the Y junction H210. Owing to the symmetry of the Y junction H210 the components of the signal SLBH output from the ports H212 and H213 of the Y junction H210 are identical and in-phase with each other; --> The in-phase components of the signal SLBH output from the output/input ports H212 and H213 of the Y junction H210 pass through the input/output ports H221 and H231 and are guided along the curved transition guides H225;H235 which provide at their output signal components SLBH which propagate parallel to the axis X-X of the coaxial guide and the mismatch of which may be kept to a negligible level by means of radii of curvature which are at least 2 or 3 times the wavelength or by means of other adaptation methods mentioned above.

--> The signal components H222; H232 output from the curved transition sections H230;H240 are identical and in-phase with each other and are fed to the adapter guides H240;H250 which deform the rectangular mode TE₁₀ for propagation in the rectangular guide into two TE₁₁ mode segments for propagation in the coaxial guide, outputting

at their output/input ports H242;H252, adapted to the annular segment ports 121b on the end wall of the coaxial guide, two in-phase components of the signal SLBH adapted to the TE₁₁ propagation mode of the said coaxial guide 120. The symmetry of the components of the excitation signals ensures that the fundamental TEM mode of the coaxial guide is not excited. The TE₁₁ mode of the coaxial guide comprises two degenerate modes which represent two orthogonal polarizations. The signal SLBH excites in a dominant manner the coaxial polarization parallel thereto and, in the event of a minimum value, also the polarization orthogonal thereto. This loss of polarization discrimination (XPD) may, if required, be controlled by providing the angular opening of the ports 121a of the annular wall 121 with suitable dimensions;

→) The second-polarization signal SLBV in the second band LB, generated by the respective transmitter LBV300, propagates in a similar manner through the respective Y junction V210. The two signal components SLBV divided by the Y junction V210 then propagate along the respective curved transition section V220;V230 from which they exit parallel to the propagation axis X-X of the coaxial guide 100, from ports V232;V222 lying in a plane parallel to the plane of the respective ports 121b of the rear end annular wall 121 of the coaxial guide 100.

→) The components input to the openings 121b in the annular wall 121 excite the TE₁₁ mode of the coaxial waveguide 100 with polarization orthogonal to the first polarization (H). The isolation between the input/output ports 121a,b of the signals SLBH and SLBV may be maximized by modifying the angular opening of the ports 121a and 121b.

→) During reception, the mode of operation is exactly the same and is not described in detail.

[0050] Fig. 4 shows a second embodiment of a connecting structure 1200 according to the invention, in which parts which are the same compared to the embodiments of Figs. 1-3 retain the same alphanumeric references. The structure 1200 shown in Figure 4 differs from the preceding embodiment in that the transition sections H1220;H1230 with curve H1225 are formed with a right angle on the inside of the curve and with a curved outer wall H1225 with chamfer H1226 at 45°. The length of the chamfer must be a fourth of the nominal guided wavelength for the band LB. This embodiment has the advantage of being more compact in the axial direction X-X and it is particularly advantageous when there is limited installation space in the longitudinal direction, but may have behaviours which are dependent to a certain extent on the frequency and therefore an operating band which is slightly narrower than that of the preceding embodiment illustrated.

[0051] Fig. 5 shows a variation of embodiment of the connecting structure 1200 shown in Figure 4 in which the coupling/dividing Y junction H210 and the curved transition sections are formed as one piece which, although not being a commercial component and therefore having to be specially made, nevertheless offers a number of advantages owing to the smaller number of components and flanges to be interconnected, with consequent fewer problems of electrical contact between the parts.

[0052] With the connecting structure shown by way of example in Fig. 1, the rectangular input/output port V211 for the signal SLBV with second polarization V is located in a plane orthogonal to that of the input/output port H211 of the polarization signal H. If, as shown in Fig. 6, it should be required to position the ports in parallel planes or even arrange them so that they are coplanar (for example if required by the positioning of the output/input ports of the transceiver devices from which the second-band signals LB are derived), the input/output port H211 of one of the two Y junctions H210;V210 may be connected to a curved rectangular guide 20 in the same plane as the Y junction H210 (and therefore be able to be milled in the same plane as the Y junction H210) with a successive rectangular guide section 21 for connection to the corresponding port of the transceiver LBH301.

[0053] As shown in Figure 9, in a similar manner, the input/output port H211;V211 of one or both the two Y junctions H210;V210 may be connected to a respective curved rectangular guide 22, 23 in a plane parallel to the plane of the respective curves H225,H235; V225,V245 of the curved transition section H230,H240; V230,V240. With this embodiment it is possible to position one or both the input/output ports for connection to the transceivers LBV300;LBH300 in a parallel plane, and optionally in the same plane, as that of the rear output port 112 of the circular guide forming an extension of the inner guide 110 of the coaxial guide, in the case where the respective transceivers of the first and second band have coplanar output/input ports. The angle of the additional curves is preferably the same as that of the respective curves H225;H235 and/or V225;V235.

[0054] The third embodiment, which is shown in Figure 7, is structurally identical to that of Fig. 5, but is characterized in that the Y section H210, the curved transitions H1220;H1230 and, if present, the adapters H240;H250 are manufactured by means of milling from a single solid metal block M.

[0055] Milling is preferably performed in two steps with the milling tool acting in opposite directions: during the first milling step the Y junction is produced by means of removal of material from the rear side, which is then closed with a cover H216 (Fig. 8).

[0056] During the second milling step, the adapter part H240;H250 for adaptation from annular segment to rectangular form and the transition sections H1220;H1230 which have a curve with chamfer are formed along the direction opposite to the direction of removal of the first milling step. The second milling step can be easily carried out if the rectangular section of the guide is contained entirely inside the annular segment and if the chamfer of the curve has a length smaller

than the larger side of the rectangular section multiplied by the square root of 2 (something which normally occurs since the wide side of the standard guide is slightly smaller than half the wavelength guided in the vacuum, while the chamfer has a length of about a quarter of a wavelength).

[0057] Preferably through-holes are formed in the rear wall of the part M so as to be able to fix the connecting structure to the rear wall 121 of the coaxial guide 120.

[0058] The structure is therefore simplified, easier to manufacture and at the same time compact in the longitudinal direction X-X.

[0059] With reference to Fig. 8, this figure shows a schematic view of an adapter guide section, the cross-section of which varies gradually from a rectangular guide to an annular segment, suitable for use in any of the embodiments described in the present application. The following description is of a general nature and applicable to all the adapter sections for adaptation from a rectangular guide to an annular segment port according to the present invention.

[0060] Still with reference to Fig. 8, the cross-section of an upstream rectangular guide part 251 of the adapter guide section is shown in a plane x-y (with z=0), wherein the larger dimension W of the upstream port is parallel to the axis x and the smaller dimension H of the upstream port is parallel to the axis y.

[0061] Also shown in the same plane x-y is the cross-section of a downstream port 252 with an annular segment cross-section of the adapter section (this downstream port lies in reality in a plane x-y (with z=L) parallel to that in which the rectangular cross-section lies). The centre of the radius circumferences ROut and RIn which define respectively the outer arc and inner arc of the annular segment is located at the origin of the x and y axes. The amplitude A of the angle at the centre subtended by the annular segment is indicated with reference to the two half-amplitudes A/2 respectively lying in the half-planes $x \geq 0$ and $x \leq 0$.

[0062] Fig. 8 shows moreover in schematic form the inner surfaces of the guide for adapting the connection of the rectangular upstream port to the annular segment downstream port, respectively identified as radially outer ext, radially inner inn, right-hand side rgt and left-hand side lft.

[0063] Based on this agreed reference system a modelled form of the (inner) surfaces of a guide section for adaptation from rectangular guide to annular segment may be defined at each spatial point x,y,z by means of a linear interpolation, relative to the axis z of propagation in the adapter guide, between the two respectively rectangular and annular segment sections, which have known/defined dimensions and/or coordinates in the upstream rectangular part (z=0) and the downstream annular segment part (z=L) of the respective adapter guide section.

[0064] A preferred example of such a modelled form may be defined as follows:

the radially outer surface ext (xext, yext, zext) which joins the long side W of the rectangular upstream port, extending parallel to the axis x and located at $y=O+H$, to the outer arc of radius ROut of the annular segment may be constructed in parametric form based on two adimensional parameters u and v, where u ranges between 0 and 1 while v ranges from -1/2 to 1/2, as follows:

$$x_{\text{ext}}(u,v) = (v) \cdot (1-u) + (R_{\text{Out}} \cdot \sin(v \cdot A)) \cdot u$$

$$y_{\text{ext}}(u,v) = (O+H) \cdot (1-u) + (R_{\text{Out}} \cdot \cos(v \cdot A)) \cdot u$$

$$z_{\text{ext}}(u,v) = L \cdot u$$

[0065] Similarly, the radially inner surface inn (xinn, yinn, zinn) which joins the long side W of the rectangular upstream port, extending parallel to the axis x and located at $y=O$, to the inner arc of radius RIn of the annular segment port may be constructed in parametric form based on two adimensional parameters u and v, where u ranges between 0 and 1 while v ranges from -1/2 to 1/2, as follows:

$$x_{\text{inn}}(u,v) = (v) \cdot (1-u) + (R_{\text{In}} \cdot \sin(v \cdot A)) \cdot u$$

$$y_{\text{inn}}(u,v) = (O) \cdot (1-u) + (R_{\text{In}} \cdot \cos(v \cdot A)) \cdot u$$

$$z_{\text{inn}}(u,v) = L \cdot u$$

[0066] The right-hand side surface rgt (xrgt, yrgt, zrgt) which joins the short side of dimension H of the rectangular

port, extending parallel to the axis y and located at $x=W/2$, together with the annular segment side which lies in the half-plane $x>0$ may be constructed in parametric form based on two adimensional parameters u and v, which both range between 0 and 1, as follows:

$$x_{rgt}(u,v) = (W/2)*(1-u) + ((R_{In}+(R_{Out}-R_{In})*v)*\sin(A/2))*u$$

$$y_{rgt}(u,v) = (O+H*v)*(1-u) + ((R_{In}+(R_{Out}-R_{In})*v)*\cos(A/2))*u$$

$$z_{rgt}(u,v) = L*u$$

namely satisfying the linear interpolation condition for each value of u:

$$y_{rgt}(u,v) = (y_{inn}(u,1/2))*(1-v) + (y_{ext}(u,1/2))*v$$

[0067] The left-hand side surface 1ft which joins the short side of dimension H of the rectangular port extending parallel to the axis y and located at $x=W/2$, to the annular segment side which lies in the half-plane $x<0$ is a mirror image, relative to the plane $x=0$, of the right-hand side surface rgt.

[0068] Figure 10 shows a further variation of embodiment of the connecting structure according to the invention, which differs from the preceding embodiments shown in that each rectangular waveguide transition section H2220,H2230; V2220,V2230 has a respective curve which has the respective output ports H,V2222;H,V2232 positioned so as to lie in a plane directed at 180° (and therefore parallel, but with opposite direction of propagation, for the output/input signals from/to the curved transition section) relative to the respective output/input ports H211;V211 of the respective Y junction H210,V210.

[0069] According to the invention, the curved transitions of the structure according to the present invention have a respective curve with an angle of between 20° and 180° designed so that the output/input port is positioned in a plane oriented at a corresponding angle of between 20° and 180° relative to the corresponding input/output port.

[0070] With general reference to Fig. 11, a description is now provided of a number of preferred embodiments of the connecting structure of the invention designed to connect input/output waveguide ports for the signals SLBH,SLBV in the second band LB, which have a larger dimension (H211a,V211a), suitable for performing single-mode guided propagation for the TE₁₀ mode inside the respective rectangular guides, with a coaxial guide 100 which has an annular end wall 100, the surface of which is not large enough to be able to accommodate four ports 121a,121b (with a rectangular or annular segment cross-section) having a larger dimension compatible with the rectangular output/input ports of the curved transition sections of the connecting structure.

[0071] This situation may occur, during practical use of the structure according to the invention, if it is required to design the dimensions of the coaxial guide 100 for connection to the dual-band antenna and the rectangular waveguides of the connecting structure according to the invention in such a way as to minimize:

- on the one hand, the presence inside the coaxial guide 100 of undesirable propagation modes other than the TE₁₁ mode useful for propagation to/from the antenna; this is obtained by designing the dimensions of the coaxial guide 100 with a diameter as close as possible to the minimum dimension needed to ensure that the cut-off frequency of the relevant coaxial mode TE₁₁ is less than the minimum frequency of the signals SLBV and SLBH in the frequency band LB;
- on the other hand, the presence inside the rectangular guides of the connecting structure of undesirable propagation modes other than the mode TE₁₀ useful for propagation to/from the coaxial guide 100; this is obtained by designing the rectangular guides with a larger dimension as close as possible to the minimum dimension needed to ensure that the cut-off frequency of the relevant mode TE₁₀ is less than the minimum frequency of the signals SLBV and SLBH.

[0072] For example, a coaxial guide 100 with diameter of the inner conductor equal to 6.4 mm which supports only the propagation modes TEM and TE₁₁ in a second band LB with nominal frequency 11 GHz has an outer diameter of about 18 mm, so as to obtain a cut-off frequency of the TE₁₁ mode at 7.8 GHz and a first higher mode which can be triggered at 14.8 GHz.

[0073] The rectangular guides of the connecting structure, which are designed to guide the signals SLBH,SLBV in such a single-mode frequency band LB exciting only the mode TE₁₀, will have a larger dimension H211a,V211 greater

than or equal to 22.8 mm.

[0074] In this example, the output/input ports H222,H232 of the curved transition sections H220,H230 of each polarization H,V in said second frequency band will be parallel to the annular end wall of the coaxial guide 100. However, it will not be possible to form in this rear wall four symmetrical and angularly equidistant ports with a larger dimension

suitable for connection to a rectangular guide of width 22.8 mm, because the rear annular wall has a diameter of 18 mm. **[0075]** Using a coaxial guide 100 with a diameter larger than the necessary minimum diameter calculated above is possible, but not preferable, because a guide which is much larger than necessary is able to support other propagation modes other than TE₁₁ (and the TEM mode which is always present) and this means that the structure is more exposed to power dispersions and the creation of "echoes" which are propagated at different speeds and result in poorer isolation of the transported signals.

[0076] In order to overcome these drawbacks, a variation of embodiment of the connecting structure according to Figure 1, not shown in detail, comprises waveguide adapter sections for adaptation from a rectangular to annular segment cross-section, which are connected downstream of the output/input ports of respective curved transition sections, which gradually taper towards the end wall of the coaxial guide so that the corresponding output/input ports suitable for connection to the ports 121a,121b of the end wall 121 are designed with the correct dimensions for the latter. This embodiment is preferred if the gradual tapering does not preclude correct propagation towards/from the coaxial guide 100.

[0077] Such a gradually tapering adapter guide may be obtained/modelled as described above in connection with Figure 8.

[0078] The modelled example of the form of the surfaces of the adapter guide section varying gradually from a rectangular to annular segment cross-section described above with reference to Fig. 8, especially in the case where gradual tapering of the adapter guide is introduced, could be subject to minor reflections due to the fact that the signal which is emitted from the rectangular guide undergoes a deflection along the y axis of Fig. 8. This deflection is all the greater the steeper the degree of tapering towards the annular segment section. In order to improve further the adaptation reducing these possible reflections, it is possible to use a further preferred embodiment of the adapter guides which is slightly modified so that the signal is even more gradually curved towards the ring.

[0079] This further preferred embodiment may be defined by adding three functions $Y_{ext}(u,v)$, $Y_{inn}(u,v)$, $Y_{rgt}(u,v)$ to the functions $y_{ext}(u,v)$, $y_{inn}(u,v)$, $y_{rgt}(u,v)$ described above.

[0080] The additional functions have the following values:

$$Y_{ext}(0,v)=0; Y_{ext}(1,v)=0$$

$$Y_{inn}(0,v)=0; Y_{inn}(1,v)=0$$

$$Y_{rgt}(0,v)=0; Y_{rgt}(1,v)=0$$

resulting advantageously in no modification of the edges of the transition at $y=0$ and $z=L$, so as to ensure that they still match the rectangular and annular sections.

[0081] The slope along y is controlled by means of the following:

$$d(y_{ext}(0,v)+Y_{ext}(0,v))/dv= Y_{Pext}(v)$$

$$d(y_{inn}(0,v)+Y_{inn}(0,v))/dv= Y_{Pinn}(v)$$

where $Y_{Pext}(v)$ and $Y_{Pinn}(v)$ may assume the constant value 0, so as to offset in an optimum manner the discontinuity towards the rectangular guide.

[0082] Simple polynomial functions $Y_{ext}(u,v)$ and $Y_{inn}(u,v)$ may be constructed in order to satisfy the conditions described above.

[0083] $Y_{rgt}(u,v)$ may then be determined so as to connect the "right-hand" edge of the new radially inner surface $y_{inn}(u,1/2)+Y_{inn}(u,1/2)$ with the "right-hand" edge of the new radially outer surface $y_{out}(u,1/2)+Y_{out}(u,1/2)$, resulting in:

$$y_{rgt}(u,v)=(y_{inn}(u,1/2))*(1-v)+(y_{ext}(u,1/2))*v$$

[0084] The left-hand side surface is a mirror-image of Yrgt.

[0085] A similar procedure may also be used for the annular segment, if necessary.

[0086] It is clear to the person skilled in the art that, based on these analytically derivable modelled forms and with the aim of simplifying production, it is possible to discretize the curved surfaces into flat sections which approximate the ideal modelled surface, without this giving rise to substantial differences in practice.

[0087] According to a further preferred embodiment which solves the problem of tapering towards the coaxial guide, the connecting structure comprises a waveguide in the form of a coaxial adapter funnel 160 for connection to the rear of the outer guide of the coaxial guide. The coaxial adapter funnel will be formed by two coaxial cone portions, i.e. an outer portion and inner portion, designed to form a coaxial guide with gradually diminishing diameter. The larger annular base of the coaxial funnel will be directed towards the connecting structure of the invention and will have input/output ports with a cross-sectional form of an annular segment having correct dimensions suitable for connection to the output/input ports of the adapter guide sections connected downstream of the curved transition guides and lying in a plane parallel to the said ports, while the smaller base will be in the form of a coaxial guide which may be connected directly to the rear end of the outer guide of the coaxial guide 100, which in this case will not be closed by the rear annular wall 120, the function of which is instead performed by the annular surface with input/output ports of the larger base of the funnel 160. The use of the funnel alone for the tapering towards the coaxial guide may, in rare cases where the cross-section of the coaxial guide is very small compared to the larger base of the funnel, give rise to the presence, in the part close to the larger base, of imperfect propagation since the propagation of modes higher than then TE₁₁ mode might be allowed.

[0088] In view of the not always perfect adaptability of the two solutions illustrated above, a particularly preferred embodiment of the structure according to the invention, shown in Figure 11, comprises waveguide adapter sections H1240;V1240 which gradually taper, converging towards the larger rear annular wall of a coaxial waveguide funnel 160 which has, formed thereon, input/output ports having suitable dimensions for connection to the output/input ports of the adapter sections H1240;V1240.

[0089] The smaller, front, annular base of the coaxial funnel is then connected to the rear part of the coaxial guide 100, being provided with suitable dimensions for correct adaptation thereto.

[0090] This embodiment is preferred since it always allows excessive tapering of the waveguide adapter sections to be avoided, so that they remain in single-mode propagation, and also excessive widening of the larger rear annular base of the funnel 160 to be avoided, preventing the propagation of higher modes inside the said funnel.

[0091] Generally, however, it is nevertheless possible, depending on the working frequency and the dimensions of the guides selected, that only one of the two measures described above (tapering adapter guides and coaxial funnel) may be sufficient.

[0092] It is therefore clear how, with a connecting structure according to the invention, it is possible to connect the output/input ports for orthogonal polarization signals in the second frequency band to the outer circular guide 120 of the coaxial guide, minimizing the signal power losses, while being extremely compact and having a simple structure.

[0093] With a connecting structure comprising, for each polarization, a Y-shaped junction section followed by a pair of curved transition sections having an angle of between 20° and 180°, preferably with a radius of curvature greater than or equal to 2 or 3 times the guided wavelength, and by guide sections for adaptation from a rectangular guide to an annular segment guide it is possible to obtain optimum adaptation (minimal reflections) and a wide through band width with a simple structure for emitting and receiving two signals both with dual polarization along the coaxial guide 100.

[0094] By designing the curved transition section with a 45° chamfer it is possible to provide a more compact connecting structure, with any more sensitive reactions to the variations in frequency and therefore tapering of the operating band for the signals SLBH, SLBV being able to be offset by suitable methods.

[0095] The curved transition sections may have different curves for the different polarizations, for easier connection to transceivers of the original signals which lie in different planes.

[0096] The connecting structure may be advantageously formed as single component with cover by milling the parts for each polarization in the second band without a further deterioration of the performance and using a simple and low-cost manufacturing method.

[0097] The adapter sections for adaptation from rectangular guide to annular segment downstream of the curved transition section ensure optimum adaptation and polarization discrimination characteristics.

[0098] With the architecture thus proposed it is possible to provide a system for emission/reception of a first dual-polarization signal in a first frequency band and a second dual-polarization signal in a second frequency band towards/from a dual-band antenna, with advantages in terms of the constructional simplicity and working band width of the device, obtained by means of a connecting structure which reduces the elements which in the prior art were the cause of a behaviour extremely sensitive to frequency (resonance).

[0099] It therefore becomes possible to design communication systems on dual frequency bands both with dual polarization which use a single dual-band antenna for the four radio wave flows (in each direction) connected to the transceiver apparatus via a single physical interface (the coaxial guide which includes the circular guide), allowing simpler

installation than the solutions with multiple interfaces. Owing to the intrinsically less frequency-sensitive behaviour of the solution proposed it is possible to reduce or eliminate the measures needed for manual or semi-automatic calibration of the emission system, with a consequent reduction in the manufacturing and installation costs compared to the conventional resonating solutions.

[0100] Moreover, owing to the form of the structure and the resultant signal path it is also possible to obtain directly easier connection of the transceiver apparatus arranged in a variety of relative positions, thus reducing the manufacturing, assembly and spatial volume costs.

[0101] An applicational example in which this characteristic feature of the invention may be particularly advantageous is that of radio links in a dual-band XPIC configuration (dual-band and double polarization in both cases), the development of which is today greatly hindered by the absence of solutions which are simultaneously wide-band and compact for the purpose of connection to dual-band antennas fed with a coaxial guide. The growing demand for this type of configuration may be satisfied by means of the invention.

[0102] Although described in connection with a number of embodiments and a number of preferred examples of implementation of the invention, it is understood that the scope of protection of the present patent is determined solely by the claims below.

Claims

1. Connecting structure for transporting a signal SLBH with a first polarization (H) in a frequency band LB and a signal SLBV with a second polarization (V) in said frequency band LB from/to upstream to/from a downstream coaxial guide (100), comprising:

-) an upstream rectangular-waveguide port (H211) for input/output of the first-polarization signal SLBH, having a smaller dimension (H211b) and larger dimension (H211a) orthogonal thereto, connected to:
-) a waveguide junction (H210) with a Y-shaped form in a plane orthogonal to the plane in which the upstream input/output port (H211) lies and parallel to the smaller dimension (H211b) of the said input/output port (H211) which is connected to the shank of the Y junction,

and with two coplanar rectangular-waveguide ports (H212,H213) for output/input of a respective component of the signal SLBH, each arranged at the downstream end of a respective branch of the Y junction, and having a larger inner dimension equal to the larger inner dimension (H211a) of the upstream input/output port (H211) and a smaller inner dimension equal to half the smaller inner dimension (H211b) of the upstream port (H211); the following being connected to each of the two rectangular output/input ports (H212,H213) of the Y junction (H210):

-) a respective waveguide transition section (H220;H230) which has a curve (H225;H235) in a plane orthogonal to the plane of the respective downstream, rectangular guide, output/input port of the Y junction (H210) and parallel to the larger dimension of said port and which terminates in a rectangular port (H222;H232) for output/input of the respective component of the first-polarization signal SLBH;

the curves (H225;H235) of the two transition sections (H220;H230) being identical, parallel and directed in a same direction and each having a same angle of between 20° and 180°;

-) an upstream rectangular guide port (V211) for input/output of the second polarization signal SLBV, having a smaller inner dimension (V211b) and larger inner dimension (V211a) orthogonal thereto, connected to:
-) a waveguide junction (V210) with a Y-shaped form in a plane orthogonal to the plane of the input/output port (V211) and parallel to the smaller dimension (V211b) of the said input/output port (V211) which is connected to the shank of the Y junction,

and with two coplanar, rectangular-waveguide, downstream ports (V212,V213) for output/input of a respective component of the signal SLBV, each arranged at the downstream end of a respective branch of the Y junction, and having a larger inner dimension equal to the larger inner dimension (V211a) of the upstream input/output port (V211) and a smaller inner dimension equal to half the smaller inner dimension (V211b) of the said upstream port (V211); the following being connected to each of the two rectangular output/input ports (V212,H213) of the Y junction (V210):

-) a respective waveguide transition section (V220;V230) which has a curve (V225;V235) in a plane orthogonal to the plane of the respective rectangular guide output/input port of the Y junction (V210) and parallel to the larger dimension of the said output/input port, and which terminates in a rectangular port (V222;V232) for

output/input of the respective component of the signal SLBV, lying in a plane parallel to the plane of the input/output ports (H222;H232) of the curved transition sections (H220;H230) for transporting the components of the signal SLBH with first polarization (H);

wherein the curves (V225;V235) of the two transition sections (V220;V230) for the components of the signal SLBV with second polarization (V) are directed in the same direction and each have a same angle of between 20° and 180°; and are identical and oriented in parallel planes, orthogonal to the planes of said curves (H225;H235) of the transition sections (H220;H230) for transporting the components of the first-polarization signal SLBH; and wherein the curved transition sections (V220,V230) for transporting the components of the second-polarization signal SLBV have downstream output/input ports axially offset in a longitudinal/axial direction (X-X), orthogonal to the plane of the said output/input ports, relative to the downstream output/input ports of the curved transition sections (H220,H230) for transporting the components of the first-polarization signal SLBH, the connecting structure further comprising a respective waveguide adapter section (H240;H250,V240;V250), the cross-sectional form of which varies gradually from a rectangular waveguide to a waveguide with a cross-section in the form of an annular segment, connected downstream of each curved transition section (H220;H230,V220;V230), each waveguide adapter section being ridgeless and having an upstream rectangular port (H241;H251) connected to the rectangular output/input port (H222;H232) of the respective curved transition section (H220;H230) and a downstream annular-segment port (H242;H252) for output/input of the respective component of the signal with first or second polarization in the frequency band LB.

2. Connecting structure according to Claim 1, **characterized in that** the waveguide adapter sections (H240;H250) for transporting the components of the first-polarization signal SLBH are identical to each other and have a linear extension different from that of the adapter sections (V240;V250) for transporting components of the second-polarization signal SLBV.
3. Connecting structure according to any one of the preceding claims, wherein the Y junction (H210) and the curved transition sections (H1220;H1230) and the waveguide adapter sections connected to it are formed as one piece for one or both polarizations.
4. Connecting structure according to any one of the preceding Claims 1-3, **characterized in that** the upstream input/output port (H211;V211) of one or both the Y junctions (H210;V210) is connected upstream to a respective rectangular guide (22,23) with a curve in a plane parallel or orthogonal to the plane of the respective Y junctions (H225,H235;V225,V235).
5. Connecting structure according to any one of the preceding Claims, **characterized in that** the inner radius of curvature of each curved transition section (H220;H230; V220;V230) for transporting the components of one or both of the polarization signal/s, is greater than or equal to twice the minimum wavelength guided in the rectangular guide of the transition section.
6. Connecting structure according to any one of the preceding Claims 1-5, **characterized in that** the transition sections (H1220;H1230) with curve (H1225) for transporting the components of one or both of the orthogonal polarization signal/s have a continuous curve or a right angle inside the curve and an outer wall with curve (H1225) having a chamfer (H1226) inclined at 45°, the length of the chamfer being a quarter of the guided wavelength.
7. Connecting structure according to any one of Claims 1-6, **characterized in that** the waveguide adapter sections for adaptation from a rectangular cross-section to an annular segment, connected downstream of the output/input ports of the respective curved transition sections, gradually taper from upstream to downstream in the longitudinal direction of propagation inside the respective waveguide adapter section.
8. Connecting structure according to any one of the preceding claims, **characterized in that** it comprises a waveguide in the form of a coaxial adapter funnel (160) for connection to a rear end of the coaxial guide (100), the coaxial adapter funnel (160) being formed by two respectively inner and outer, coaxial, conducting, cone portions able to form a coaxial guide with inner and outer diameters which gradually decrease in the downstream direction, wherein the smaller base of the coaxial funnel (160) is suitable for connection with a rear end of the coaxial guide (100), and wherein the bigger base of the coaxial funnel has an annular wall with two diametrically opposite input/output ports with cross-sectional form of an annular segment for the components of the first-polarization signal SLBH, and two diametrically opposite input/output ports with cross-sectional form of an annular segment for the components of the second-polarization signal SLBV, which are combined/separated by the coaxial funnel in/from a signal with orthogonal

dual-polarization in said second frequency band LB; the four ports on the bigger annular base being angularly equidistant along the annular extension thereof.

5 9. Connecting structure according to the preceding claim, **characterized in that** the adapter sections for adaptation from a rectangular guide to an annular-segment guide are connected upstream of the coaxial funnel, each being connected to a respective one of said ports having the cross-sectional form of an annular segment.

10. Emission/reception system comprising a connecting structure according to any one of the preceding claims.

10 11. Emission/reception system according to claim 10, comprising:

- a downstream coaxial guide (100) comprising:

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- an inner circular guide (110) for transporting a signal with dual polarization in a first frequency band;
 - an outer cylindrical conductor (120), coaxial with the inner circular guide (110) so as to form an outer guide for transporting a signal with dual polarization in a second frequency band LB; the outer guide extending axially between the front end (101) of the coaxial guide and a rear end opposite to the said front end (101) in a longitudinal axial direction (X-X);

20 the inner cylindrical conductor (110) having a rear extension in the axial direction (X-X) beyond the rear end of the outer conductor (120) so as to form a circular guide (111) for transporting said signal SHB with orthogonal dual polarization in the first frequency band;

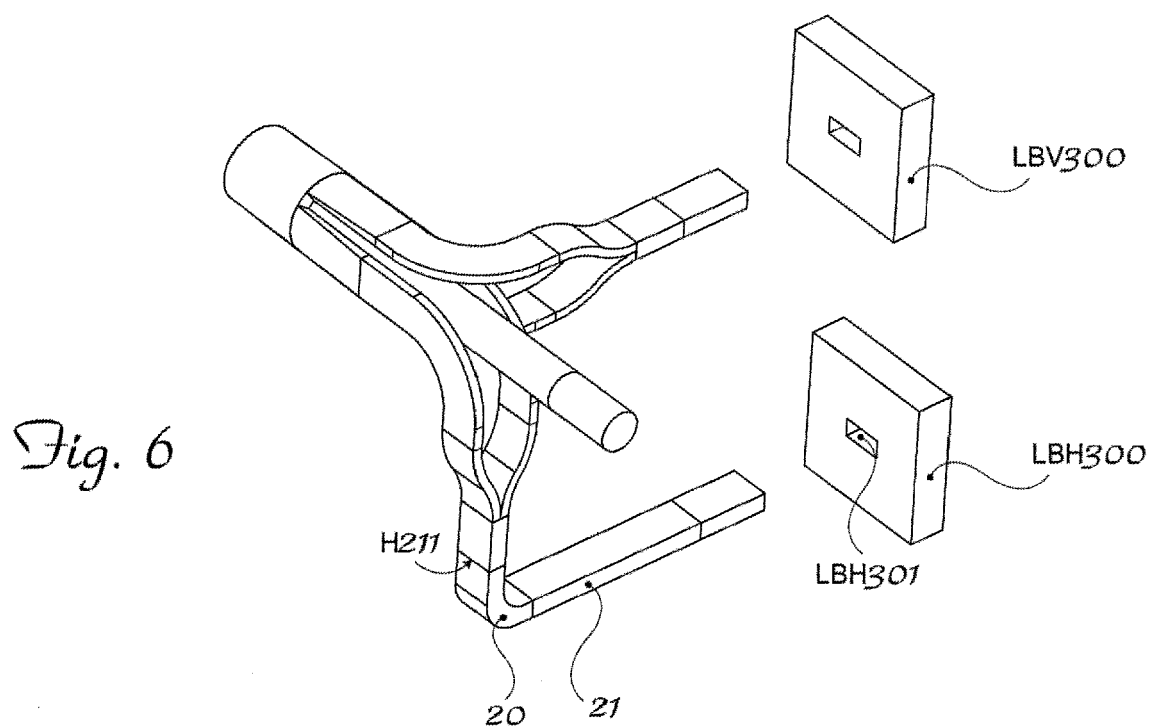
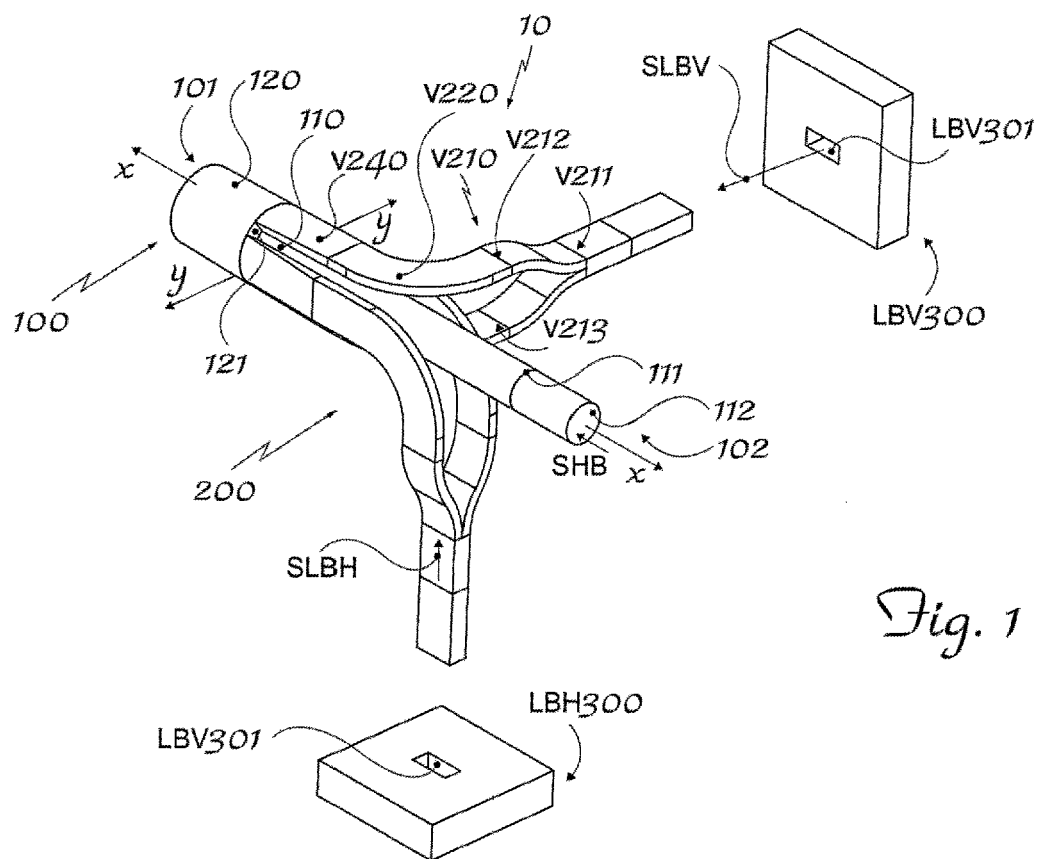
wherein the connecting structure is arranged upstream of and connected to the rear end of the outer guide of the coaxial guide (100) for input/output, into/from the coaxial guide, of said signals SLBH;SLBV or the components of the signals SLBH;SLBV in the second frequency band LB.

25 12. Emission/reception system according to the preceding claim, wherein the rear end of the outer guide of the coaxial guide is closed by a rear annular wall (121) lying in a plane parallel to a radial direction (Y-Y) and orthogonal to the longitudinal direction (X-X);

30 the rear annular wall (121) of the outer circular guide (120) having two diametrically opposite, annular segment, input/output ports (121a) for the components of the first-polarization signal SLBH in said second frequency band LB, and two diametrically opposite, annular segment, input/output ports 121b for the components of the signal SLBV with second polarization in said second frequency band LB, which are combined/separated by the coaxial guide (100) into/from a signal with orthogonal dual polarization in said second frequency band LB;

35 the four ports on the rear annular wall being angularly equidistant on the annular extension thereof; and wherein the respective ports of the connecting structure, for output/input of the respective components of the signal SLBH with first polarization and the signal SLBV with second polarization in the second frequency band (LB) are connected to a respective port of the input/output ports (121a;121b) on the rear annular wall (121) of the outer circular guide (120) of the coaxial guide (100).

40 13. Emission/reception system according to Claim 11, wherein the connecting structure is realized according to one of Claims 8 or 9, and wherein the rear end of the coaxial guide is connected to the smaller base of the coaxial funnel (160) for input/output of the signals SLBH,SLBV of the second frequency band (LB) into/from the coaxial guide (100).



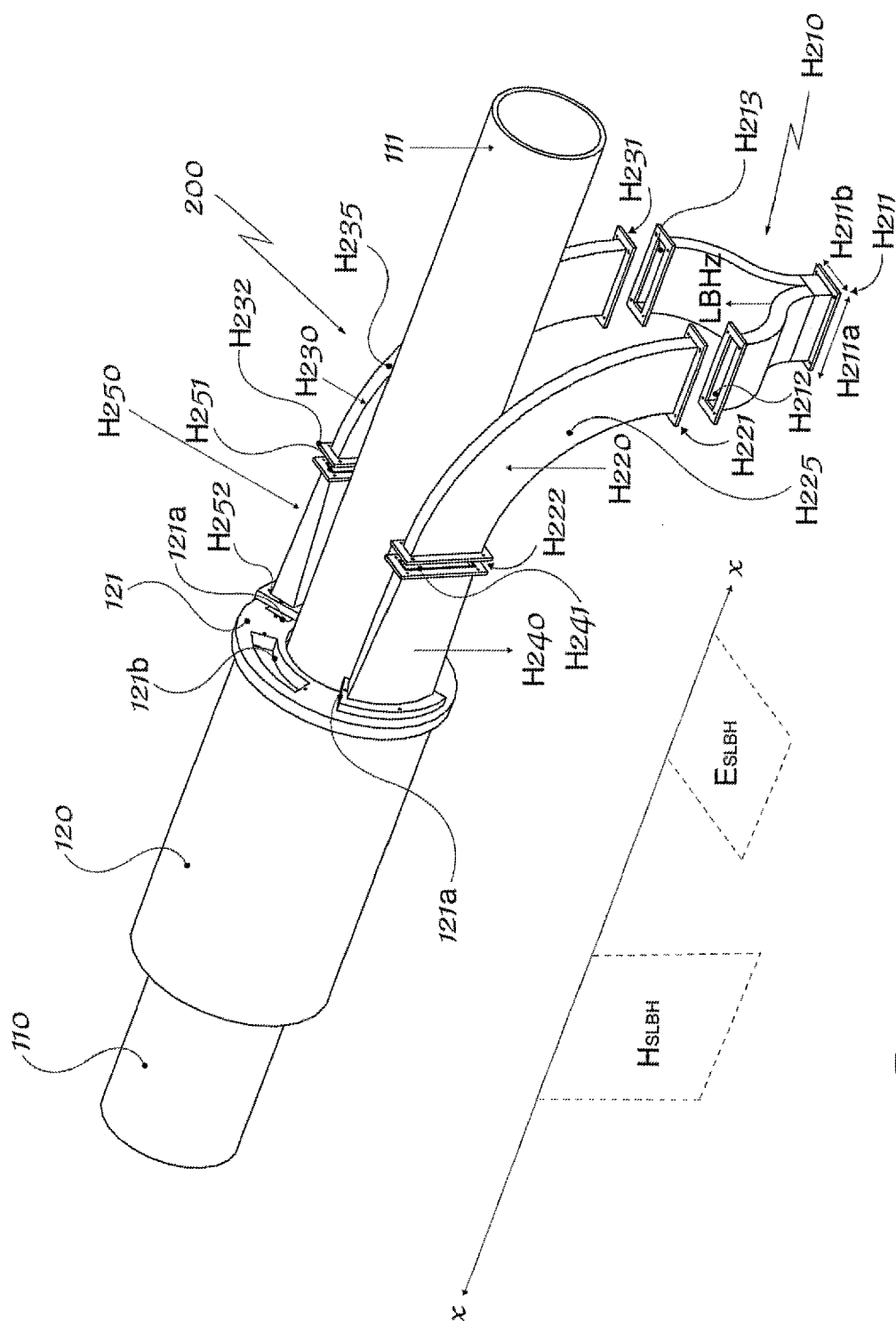


Fig. 2

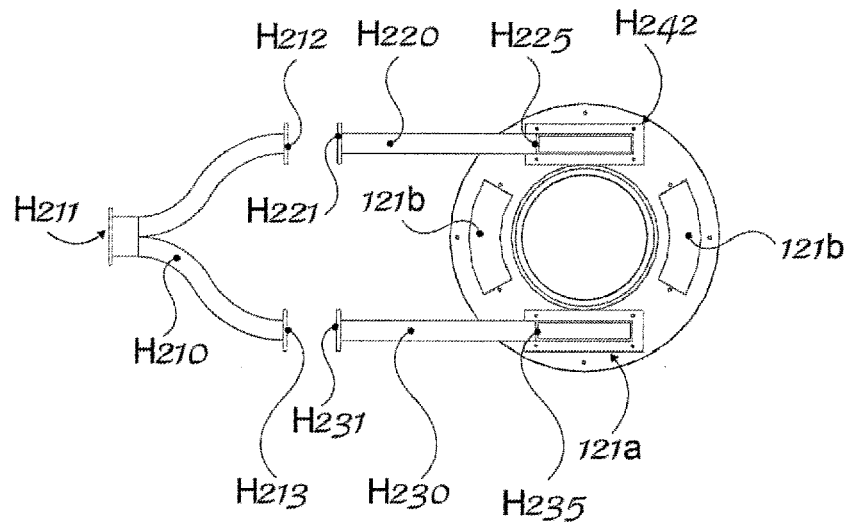


Fig. 3

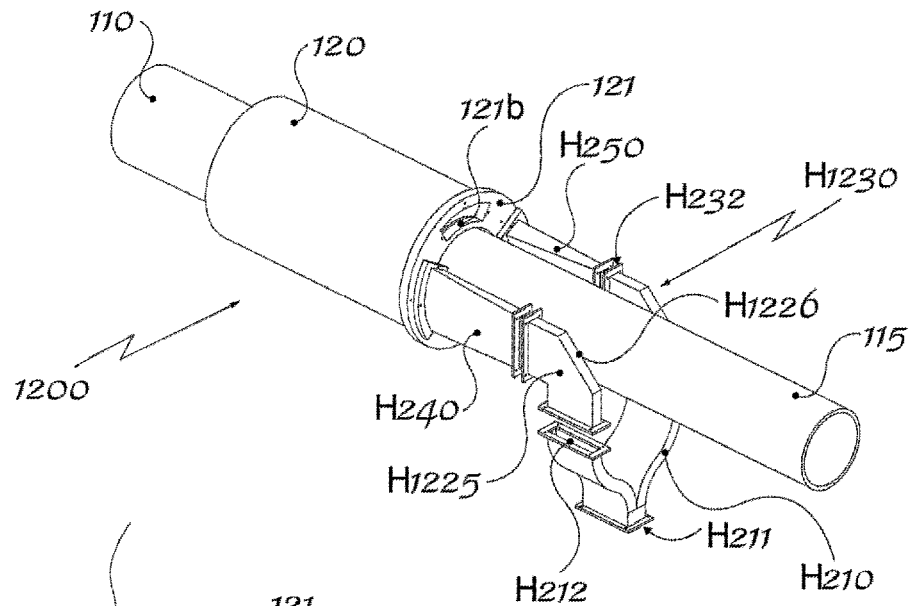


Fig. 4

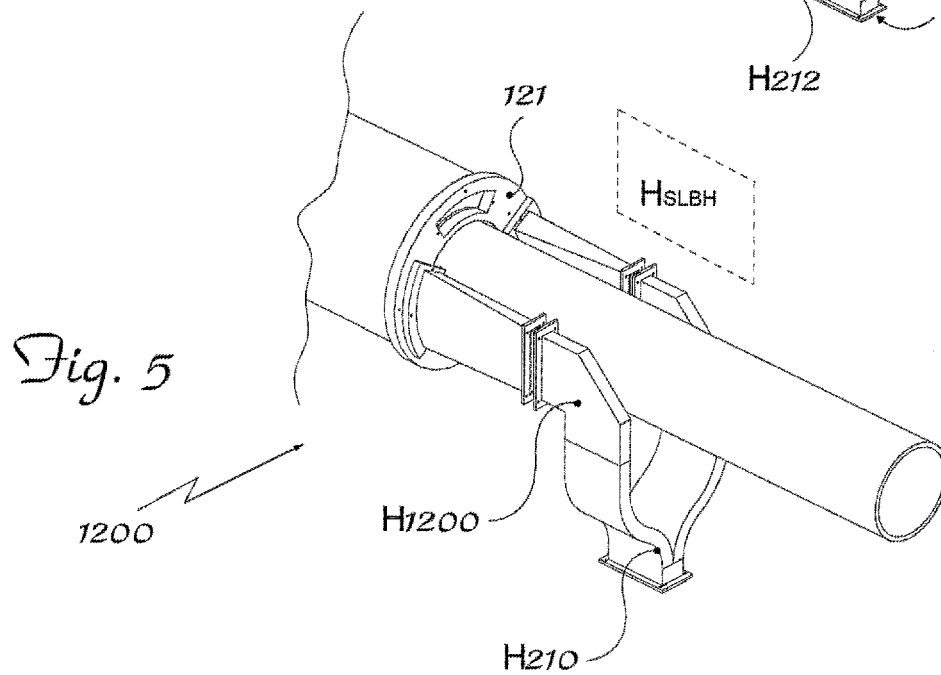


Fig. 5

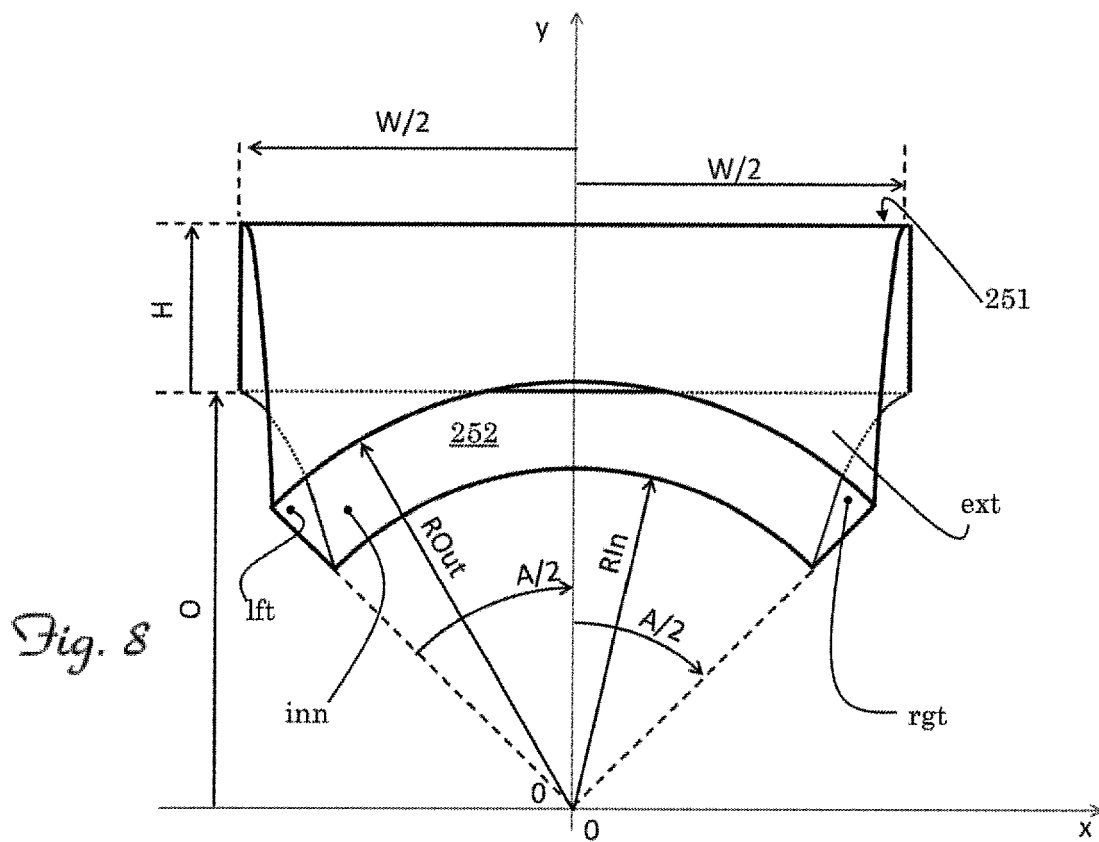
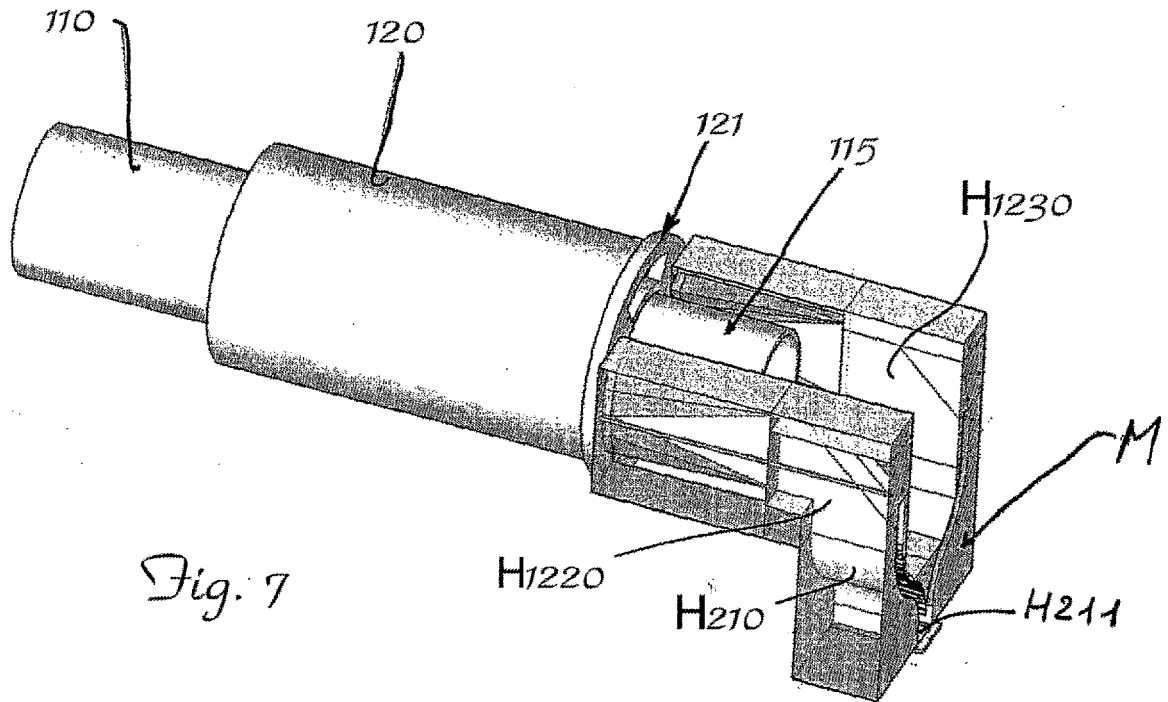


Fig. 9

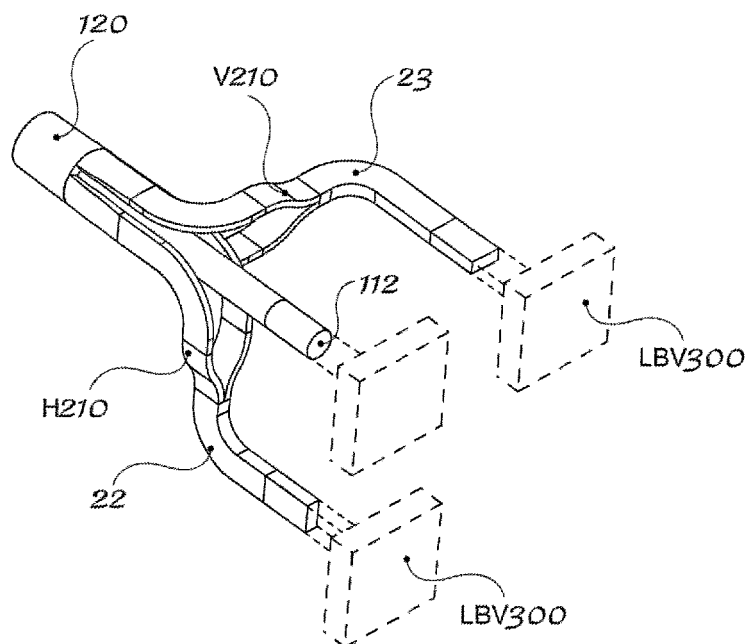
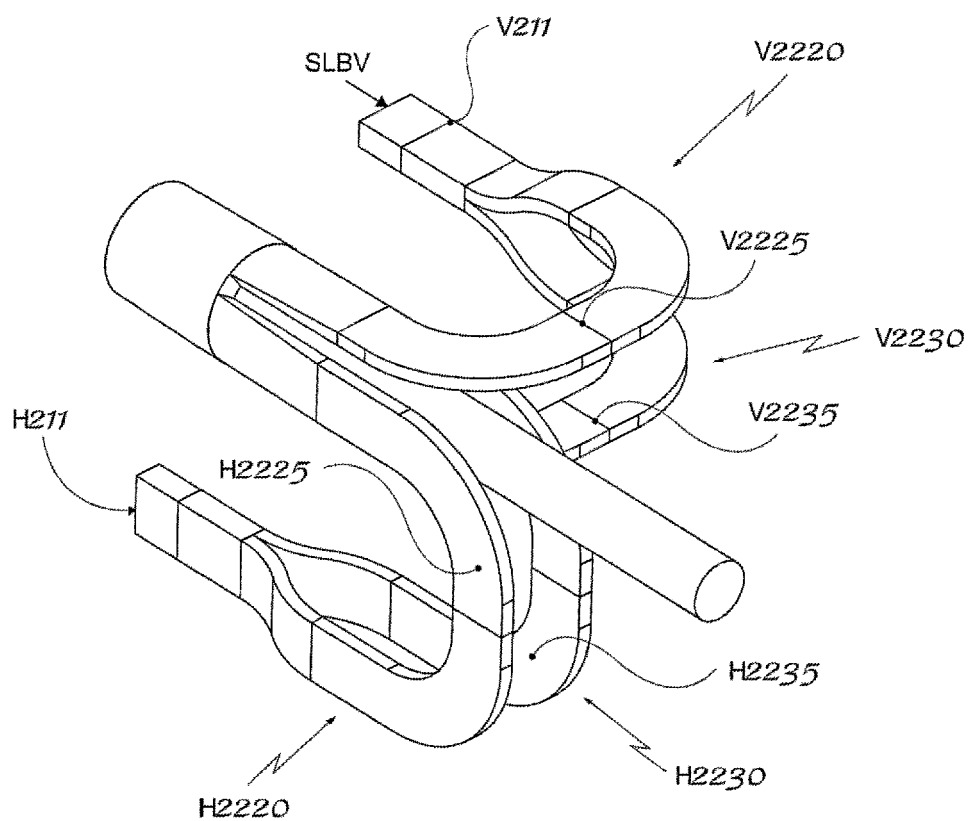
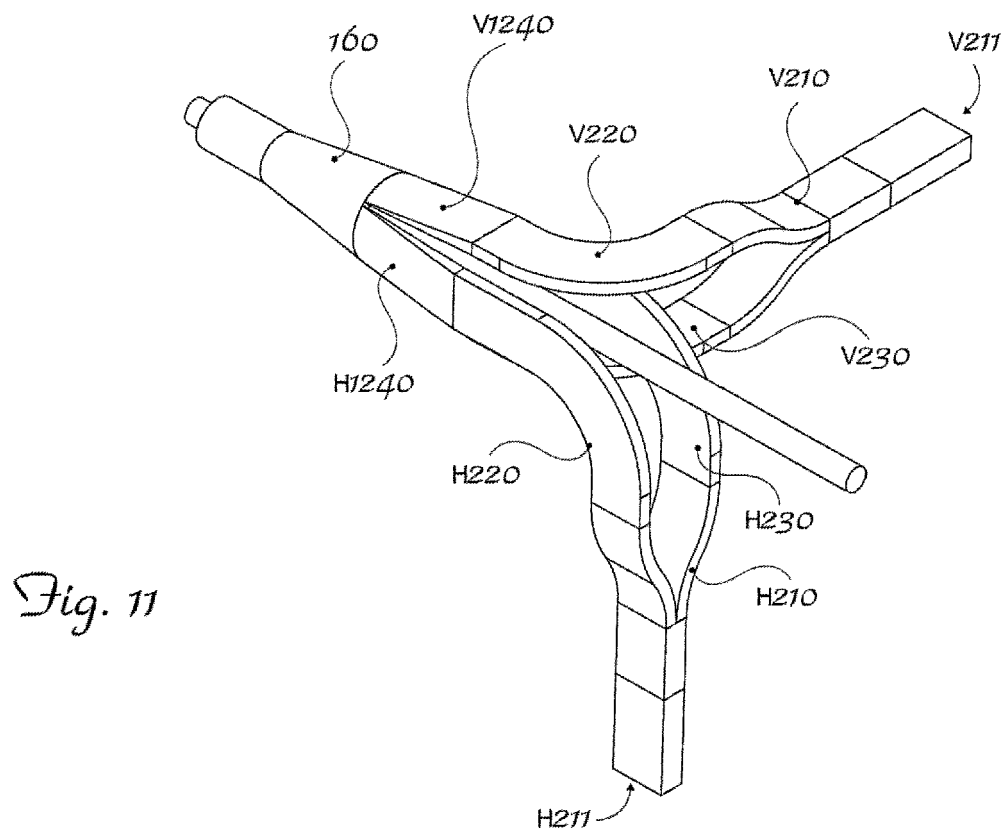


Fig. 10







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Place of search The Hague		Date of completion of the search 1 June 2018	Examiner Sípal, Vít
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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			

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