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(54) **Space borne antenna system**

Raumgestütztes Antennensystem

Système d'antenne spatiale

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EP-A2- 1 119 072 US-B1- 6 424 314

- **LUDWIG M ET AL: "Imaging Ka-band SAR interferometer", SYNTHETIC APERTURE RADAR (APSAR), 2011 3RD INTERNATIONAL ASIA-PACIFIC CONFERENCE ON, IEEE, 26 September 2011 (2011-09-26), pages 1-4, XP032024041, ISBN: 978-1-4577-1351-4**
- **D. M. SIMPSON: "The "Snapdragon" Family", PROCEEDINGS OF THE EUROPEAN CONFERENCE ON SPACECRAFT STRUCTURES, MATERIALS AND MECHANICAL TESTING, 1 January 2001 (2001-01-01), pages 337-344, XP055376639,**

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Description

[0001] The invention relates to a space borne antenna system. In particular, the invention relates to a multiple antenna system for space borne applications like radar, synthetic aperture radar (SAR), interferometric SAR or moving target indication (MTI).

[0002] Known antenna systems, for example an interferometric SAR instrument, often comprise two or more radiating apertures (i.e. antenna arrangements) which are mounted on a single platform, e.g. a spacecraft or a satellite, with a certain spatial sensor separation. A large separation, i.e. baseline, between the radiating apertures is reached by mounting at least one of the antennas on the tip of a boom like structure. The boom like structure (e.g. arm or mast) may be fixed or deployable. According to the partly high weight of the antenna mounted at the tip of the boom, the boom has to be adapted to have a sufficient, predetermined stiffness. However, this may result in a heavy and mechanically complex boom. Furthermore, the distance between platform and antenna may influence the performance of the antenna system.

[0003] US 6 424 314 B1 discloses a support for a deployable reflector for use on a modular satellite antenna assembly being constructed of an elongated boom supported at both ends by a pair of two axis actuators. The boom is attached at its inboard end to the satellite structure in close proximity to the point of attachment of the associated signal feed assembly to minimize the differential thermal stress throughout the antenna assembly.

[0004] Ludwig M et al: "Imaging Ka-band SAR interferometer" discloses a study into the feasibility of an interferometric Ka-Band SAR instrument with high resolution capabilities.

[0005] EP 1 119 072 A2 discloses a method and apparatus for producing contiguous spot beam communications coverage on the Earth's surface. The apparatus comprises an antenna system including two wide scan antennas and two narrow scan antennas. The two wide scan antennas are disposed substantially opposite each other, and the two narrow scan antennas are disposed substantially opposite each other and substantially normal to the wide scan antennas. The first wide scan antenna, second wide scan antenna, and first narrow scan antenna produce a first beam pattern on a planetary surface and the first wide scan antenna, second wide scan antenna, and second narrow scan antenna produce a second beam pattern on the planetary surface.

[0006] D.M. Simpson: "The Snapdragon Family" discloses spacecraft configuration called "Snapdragon" being a repackaging of existing hardware on a new structure.

[0007] It is therefore an object of the present invention to provide a space borne antenna system which is structural and/or functional improved.

[0008] This object is solved by an antenna system according to the features of claim 1. Preferred embodiments are set out in the dependent claims.

[0009] The invention is based on the consideration that separation of the feed arrangement and the radiation element enables a more performing antenna system. The reason for the better performance is the fact that no cables between the platform and the tip of the boom have to be installed. In known antenna systems, for the exchange of control commandos or RF signals between the platform and an antenna being arranged on the tip of the boom, the signals have to be routed along the boom by cables or waveguides which is complex. RF signal quality suffers from losses due to cable or waveguide length. Furthermore, in contrast to the known antenna systems, no calibration effort and thermal control of the antennas remote from the platform is necessary.

[0010] In the antenna system according to the invention, the first radiating element may be adapted to receive electromagnetic waves from the first feed arrangement and to redirect them in a different direction. Hence this first antenna arrangement represents a transmit (Tx) antenna. Alternatively, the first radiating element may be adapted to receive electromagnetic waves and to redirect them in a different direction to the first feed arrangement. In this case the first antenna arrangement is adapted to be a receive (Rx) antenna. Furthermore, the first radiating element may be adapted to receive electromagnetic waves from the first feed arrangement and to redirect them in a different direction and to receive electromagnetic waves from the different direction and to redirect them to the first feed arrangement. Hence, this first antenna arrangement represents a receive and transmit (Rx/Tx) antenna.

[0011] The first radiating element can comprise a flat reflector, such as a reflecting plane, or a reflector or a reflect-array.

[0012] The radiating elements can be passive elements having a predetermined shape and reflecting properties according to a desired signal beam deflection.

[0013] The first feed arrangement comprises a first secondary antenna that can comprise at least one reflector antenna or reflect-array antenna or antenna elements.

[0014] The first secondary antenna system can comprise a feed system and one or more reflectors or one and more reflect-arrays. The feed system may comprise one or more antenna elements.

[0015] In other words, according to this invention the first feed arrangement is realized as focusing secondary antenna for the first radiating element. It may comprise of at least one or more reflector antennas or reflect-array antennas. Likewise, the first feed arrangement may comprise at least one reflector antenna system, comprising or consisting of at least one or more feed elements and a one or more reflectors. The first feed arrangement may alternatively comprise at least one reflect-array antenna system, comprising or consisting of one or more feed elements and one or more reflect-arrays. Hence, electromagnetic waves may be deflected by or within the feed arrangement. In such an antenna system, multiple

antenna elements in the feed system may be used for beam squint in any direction. Likewise, one or more first secondary antennas may be used for beam squint in any direction.

[0016] An example for the first secondary antenna with more than one reflector comprises a cassegrain like secondary (hyperbolic) reflector which is illuminated with at least one focusing (parabolic) ternary reflector which is illuminated by a feed system with one or more antenna elements.

[0017] The first boom is a deployable or extractable structure (e.g. a mast or telescopic arm) with arbitrary shape and configuration. The shape and the configuration of the boom may be arbitrary, since it is not essential for the current invention as long as there is a baseline, i. e. distance, between the first feed arrangement and a corresponding first radiating element.

[0018] A further antenna or antenna system (in other words: an antenna arrangement) is arranged on or close to the platform, wherein the antenna or antenna system is adapted for reception and/or transmission of electromagnetic waves. As a result, the antenna system according to the invention comprises more than one antenna arrangements. For example, the further antenna arranged on or close to the platform may be used as a receive antenna, while the first antenna arrangement which has a respective first radiating element mounted at the tip of the first boom is a transmit antenna. The antenna system according to the invention further comprises a second antenna arrangement with the same features as the first antenna arrangement. In case the first and the second antenna arrangements are operating as transmit antennas, the antenna system may be used as an interferometric SAR antenna system.

[0019] An advantage of the antenna system according to the invention is that the radiating elements can be realized passive, i.e. no RF signals need to be routed along the boom(s) being connected to the platform. The weight of the passive radiating element at the end of the boom is low. This approach avoids laying RF waveguides along the deployable boom, and minimizes calibration efforts and electrical losses in these waveguides.

[0020] A further advantage of the proposed antenna system is that the feed system and its assigned electronics are mounted in close vicinity of the platform or directly into the platform where they are under tight thermal control.

[0021] The principle advantage is that the proposed feed system allows architectures with very long boom (boom length $\gg$ diameter of reflecting element at tip of boom) as the first secondary antenna illuminates the first radiating element.

[0022] All described configurations might be used for transmit (Tx) antennas and/or receive (Rx) antennas.

[0023] The invention will be explained in more detail with reference to the accompanying figures.

Fig. 1 shows a first example of a known antenna

system in which a radiating element is carried out as a flat reflector, such as a reflecting plane, or a reflect-array.

Fig. 2 shows a second example of a known antenna system in which the radiating element is carried out as a curved reflector.

Fig. 3 shows a third example of an antenna system useful for understanding the invention, in which a feed arrangement is carried out as a secondary antenna acting as focusing element.

Fig. 4 shows a fourth example of an antenna system useful for understanding the invention, comprising two antenna arrangements being mounted at respective tips of two booms that are arranged on opposite sides of a platform of the antenna system.

Fig. 5 shows an embodiment of an antenna system according to the invention, comprising two antenna arrangements being mounted at the tips of two booms and an additional third antenna being arranged on or close to the platform.

[0024] Fig. 1 shows a first example of a known space borne antenna system. The antenna system comprises a platform 10, a boom 20, a feed system 30 and a passive radiating element 40a. The platform 10 may be, for example, a satellite or a spacecraft. The boom 20 can be, for example, a mast or a telescopic arm. The boom 20 comprises a first end 21 and a second end 22. While the first end 21 is attached to the platform 10, the second end 22 which constitutes a tip of the boom 20 bears the radiating element 40a. This means, the radiating element 40a is mounted at the tip of the boom.

[0025] In the example of Fig. 1, the radiating element 40a is a flat reflector, such as a reflecting plane, or a reflect-array which typically have a surface which is within one plane. The feed system 30 is arranged on or close to the platform 10. The feed system 30 may comprise one or more antenna elements. The combination of feed system 30 and radiating element 40a is called an antenna arrangement. An electronics or control unit of the feed system 30 which is not shown in the figures can be mounted in close vicinity of the platform 10 or directly into the platform 10.

[0026] The feed system 30 and the radiating element 40a are arranged such that the radiating element 40a can receive electromagnetic waves from the feed system 30 and redirect them in a different direction (beam direction 50). As a result, the antenna arrangement constitutes a transmit (Tx) antenna.

[0027] Furthermore, the antenna arrangement could be realized such that electromagnetic waves received by the radiating element 40a may be directed to the feed system to constitute a receive (Rx) antenna. Likewise, the antenna system may be adapted to both receive and

transmit electromagnetic waves, such that the antenna system constitutes a receive and transmit antenna.

[0028] Fig. 2 shows a second known example of a space borne antenna system which differs from the example of Fig. 1 only in that, that the passive radiating element is a reflector 40b which may have a concave surface. The reflector may be a parabolic reflector or of any other shape.

[0029] In the third example useful for understanding the invention and illustrated in Fig. 3 the feed arrangement is a secondary antenna 44 consisting of a reflector 43 and a feed system 30 directed to the reflector or reflect-array. The feed system 30 may comprise one or more antenna elements. The reflector 43 may be realized alternatively as reflect-array. In this antenna system, the reflector 40b (or alternatively flat reflector, e.g. reflecting plane or reflect-array) at the tip of the boom 20 constitutes a primary antenna and the antenna 44 a secondary antenna. For transmission, the primary antenna 42 on the tip of the boom receives electromagnetic waves from the secondary antenna 44 and forwards them in the direction of intention (beam direction 50). For reception, the primary antenna element 42 receives electromagnetic waves from the beam direction 50 and directs them in the direction of the secondary antenna 44.

[0030] Providing a feed arrangement on or close to the platform 10 and the first end 21 of the boom, respectively, and a radiating element at the second end 22 of the boom 20 ensures that no RF (radio frequency) signals need to be routed along the boom via cables or waveguides. This approach avoids laying RF waveguides along the fixed or deployable boom, and minimizes calibration efforts and electrical losses in these waveguides.

[0031] An antenna system according to a fourth example illustrated in Fig. 4 comprises two antenna arrangements. The first antenna arrangement comprises a first boom 20-1, a first passive radiating element 40b-1 (constituting a first primary antenna 42-1) at the tip of the first boom 20-1 and a first feed arrangement (i.e. first secondary antenna 44-1) close to or arranged in the platform 10. The second antenna arrangement comprises a second boom 20-2, a second passive radiating element 40b-2 (constituting a second primary antenna 42-2) at the tip of the second boom 20-2 and a second feed arrangement (i.e. a second secondary antenna 44-2) close to or arranged in the platform 10. The first and second booms 20-1 and 20-2 are arranged on opposite sides of the platform 10. A baseline (distance) between the two radiators 40b-1 and 40b-2 is depicted with 60. Both feed arrangements (first secondary antenna 44-1 and second secondary antenna 44-2) consist of a reflecting element 43-1 and 43-2 as well as a feed system 30-1 and 30-2.

[0032] In this antenna system, one of the antenna arrangements may be used as transmit (Tx) antenna while the other antenna arrangement may be used as receive (Rx) antenna. Alternatively, at least one of the antenna arrangements might be adapted to be a receive and transmit antenna.

[0033] The embodiment of an antenna system according to the invention (Fig. 5) is based on the fourth example illustrated in Fig. 4. In addition, a further antenna 70 is mounted on or in close vicinity to the platform 10. The antenna 70 comprises a reflector or reflect-array 72 and a feed system 71. While the further antenna 70 is adapted to receive electromagnetic waves (receive Rx antenna), the two other antenna arrangements are configured to transmit electromagnetic waves (transmit Tx antennas). Alternatively, receive and transmit direction might be interchanged between the antenna arrangements.

[0034] An antenna system as illustrated in Figs. 4 and 5 may be used as across track and/or along track interferometric SAR.

LIST OF REFERENCE SIGNS

[0035]

10	platform
20	boom
20-1	first boom
20-2	second boom
21	first end of boom
22	second end of boom
30	feed system
30-1	first feed system
30-2	second feed system
40	radiating element
40a	reflecting plane / reflect-array
40b	reflector
40b-1	first reflector
40b-2	second reflector
42	primary antenna
42-1	first primary antenna
42-2	second primary antenna
43	reflector / reflecting plane / reflect-array
43-1	first reflector / reflecting plane / reflect-array
43-2	second reflector / reflecting plane / reflect-array
44	secondary antenna
44-1	first secondary antenna
44-2	second secondary antenna
50	beam direction
60	geometric baseline
70	antenna or antenna system
71	feed system
72	reflector / reflect-array
Rx	receive beam direction
Tx	transmit beam direction

Claims

1. A space borne antenna system, comprising

- a platform (10) having a first boom (20-1) and a second boom (20-2), wherein the first boom (20-1) extends from a first side of the platform

(10) in a first direction and the second boom (20-2) extends from a second side of the platform (10) in a second direction, wherein the first and second sides are opposite sides of the platform (10) and the first direction is opposite to the second direction;

- a first antenna arrangement comprising following elements:

- a first feed arrangement (30-1) arranged on or close to the platform (10), wherein the first feed arrangement (30-1) comprises a first secondary antenna (43-1), and

- a first radiating element (40b-1) being mounted at a tip of the first boom, wherein the tip of the first boom is remote to the platform (10), wherein the first boom comprises a first end and a second end, wherein the first end of the first boom is attached to the platform (10) and the second end of the first boom is the tip of the first boom, wherein the first radiating element (40b-1) is adapted to receive electromagnetic waves from the first feed arrangement (30-1) and to redirect it in a different direction and/or vice versa, wherein said different direction is a main radiation direction of the first radiating element (40b-1);

- a second antenna arrangement comprising following elements:

- a second feed arrangement (30-2) arranged on or close to the platform (10), wherein the second feed arrangement (30-2) comprises a second secondary antenna (43-2), and

- a second radiating element (40b-2) being mounted at a tip of the second boom, wherein the tip of the second boom is remote to the platform (10), wherein the second boom comprises a first end and a second end, wherein the first end of the second boom is attached to the platform (10) and the second end of the second boom is the tip of the second boom, wherein the second radiating element (40b-2) is adapted to receive electromagnetic waves from the second feed arrangement (30-2) and to redirect it in a different direction and/or vice versa, wherein said different direction is a main radiation direction of the second radiating element (40b-2); and

- a further antenna (70) arranged on the platform (10) and adapted for reception and/or transmission of electromagnetic waves in a main radiation direction, wherein the first and second

booms (20-1, 20-2) are deployable or extractable structures, and wherein a boom length of the first boom (20-1) is longer than a diameter of the first radiating element (40b-1), and wherein a boom length of the second boom (20-2) is longer than a diameter of the second radiating element (40b-2),

wherein the main radiating directions of the first and second radiating elements correspond to the main radiating direction of the further antenna (70), wherein, in a first alternative, the further antenna (70) is adapted to receive electromagnetic waves, while the first and second antenna arrangements are adapted to transmit electromagnetic waves, or wherein, in a second alternative, the further antenna (70), the first and the second antenna arrangements are adapted such that the receive and transmit directions are interchanged with respect to the first alternative.

2. The antenna system according to claim 1, wherein each of the first and second radiating elements (40b-1, 40b-2) comprises a reflecting plane or a reflector or a reflect-array.
3. The antenna system according to claim 1 or 2, wherein each of the first and second secondary antennas (44-1, 44-2) comprises a reflector antenna or a reflect-array antenna or antenna elements.
4. The antenna system according to any one of the foregoing claims, wherein the first feed arrangement (30-1) is arranged on or close to the first side of the platform (10), and wherein the second feed arrangement (30-2) is arranged on or close to the second side of the platform (10).
5. The antenna system according to any one of the foregoing claims, wherein the further antenna (70) is arranged on a third side of the platform (10) different from the first and second sides of the platform (10).
6. The antenna system according to any one of the foregoing claims, wherein the space born antenna system is synthetic aperture radar.

Patentansprüche

1. Weltraumgestütztes Antennensystem, umfassend
 - eine Plattform (10) mit einem ersten Ausleger (20-1) und einem zweiten Ausleger (20-2), wobei der erste Ausleger (20-1) von einer ersten Seite der Plattform (10) in einer ersten Richtung verläuft und der zweite Ausleger (20-2) von einer zweiten Seite der Plattform (10) in einer zweiten

Richtung verläuft, wobei die erste und die zweite Seite gegenüberliegende Seiten der Plattform (10) sind und die erste Richtung der zweiten Richtung entgegengesetzt ist;

- eine erste Antennenanordnung, die die folgenden Elemente umfasst:

- eine erste Einspeisungsanordnung (30-1), die auf der Plattform (10) oder nahe an dieser angeordnet ist, wobei die erste Einspeisungsanordnung (30-1) eine erste sekundäre Antenne (43-1) umfasst und
- ein erstes Strahlungselement (40b-1), das an einer Spitze des ersten Auslegers montiert ist, wobei die Spitze des ersten Auslegers von der Plattform (10) entfernt ist, wobei der erste Ausleger ein erstes Ende und ein zweites Ende umfasst, wobei das erste Ende des ersten Auslegers an der Plattform (10) befestigt ist und das zweite Ende des ersten Auslegers die Spitze des ersten Auslegers ist, wobei das erste Strahlungselement (40b-1) ausgelegt ist, elektromagnetische Wellen von der ersten Einspeisungsanordnung (30-1) zu empfangen und sie in eine andere Richtung umzuleiten und/oder umgekehrt, wobei die andere Richtung eine Hauptstrahlungsrichtung des ersten Strahlungselements (40b-1) ist;

- eine zweite Antennenanordnung, die die folgenden Elemente umfasst:

- eine zweite Einspeisungsanordnung (30-2), die auf der Plattform (10) oder nahe an dieser angeordnet ist, wobei die zweite Einspeisungsanordnung (30-2) eine zweite sekundäre Antenne (43-2) umfasst und
- ein zweites Strahlungselement (40b-2), das an einer Spitze des zweiten Auslegers montiert ist, wobei die Spitze des zweiten Auslegers von der Plattform (10) entfernt ist, wobei der zweite Ausleger ein erstes Ende und ein zweites Ende umfasst, wobei das erste Ende des zweiten Auslegers an der Plattform (10) befestigt ist und das zweite Ende des zweiten Auslegers die Spitze des zweiten Auslegers ist, wobei das zweite Strahlungselement (40b-2) ausgelegt ist, elektromagnetische Wellen von der zweiten Einspeisungsanordnung (30-2) zu empfangen und sie in eine andere Richtung umzuleiten und/oder umgekehrt, wobei die andere Richtung eine Hauptstrahlungsrichtung des zweiten Strahlungselements (40b-2) ist; und

- eine weitere Antenne (70), die auf der Plattform

(10) angeordnet ist und zum Empfang und/oder zum Senden von elektromagnetischen Wellen in eine Hauptstrahlungsrichtung ausgelegt ist, wobei der erste und der zweite Ausleger (20-1, 20-2) entfaltbare oder ausziehbare Strukturen sind und wobei eine Auslegerlänge des ersten Auslegers (20-1) länger als ein Durchmesser des ersten Strahlungselements (40b-1) ist und wobei eine Auslegerlänge des zweiten Auslegers (20-2) länger als ein Durchmesser des zweiten Strahlungselements (40b-2) ist,

wobei die Hauptstrahlungsrichtungen des ersten und des zweiten Strahlungselements der Hauptstrahlungsrichtung der weiteren Antenne (70) entsprechen, wobei die weitere Antenne (70) in einer ersten Alternative ausgelegt ist, elektromagnetische Wellen zu empfangen, während die erste und die zweite Antennenanordnung ausgelegt sind, elektromagnetische Wellen zu senden, oder

wobei die weitere Antenne (70), die erste und die zweite Antennenanordnung in einer zweiten Alternative so ausgelegt sind, dass die Empfangs- und Senderichtungen in Bezug auf die erste Alternative vertauscht sind.

2. Antennensystem nach Anspruch 1, wobei jedes des ersten und des zweiten Strahlungselements (40b-1, 40b-2) eine Spiegelebene oder einen Reflektor oder eine Reflexionsanordnung umfasst.

3. Antennensystem nach Anspruch 1 oder 2, wobei jede der ersten und der zweiten sekundären Antennen (44-1, 44-2) eine Reflektorantenne oder eine Reflexionsanordnungsantenne oder Antennenelemente umfasst.

4. Antennensystem nach einem der vorangehenden Ansprüche, wobei die erste Einspeisungsanordnung (30-1) auf oder nahe der ersten Seite der Plattform (10) angeordnet ist und wobei die zweite Einspeisungsanordnung (30-2) auf oder nahe der zweiten Seite der Plattform (10) angeordnet ist.

5. Antennensystem nach einem der vorangehenden Ansprüche, wobei die weitere Antenne (70) auf einer dritten Seite der Plattform (10) angeordnet ist, die von der ersten und der zweiten Seite der Plattform (10) verschieden ist.

6. Antennensystem nach einem der vorangehenden Ansprüche, wobei das weltraumgestützte Antennensystem ein Radar mit synthetischer Apertur ist.

Revendications

1. Système d'antenne spatiale, comprenant

- une plate-forme (10) ayant un premier segment tubulaire (20-1) et un second segment tubulaire (20-2), le premier segment tubulaire (20-1) s'étendant depuis un premier côté de la plate-forme (10) dans une première direction et le second segment tubulaire (20-2) s'étendant depuis un deuxième côté de la plate-forme (10) dans une seconde direction, les premier et deuxième côtés étant des côtés opposés de la plate-forme (10) et la première direction étant opposée à la seconde direction ;
- un premier agencement d'antenne comprenant les éléments suivants :
 - un premier agencement d'alimentation (30-1) disposé sur ou près de la plate-forme (10), le premier agencement d'alimentation (30-1) comprenant une première antenne secondaire (43-1), et
 - un premier élément rayonnant (40b-1) qui est monté au niveau d'un bout du premier segment tubulaire, le bout du premier segment tubulaire étant éloigné de la plate-forme (10), le premier segment tubulaire comprenant une première extrémité et une seconde extrémité, la première extrémité du premier segment tubulaire étant fixée à la plate-forme (10) et la seconde extrémité du premier segment tubulaire étant le bout du premier segment tubulaire, le premier élément rayonnant (40b-1) étant conçu pour recevoir des ondes électromagnétiques en provenance du premier agencement d'alimentation (30-1) et pour rediriger celles-ci dans une direction différente et/ou inversement, ladite direction différente étant une direction de rayonnement principale du premier élément rayonnant (40b-1) ;
- un second agencement d'antenne comprenant les éléments suivants :
 - un second agencement d'alimentation (30-2) disposé sur ou près de la plate-forme (10), le second agencement d'alimentation (30-2) comprenant une seconde antenne secondaire (43-2), et
 - un second élément rayonnant (40b-2) monté au niveau d'un bout du second segment tubulaire, le bout du second segment tubulaire étant éloigné de la plate-forme (10), le second segment tubulaire comprenant une première extrémité et une seconde extrémité, la première extrémité du se-

cond segment tubulaire étant fixée à la plate-forme (10) et la seconde extrémité du second segment tubulaire étant le bout du second segment tubulaire, le second élément rayonnant (40b-2) étant conçu pour recevoir des ondes électromagnétiques en provenance du second agencement d'alimentation (30-2) et pour rediriger celles-ci dans une direction différente et/ou inversement, ladite direction différente étant une direction de rayonnement principale du second élément rayonnant (40b-2) ; et

- une antenne supplémentaire (70) disposée sur la plate-forme (10) et conçue pour la réception et/ou l'émission d'ondes électromagnétiques dans une direction de rayonnement principale, les premier et second segments tubulaires (20-1, 20-2) étant des structures pouvant être déployées ou extraites, et une longueur de segment tubulaire du premier segment tubulaire (20-1) étant plus longue qu'un diamètre du premier élément rayonnant (40b-1), et une longueur de segment tubulaire du second segment tubulaire (20-2) étant plus longue qu'un diamètre du second élément rayonnant (40b-2),

la direction de rayonnement principale des premier et second éléments rayonnants correspondant à la direction de rayonnement principale de l'antenne supplémentaire (70),

dans une première alternative, l'antenne supplémentaire (70) étant conçue pour recevoir des ondes électromagnétiques, tandis que les premier et second agencements d'antenne sont conçus pour émettre des ondes électromagnétiques, ou

dans une seconde alternative, l'antenne supplémentaire (70) et les premier et second agencements d'antenne étant conçus de telle sorte que les directions de réception et d'émission sont échangées par rapport à la première alternative.

2. Système d'antenne selon la revendication 1, dans lequel chacun des premier et second éléments rayonnants (40b-1, 40b-2) comprend un plan de réflexion ou un réflecteur ou un réseau de réflexion.
3. Système d'antenne selon la revendication 1 ou 2, dans lequel chacune des première et seconde antennes secondaires (44-1, 44-2) comprend une antenne à réflecteur ou une antenne à réseau de réflexion ou des éléments d'antenne.
4. Système d'antenne selon l'une quelconque des revendications précédentes, dans lequel le premier agencement d'alimentation (30-1) est disposé sur ou près du premier côté de la plate-forme (10), et le second agencement d'alimentation (30-2) est dispo-

sé sur ou près du deuxième côté de la plate-forme (10).

5. Système d'antenne selon l'une quelconque des revendications précédentes, dans lequel l'antenne supplémentaire (70) est disposée sur un troisième côté de la plate-forme (10) différent des premier et deuxième côtés de la plate-forme (10). 5
6. Système d'antenne selon l'une quelconque des revendications précédentes, dans lequel le système d'antenne spatiale est un radar à synthèse d'ouverture. 10

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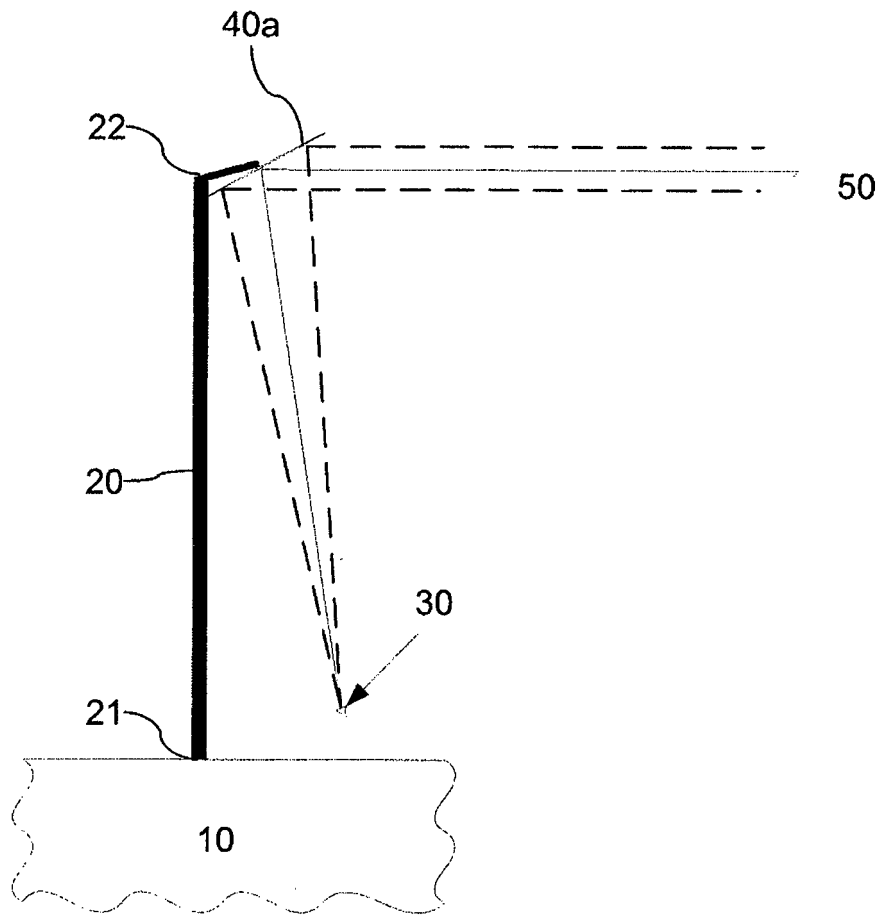


Fig. 1

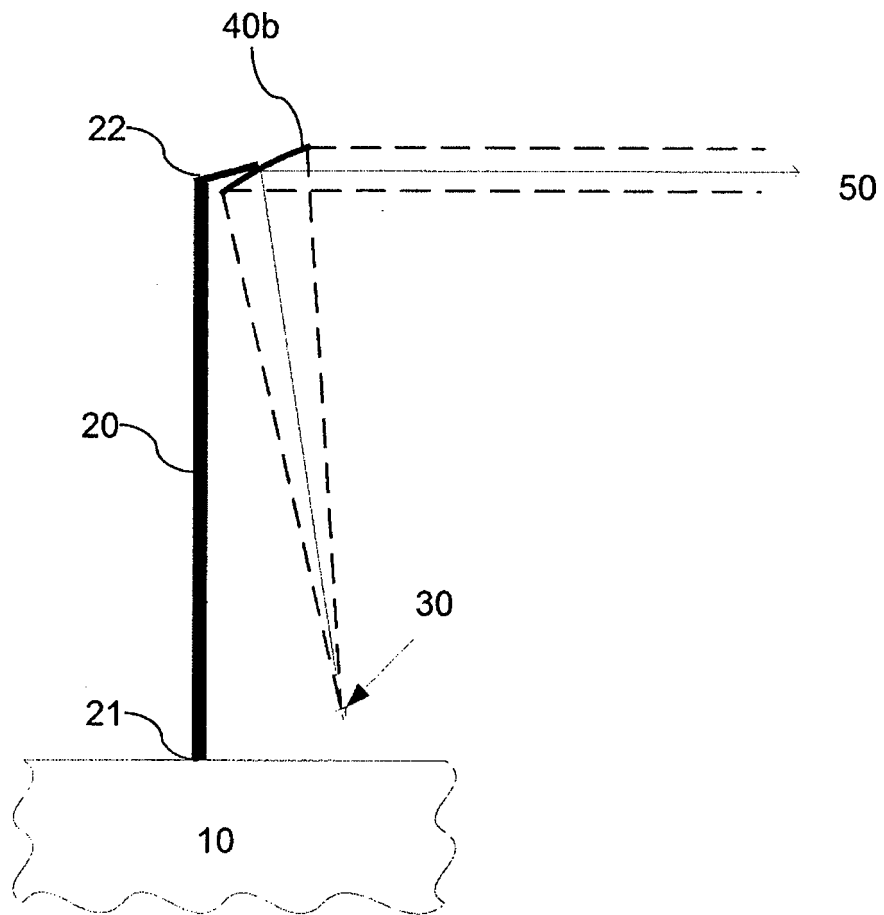


Fig. 2

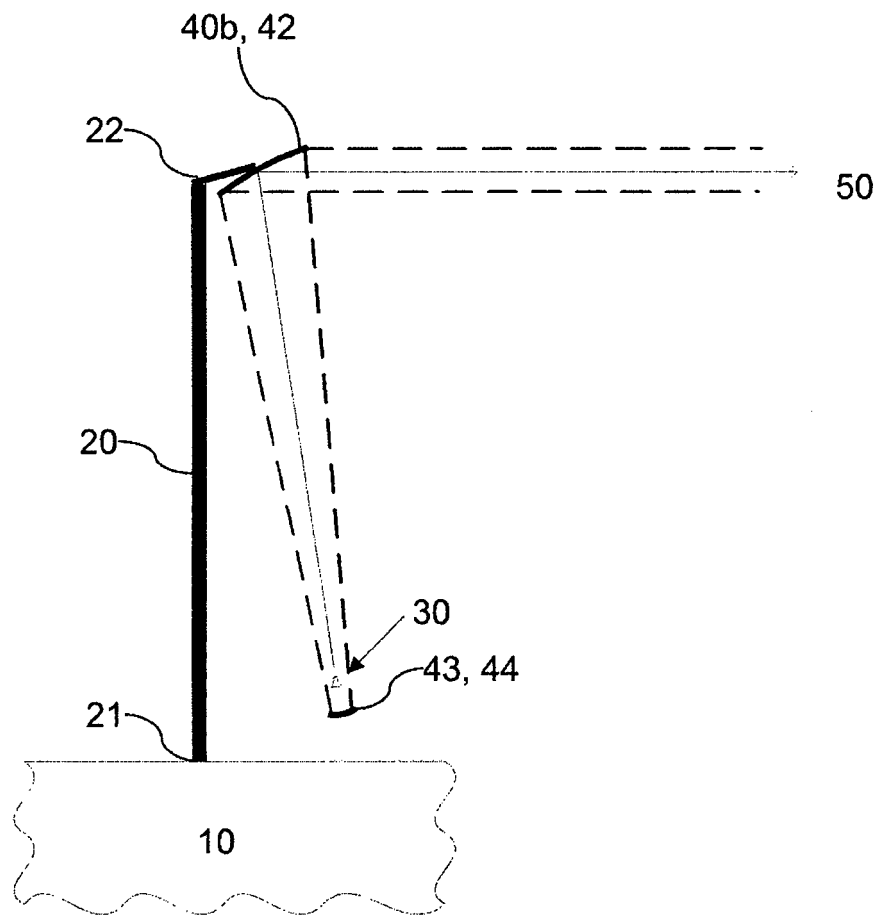


Fig. 3

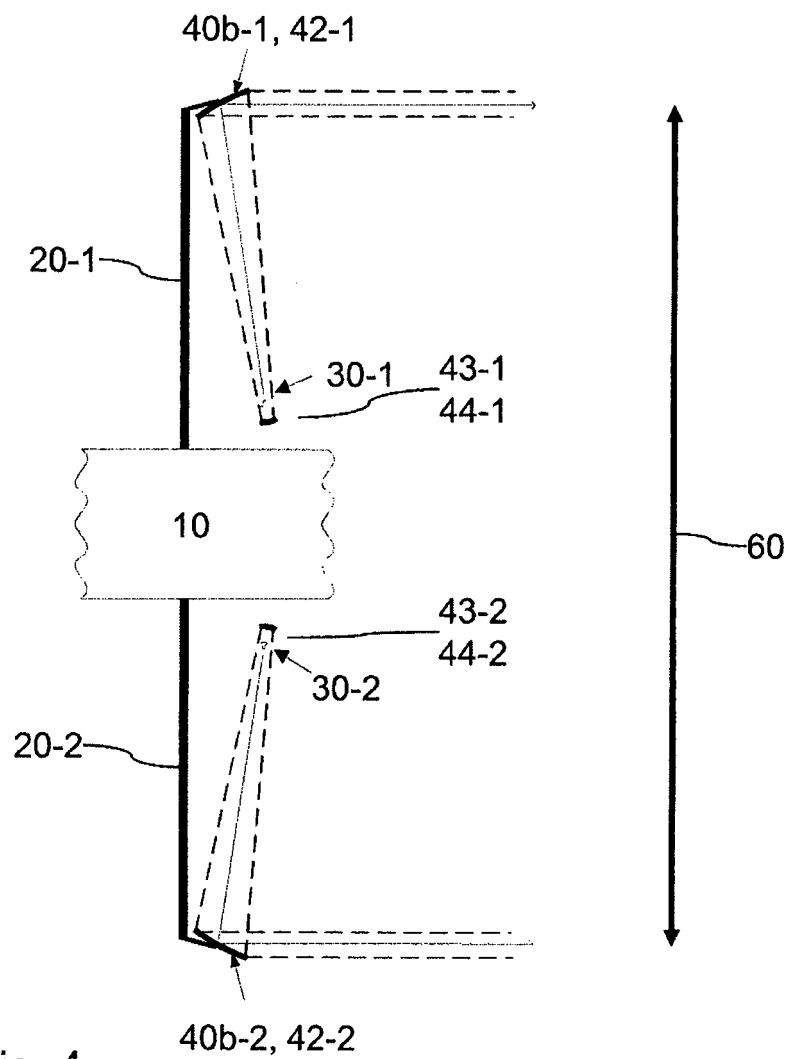


Fig. 4

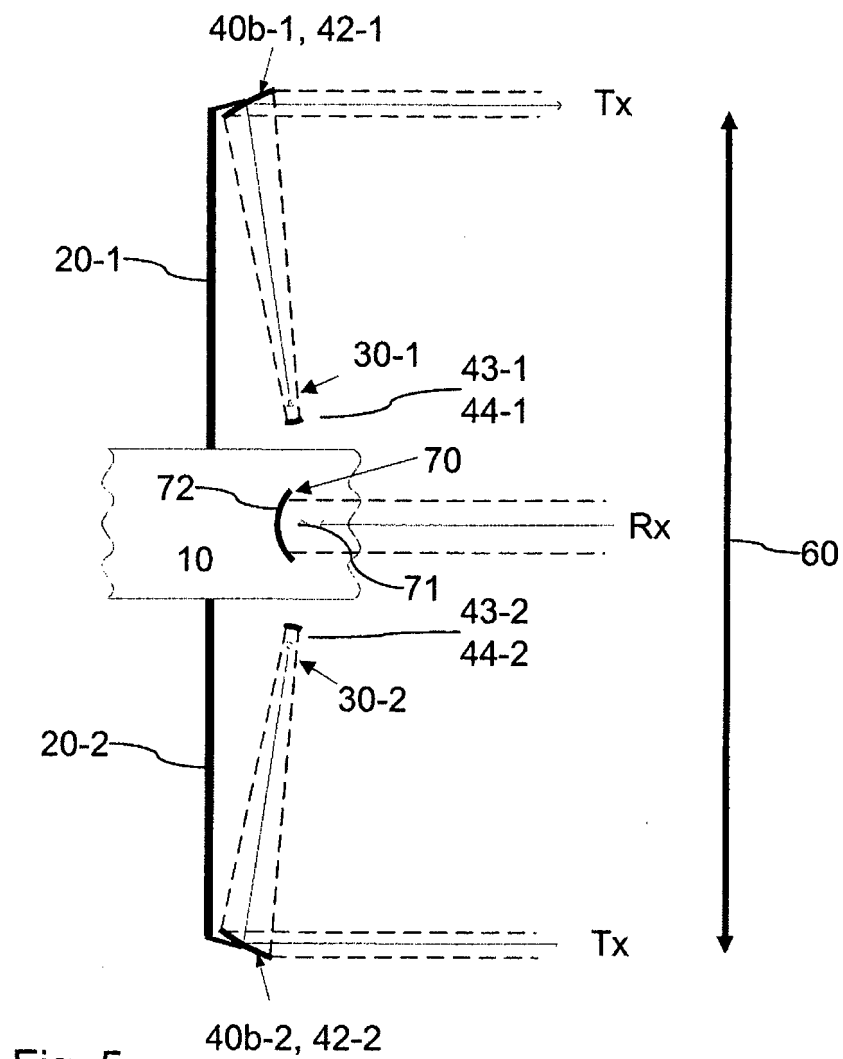


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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