(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 262 056 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
15.12.2010 Bulletin 2010/50

(21) Application number: **09305530.9**

(22) Date of filing: **10.06.2009**

(51) Int Cl.:
H01Q 1/34 *(2006.01)* ***H01Q 3/02*** *(2006.01)*
H01Q 3/04 *(2006.01)*

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR

(71) Applicant: **Constructions Mecaniques de Normandie**
75008 Paris (FR)

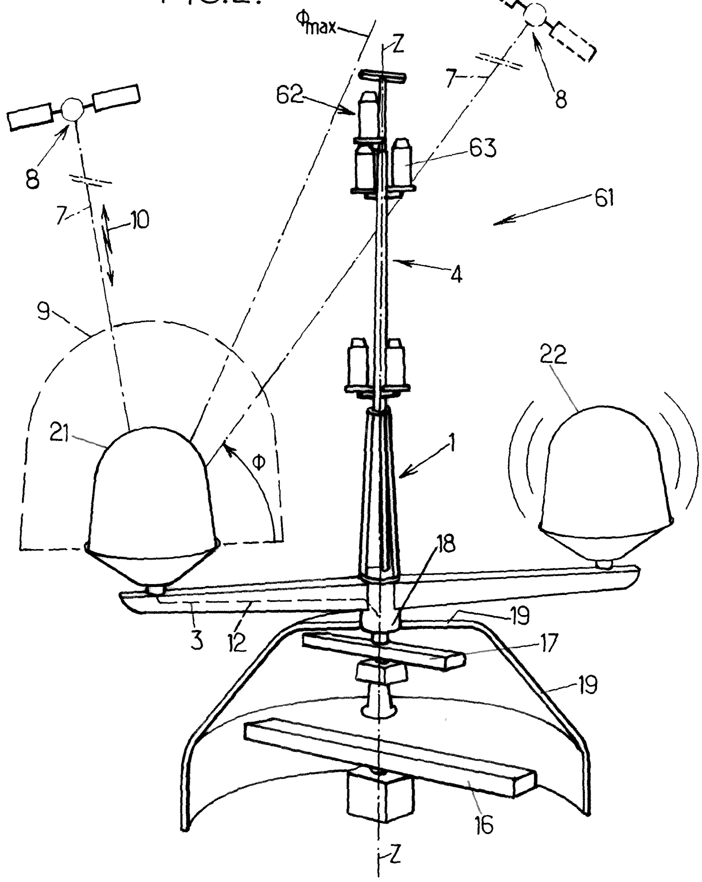
(72) Inventor: **Rochefort, Erwan**
50470, LA GLACERIE (FR)

(74) Representative: **Cabinet Plasseraud**
52, rue de la Victoire
75440 Paris Cedex 09 (FR)

(54) **Transducer assembly and vehicle comprising such assembly.**

(57) Transducer assembly, in particular for a ship mast, including: a base (19), one or several transducers (21,22,23,24) adapted for emitting and/or receiving electromagnetic waves to/from a distant unit, a barrier forming element (4) masking emissions and/or receptions of electromagnetic waves in a relative azimuth angle of masking, a mobile support (3;30) which bears the transducer (21,22,23,24) and which is movably mounted relative to the base along a generally circular path of movement around the mast, an actuating system for moving said mobile support (3;30) along said path of movement.

FIG.2.



Printed by Jouve, 75001 PARIS (FR)

Description

Field of the invention

[0001] The present invention relates to transducer assemblies and to vehicles (e.g. ships) comprising such assemblies.
[0002] More precisely, the present invention relates to a transducer assembly including:

- a base ;
- at least one transducer adapted for emitting and/or receiving electromagnetic waves;
- at least a barrier forming element which is borne by the base and which forms a barrier for emissions and/or receptions of electromagnetic waves by the transducer in at least one relative azimuth angle of masking, said relative azimuth angle of masking being defined relative to the base;
- at least one mobile support which bears the transducer and which is movably mounted relative to the base along a predetermined path of movement which is such that moving said mobile support along said path changes said relative azimuth angle of masking;
- an actuating system for moving said mobile support along said path of movement.

Background of the invention

[0003] From document JP59015308 is known an antenna supporting device, slidably mounted on a rail disposed between portside and starboard. This supporting device comprises an actuating system to translate the antenna along the rail. However, the solution described in this document is bulky and furthermore is not adapted to handle several antennas.

Object and Summary of the invention

[0004] The goal of the present invention is to improve transducer assemblies of the above-mentioned type, in particular for enhancing the performance and the availability of communication and/or detection systems transducer assemblies.
[0005] According to the invention, a transducer assembly of the type in question is **characterized in that** said path of movement is curved and has a concavity oriented toward said barrier forming element.
[0006] Thanks to this arrangement, the transducer assembly has a better compactness and the relative azimuth angle of masking can be efficiently changed by moving the mobile support substantially around the barrier forming element, thanks to the actuating system.
[0007] In various embodiments of the invention, one and/or the other of the following features may be incorporated:

- said barrier forming element is a portion of a mast belonging to a ship;
- said path of movement extends substantially all around the barrier forming element;
- said path of movement is circular;
- said mobile support is pivotally mounted relative to said base;
- the mast has an elongation axis, and said mobile support is pivotally mounted on said elongation axis;
- the mobile support is guided along a substantially circular rail;
- said transducer assembly comprises a plurality of individual mobile supports, each mobile support bearing a transducer and each mobile support being moved by an individual actuating system;
- said transducer assembly comprises a correction system whereby the transducer pointing direction is corrected by a correction system in response to an angular displacement of the mobile support;
- the correction system is a mechanical linkage between the mast base and the transducer direction ;
- the correction system comprises an angular encoder suitable for measuring the angular displacement of the mobile support ;
- the correction system comprises a differential GPS including a GPS receiver mounted on the mast axis and a GPS receiver mounted on the centre of the transducer.

[0008] The invention also concerns a vehicle comprising a transducer assembly according to the features described above.
[0009] The vehicle may be a ship, and the barrier forming element may be a ship mast belonging to said ship.
[0010] The above and other objects and advantages of the invention will become apparent from the detailed description of three embodiments of the invention, given by way of non limiting examples and considered in conjunction with the accompanying drawings.

Brief description of the drawings

[0011]

Figure 1 shows a ship on which is mounted a transducer assembly according to a first embodiment of the invention;
Figure 2 shows a cutout, perspective view of the transducer assembly belonging to the ship of Figure 1;
Figure 3a is a diagrammatic top view of the transducer assembly of Figure 2, showing an angle of masking;
Figure 3b is a view analogous to Figure 3a, in which a transducer has been moved relative to a barrier forming element;
Figure 4 is a view of a variant of the transducer assembly of Figure 2;
Figure 5 shows a diagrammatic top view of a transducer assembly according to a second embodiment of the invention;
Figure 6 shows a cutout, elevation view of the transducer assembly of Figure 5;
Figure 7 is a cutout, perspective view of the transducer assembly of Figure 5;
Figure 8 shows a cutout, elevation view of a transducer assembly according to a third embodiment of the invention, with several independently movable transducers;
Figure 9 shows a top view of the transducer assembly of Figure 8;
Figure 10 is a cutout, perspective view of the transducer assembly of Figure 8;
Figure 11 is a block diagram of a control system useable to control the transducer assembly according to the invention;
Figure 12 shows a functional block diagram of a control process useable to control the transducer assembly according to the invention.

More detailed description

[0012] In the various figures, the same references designate elements which are identical or similar.

[0013] Figure 1 shows a ship 60 on which is mounted a mast 61 including a mast structure 1 which supports various devices including communication transducers and/or detection transducers adapted to transmit and/or receive electromagnetic waves (including in particular optical and radio signals).

[0014] Each communication transducer may be part of a communication system, designed to support communications, in one or two directions, between the ship and a distant communication unit like a satellite, a radio-navigation beacon, another vessel, or any other communication unit known in the art.

[0015] Each detection transducer may be part of a detection system, like a radar, a lidar or other detection system known in the art. The transducer may also belong to a tracing system or a pointing system.

[0016] The mast 61 may also include other devices like marker lights, or any other device. In particular, some lighting devices may have to be supported by the highest part of the mast 61.

[0017] With reference to Figure 2, the mast structure 1 extends along a elongation axis Z, substantially vertical in the example, and comprises a top part 4 which supports for example a lighting assembly 62, including regulatory marker lights 63, and a base part 19, the top part 4 being rigid with the base part 19. In this particular example, the base part 19 also forms a radome for radars antennas 16,17 enclosed therein.

[0018] The mast 61 further comprises at least one communication or detection transducer 21 which is mounted on a mobile support 3. In the example of Figure 2, the mobile support 3 may have two transducers 21, 22 which are diametrically opposed relative to the mast 61. This transducer 21 may be used for example in a communication system involving a distant communication unit like **a** satellite 8. The transducers 21,22 send and/or receive electromagnetic waves 10 to/ from the satellite 8 along a straight line 7 called in the following a 'communication line' 7, the projection of which on the horizontal plane is known as communication azimuth direction.

[0019] Said mobile support 3 is pivotally mounted around axis Z on the mast structure 1, said mobile support 3 being for example integral with a hub 18 pivotally mounted around Z axis Z on the mast structure 1, and which can be moved by a motorized, automatic actuating system (not shown in Figure 2).

[0020] When the heading of the ship and the position of the satellite 8 is such that the mast 61 masks the satellite 8 from the transducer 21 (see position of the satellite 8 in dotted lines in Figure 2), the communication line 7 may be interrupted by part of the mast 61 (e. g. by the top part 4 of the mast 61). Said communication line 7 may also be masked by any other barrier forming element, like the other transducer 22, located within a useful communication area 9 of the transducer.

[0021] According to the invention, as explained above, the transducer 21 is mounted on the mobile support 3 which is able to be moved around the rotation axis Z which coincides with the elongation direction Z of the mast structure 1 in the given example. Thanks to this disposition, the communication line 7 can be displaced in such a manner that the masking object is no longer an obstacle to the communication line 7.

[0022] Any path of movement 6 to achieve an appropriate displacement of the transducer 21, with respect to the top part 4 of the mast 60 or another transducer 21, in particular any concave path of movement 6 with a concavity oriented toward the mast axis Z, is suitable, or even any path of movement 6 having at least a concave portion with a concavity oriented toward the mast axis Z may also be suitable.

[0023] The actuating system 5 (not shown in Figure 2) may comprise a motor, a reduction gear, and an output gear. The actuating system 5 may be rigid with the base structure 1 of the mast, or rigid with another stationary part relative to the mast 61, or even rigid with the mobile support 3. This actuating system 5 comprises a non reversibility feature as known in the art : forces exerted on the mobile support (in particular wind forces or inertia forces) are not able to entail a movement of said mobile support 3, and the movement is only possible when provoked by the actuation of the actuating system 5.

[0024] Other alternatives for the actuating system 5 are considered within the scope of the present invention: an hydraulic or pneumatic actuator may also be used.

[0025] A wiring harness 12 establish all necessary electrical links between the transducer 21 and related on-board control units (not shown). The actuating system 5 is also linked by a wiring harness to related on-board control units (not shown).

[0026] Turning now to Figures 3a and 3b, the ship heading is denoted by the line 'H', which is directed with reference to the North direction 'N' according to a heading angle 'α'. The mobile support 3 is extending perpendicularly from the axis Z in a support direction '**S**' with an angle of support 'β' which represents the angular position of the mobile support 3 relative to a reference position where β=0 (in the reference position, the mobile support direction 'S' is aligned with the ship heading).

[0027] In the example illustrated in Figure 3a, the current angular position of the mobile support is roughly β1=90 degrees.

[0028] On the mobile support 3 is mounted the transducer 21 which comprises a base rigid with the mobile support 3 and a pointing device 11 adapted to focus the electromagnetic waves in a preferred direction, called in the following the 'transducer direction' 'T'. In the example illustrated here, the pointing device is a rotating antenna 11, but other pointing devices known in the art, in particular electronic focused antennae, may be used.

[0029] As illustrated in Figure 3a, the transducer direction 'T' is referenced by an angle 'δ" with respect to the support direction 'S'. In case the transducer 21 sends or receives to/from a satellite 8, the transducer direction 'T' coincides with the communication line 7 explained above.

[0030] In the example of Figure 3a, the angle 'δ' is referenced with the support direction '**S**', but the origin of δ could be different, and in this case a corresponding offset shall be taken into account.

[0031] It will be understood that in the case the satellite 8 is positioned at the position 8', the transducer direction is denoted by the angle δ1, but the communication line 7' between the transducer 21 and the satellite 8 is interrupted by the top part 4 of the mast. The masking area in this configuration is represented by a mask area **'M'** extending across a range having an angular width denoted by an angle η. The masking area M defines a set of relative azimuth angles of masking as referred to in the preamble of claim 1.

[0032] The relative azimuth angle of masking, relative to the mast base part 19, is equal to: $\beta + \delta$.

[0033] In order to preclude the masking effect, and thanks to the actuating system 5, the mobile support 3 is rotated in the clockwise direction to a new position depicted in Figure **3b**. In this example, the ship heading is not changed, but the angle of support is now β2 which is less than 90 degrees. The transducer direction corresponding to the communication line 7 is now 'δ2' with respect to the mobile support 3 reference. Therefore the communication line 7 is now outside the masking area 'M'.

[0034] As a result, the communication between the transducer 21 and the satellite 8 can be achieved at any time and irrespective of the relative position of the satellite 8 and the heading H of the ship.

[0035] According to another aspect of the invention, the angular displacement β2-β1, performed on the mobile support to avoid the above mentioned masking effect, must be compensated for, regarding the transducer direction which T which should be offset in an opposite direction. The compensation can thus be expressed by the following formula:

$$\delta 2-\delta 1 = -\beta 2+\beta 1. \qquad [Eq1]$$

[0036] The range of movement of the mobile support 3 may be limited to less than 360 degrees and it is understood that not only one angular position can solve the masking area effect explained above.

[0037] The general process to avoid the masking area may be performed as follows, knowing that the goal is to have the transducer direction outside the masking area 'M', with a safety margin expressed by an angle 'εm', (εm is for example 5 degrees):

$$-180° + \eta/2 + \varepsilon m < \delta < 180° - \eta/2 - \varepsilon m. \qquad [Eq2]$$

[0038] If $\delta 1$ is not comprised in this range, i.e. not comprised between -180° + $\eta/2$ + εm and 180° -$\eta/2$-εm, and if $\delta 1 > 0$ then it is decided to move the mobile support in the counter-clockwise direction (increase β), whereas if $\delta 1 < 0$ then it is decided to move the mobile support in the clockwise direction (decrease β).

[0039] As a the result, the transducer direction 'T' is maintained outside the masking area 'M', in the following range :

$$-180° + \eta/2 + \varepsilon m < \delta < 180° - \eta/2 - \varepsilon m. \quad [Eq2]$$

[0040] In the case the angular range of the mobile support 3 is limited, for example from angles βmin to βmax, an additional parameter is taken in the decision making process.

[0041] If the solution expressed in the process above tends to change β toward one of the limit (βmin or βmax), then an additional change to move from one extremum to the other one is decided, and of course a correction of compensation on δ is made accordingly.

[0042] It should be noted that a masking effect can also be due to the second transducer 22, located symmetrically to the transducer 21 with respect to the mast axis, as shown in particular in Figure 3b. In this case, the correction process explained before fully applies.

[0043] The angle θ denotes the angular bearing of the transducer direction 'T' relative to the north 'N'. As illustrated in Figure 3a, this angular bearing θ is expressed by :

$$\theta = \alpha + \beta + \delta \quad [Eq3]$$

[0044] In case the distant unit 8 is a satellite 8, provided that its position is known, and that the ship position is known (from GPS or inertia system), the theoretical bearing of the satellite relative to the ship can be computed and results in a value $\theta 1$. From the relative bearing $\theta 1$, it can be deducted the transducer pointing angle $\delta 1$ according to the following formula :

$$\delta 1 = \theta 1 - \alpha - \beta \quad [Eq4]$$

[0045] Of course, the masking effect explained above may not exist in all the range of elevation angle ϕ, but only for a range comprised between 0° and ϕmax as illustrated in Figure 2.

[0046] Referring now to Figure 4, it is shown a variant of the first embodiment where three transducers 21,22,23 are arranged on a mobile support 3 having three spaced arms, equally distributed at 120 degrees around the circumference and pivotally mounted on the mast structure 1.

[0047] The constraints and solutions are similar, mutatis mutandis, to the solutions explained in the second embodiment described in detailed just above.

[0048] Figures 5 to 7 illustrate a second embodiment of the invention. In this second embodiment, the mobile support is bearing four transducers 21,22,23,24 each of them is involved in a communication or detection system.

[0049] In this configuration, the masking effect is not only due to the top part of the mast 4, but also to the neighbouring transducer(s). The masking angle is then larger than in the first embodiment illustrated above. Further, for a transducer 22,23 which is located in an intermediate position, there is not only one masking area but two masking areas (denoted by $\eta 22a$ and $\eta 22b$ for transducer 22, and $\eta 23a$ and $\eta 23b$ for transducer 23.

[0050] In order to ensure a good communication between each transducer 21,22,23,24 and its respective distant unit 8, a process similar to the process explained before is performed to find a solution to the degree of freedom which is the position β of the mobile support, but in this second embodiment, there are more than one constraint to find a suitable solution for β.

[0051] The solution should comply with the following constraints:

$$-180 + (\eta 21)/2 + \varepsilon m < \delta 21 < 180 - (\eta 21)/2 - \varepsilon m;$$

$$-180 + (\eta 22a)/2 + \varepsilon m < \delta 22 < -\eta 22b/2 - \varepsilon m \text{ and } + \eta 22b/2 + \varepsilon m < \delta 22 < 180 - (\eta 22a)/2 - \varepsilon m;$$

$$-180 + (\eta 23a)/2 + \varepsilon m < \delta 23 < -\eta 23b/2 - \varepsilon m \text{ and } + \eta 23b/2 + \varepsilon m < \delta 23 < 180 - (\eta 23a)/2 - \varepsilon m;$$

$$-180 + \eta/2 + \varepsilon m < \delta 24 < 180 - \eta/2 - \varepsilon m$$

[0052] This process can be an iterative process or an analytic calculation derived from the calculation illustrated in the first embodiment above.

[0053] In this second embodiment, the mast base 19 includes radome sections 19a, 19b which respectively enclose the radar antennas 16, 17.

[0054] It should be noted that different types of distant communications units 8 are considered within the scope of the invention, including stationary radio beacon 80, like ground or maritime radio beacon, as illustrated in Figure 5.

[0055] Figures 8 to 10 illustrate a third embodiment of the invention. In this third embodiment, each transducer is borne by an individual mobile support 30. Each individual mobile support 30 is moved by an individual actuating system 50. Each individual mobile support is movable along a circular rail 6 arranged in a horizontal plane, and having as axis the mast axis Z.

[0056] Other different shapes of rail may be considered within the scope of the invention, which result in the mobile being movable in general along a path of movement 6 substantially around the mast axis.

[0057] In this configuration, the masking effect is not only due to the top part of the mast, but mainly to other transducers. The masking areas are then larger than in the first embodiment illustrated above.

[0058] Each individual mobile support 3 transducer 21,22,23 has its own β orientation, in such a manner that β21 denotes the angular position of the first transducer 21, β22 denotes the angular position of the second transducer 22, β23 denotes the angular position of the third transducer 23.

[0059] β21, β22, β23 should be spaced enough in order to diminish the masking effect produced by a neighbouring transducer 21,22,23. This constraint can be expressed by the following set of equations, where λ is the minimum angular gap between two subsequent transducers 21,22,23.

$$\beta 23 + \lambda < \beta 21 < \beta 22 - \lambda$$

$$\beta 21 + \lambda < \beta 22 < \beta 23 - \lambda$$

$$\beta 22 + \lambda < \beta 23 < \beta 21 - \lambda$$

[0060] For each transducer, there may be more than one angle of masking: the number of different masking areas may be up to the number of transducer plus the top part of the mast 4.

[0061] Hence for each transducer 21, 22, 23 the masking constraint is a set of masking constraint similar to those explained above in the second embodiment. Again like in the second embodiment, this process can be an iterative process or an analytic calculation derived from the calculation illustrated in the first and second embodiments above.

[0062] The transducer assembly according to the invention may also comprise a correction system intended to automatically correct the transducer pointing direction, according to the angular displacement β of the mobile support 3, which can be applied, mutatis mutandis, to the second and third embodiments.

[0063] The correction system may comprise a mechanical link between the mast base and the transducer direction T, two example of such mechanical link are given hereafter. This mechanical link may comprise a deformable parallelogram linkage with one part rigid with the mast structure 1 and the opposite part rigid with the transducer antenna.

[0064] Another preferred mechanical link may comprise a belt and pulley system: a first pulley is rigid with the mast structure 1 and a second pulley, with the same diameter as the first pulley, is pivotally mounted on the mobile support 3, and rigid in rotation with the transducer antenna.

[0065] As a result, the transducer antenna angular reference remains constant relative to the mast structure 1, whatever may be the angular position β of the mobile support 3.

[0066] In another solution, the correction system may comprise an angular encoder suitable for measuring the angular displacement deltaβ=β2-β1 of the mobile support 3. This measurement is then used in the already disclosed formula to correct the transducer pointing direction, which should be corrected in the opposite direction with the same absolute amount:

$$\delta 2-\delta 1 = -\beta 2+\beta 1. \qquad [Eq1]$$

[0067] Further, in another solution, the correction system may comprise a differential GPS including a GPS receiver mounted on the mast axis and a GPS receiver mounted on the centre of the transducer 21. The calculation of the difference of the two acquired positions gives the relative position of the centre of the transducer 21 with respect to the mast base 1, which gives in turn the angular displacement deltaβ=-β2-β1. The rest of the process is similar to the preceding example.

[0068] According to the invention, the transducer assembly is controlled by control means that will be explained below, together with the reference to Figures 11 and 12.

[0069] Figure 11 shows the structure of the control system adapted to control the transducer assembly. The system comprises a control unit 80, at least one angular position sensor 84 able to measure the angular displacement or position of the mobile support 3, at least one angular position sensor 85 able to measure the angular position δ of the transducer direction 'T', the respective angular information being inputted into the control unit 80. Further the control unit 80 receives information from other units (not shown) in particular the ship heading 81, the ship position 82, the position of the distant communication unit 83. The control unit also comprises outputs adapted to control the mobile support actuating system 5, in the example of first and second embodiment, and one or several transducer actuation means 29 which is/are able to direct individually each transducer direction 'T'. In the case of the third embodiment, a plurality of actuating system 50, i.e. one per transducer 21, 22, 23 are controlled by the control unit 80.

[0070] The control unit 80 may be realized not only in one single unit but in various distinct control units linked together by data links.

[0071] Turning now to Figure 12, which depicts a functional diagram, a first functional block 100 computes permanently the ship heading: this first functional block is usually included in the standard instruments equipping the ship. The output of this functional block 100 is the heading angle α.

[0072] A second functional block 210 computes the ship geographical position, either using GPS receiver or using conventional inertial platform as known in the art, this second functional block 210 is usually also included in the standard instruments equipping the ship.

[0073] A third functional block 220 computes the position of the distant unit 8 to be pointed to by the transducer 21. This position is given by a local database or received by conventional radio navigation means.

[0074] A fourth functional block 200 computes, from the two outputs of the preceding blocks 210,220 the bearing angle θ of the distant unit 8 with respect to the position of the ship.

[0075] The output of this functional block 220 is the bearing angle θ1.

[0076] A fifth functional block 300 acquires or measures the angular position of the mobile support 3, for example from the encoder or the differential method explained above.

[0077] The output of this functional block 220 is the mobile support angular position β.

[0078] A sixth functional block 400 computes, from the three angle values outputted respectively by functional block 100, 200, 300, the target value to be applied to the transducer pointing direction 'δ1target' according to equation Eq4 explained above.

[0079] A further step is performed in a seventh functional block 500 : the condition of Eq2 is evaluated, and if necessary in case of δ1target being located within or close to the masking area 'M' (angle η) according to Eq2, a decision to move the mobile support 3 is taken and a new mobile support angular position is defined. This change of β angle can be an increase by a predetermined value or a decrease by a predetermined value, as explained above.

[0080] The output of this functional block 500 is a new angular position βtarget.

[0081] A further step in this seventh functional block 500 controls the actuating system 5 to reach this position βtarget.

[0082] A eighth functional block 600 computes the angular correction to be applied to the transducer pointing direction 'δ2', from the difference measured on the mobile support angular positions deltaβ=β2-β1, using Eq1.

[0083] Another alternative is to use a direct setpoint 'δtarget' which can be computed directly by the sixth functional block 400.

[0084] The setpoint is applied to the actuation means 29 which are adapted to direct accurately the transducer pointing device 11 in direction of 'δtarget'.

[0085] It should be noted that the mast arrangement described in the preceding description may be mounted on any type of vehicle, for example trucks, military vehicles, or any type vehicle type.

[0086] The mast arrangement described in the preceding description may also be mounted on a stationary platform, in particular to improve the reliability and availability of communication system with non stationary distant units and the reliability and availability of tracking or pointing systems.

Claims

1. Transducer assembly including:

   - a base (19);
   - at least one transducer (21,22,23,24) adapted for emitting and / or receiving electromagnetic waves;
   - at least a barrier forming element (4) which is borne by the base (19) and which forms a barrier for emissions and / or receptions of electromagnetic waves by the transducer (21,22,23,24) in a least one relative azimuth angle of masking, said relative azimuth angle of masking being defined relative to the base;
   - at least one mobile support (3;30) which bears the transducer (21,22,23,24) and which is movably mounted relative to the base along a predetermined path of movement (6) which is such that moving said mobile support (3;30) along said path changes said relative azimuth angle of masking;
   - an actuating system (5;50) for moving said mobile support (3;30) along said path of movement (6);

   characterized in that at least a portion of said path of movement (6) is curved and has a concavity oriented toward said barrier forming element (4).

2. Transducer assembly according to claim 1, wherein said barrier forming element (4) is a portion of a mast belonging to a ship.

3. Transducer assembly according to anyone of the claims 1 or 2, wherein said path of movement extends substantially all around the barrier forming element (4).

4. Transducer assembly according to anyone of the claims 1 to 3, wherein said path of movement (6) is circular.

5. Transducer assembly according to anyone of the claims 1 to 4, wherein said mobile support (3;30) is pivotally mounted relative to said base (19).

6. Transducer assembly according to anyone of the claims 2 to 5, wherein the mast has an elongation axis (Z), and wherein said mobile support (3;30) is pivotally mounted on said elongation axis (Z).

7. Transducer assembly according to anyone of the claims 1 to 5, wherein the mobile support (3;30) is guided along a substantially circular rail (6).

8. Transducer assembly according to claim 7, wherein said transducer assembly comprises a plurality of individual mobile supports (3;30), each mobile support bearing a transducer (21,22,23,24) and each mobile support being moved by an individual actuating system (5;50).

9. Transducer assembly according to anyone of the claims 1-8, further comprising a correction system whereby the transducer pointing direction (δ) is corrected by a correction system in response to an angular displacement (β2-β1) of the mobile support (3;30).

10. Transducer assembly according to claim 9, wherein the correction system is a mechanical linkage linking the mast base (19) and the transducer direction (δ).

11. Transducer assembly according to claim 9, wherein the correction system comprises an angular encoder suitable for measuring the angular displacement (β) of the mobile support (3;30).

12. Transducer assembly according to claim 9, wherein the correction system comprises a differential GPS including

a GPS receiver mounted on the mast axis and a GPS receiver mounted on the centre of the transducer.

13. Vehicle comprising a transducer assembly according to anyone of the preceding claims.

14. Vehicle according to claim 13, constituting a ship.

15. Vehicle according to claim 14, comprising a ship mast (61) comprising a transducer assembly according to anyone of the claims 1 to 12.

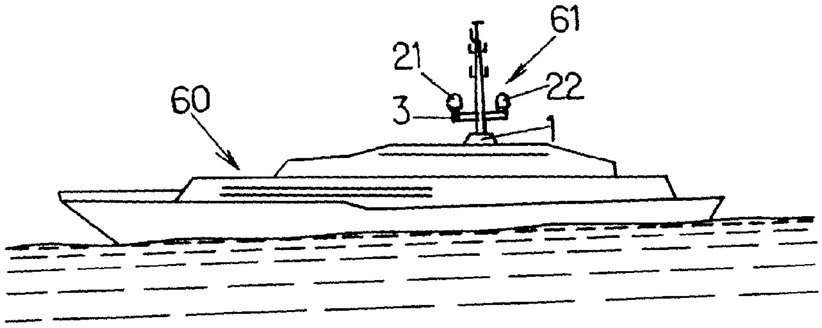

61
21
22
60
3
1

FIG.1.

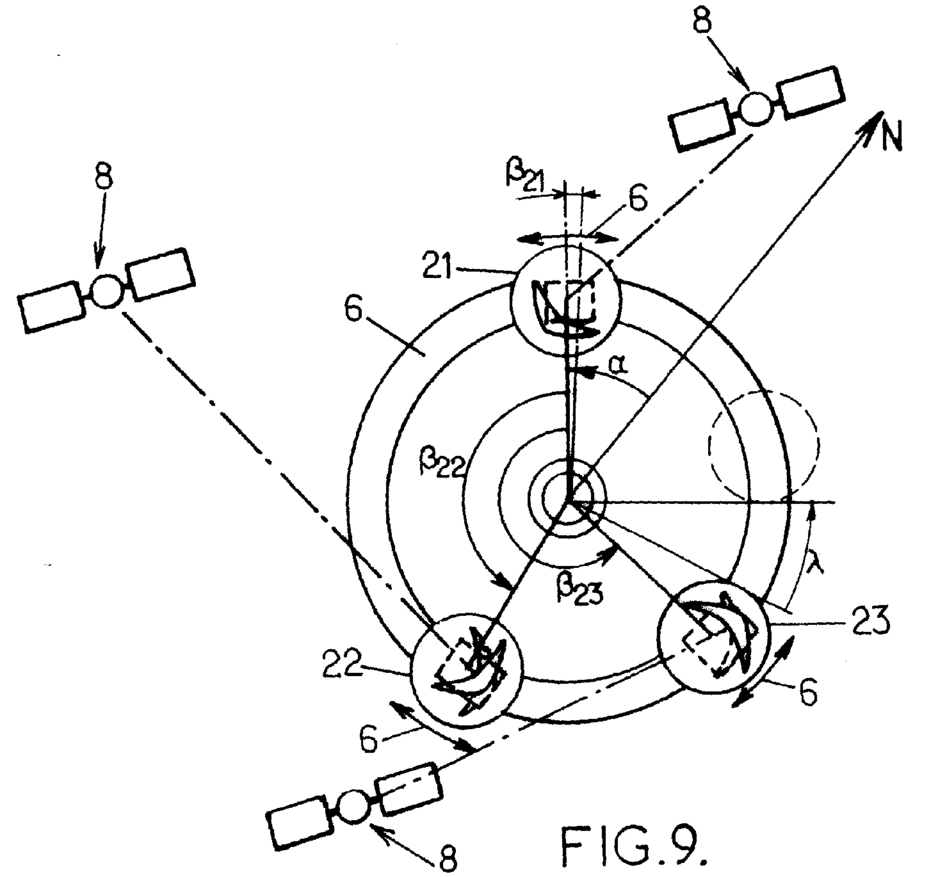
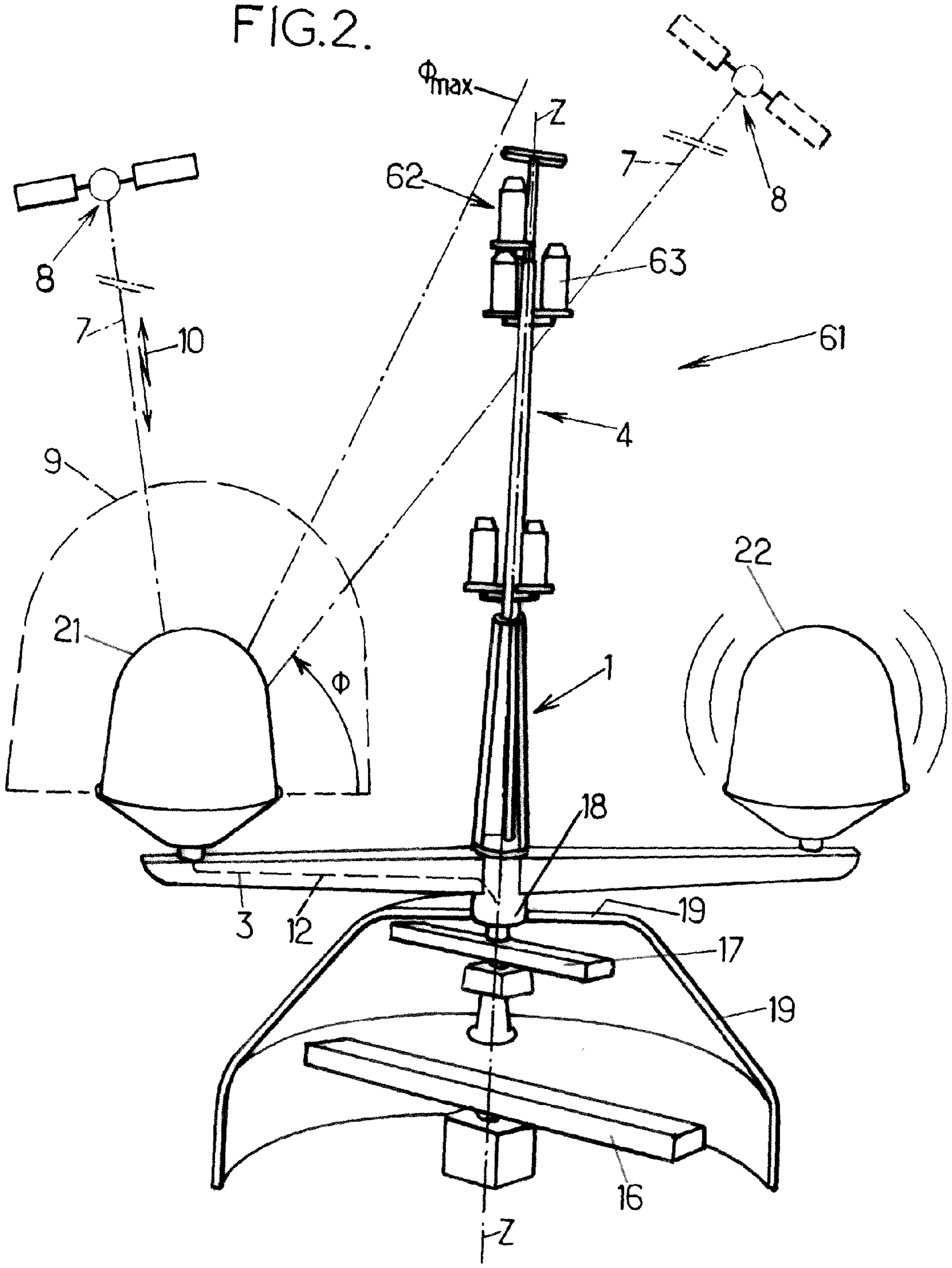

8
8
N
β_{21}
6
21
6
α
β_{22}
λ
β_{23}
23
22
6
6
8

FIG.9.

FIG.2.



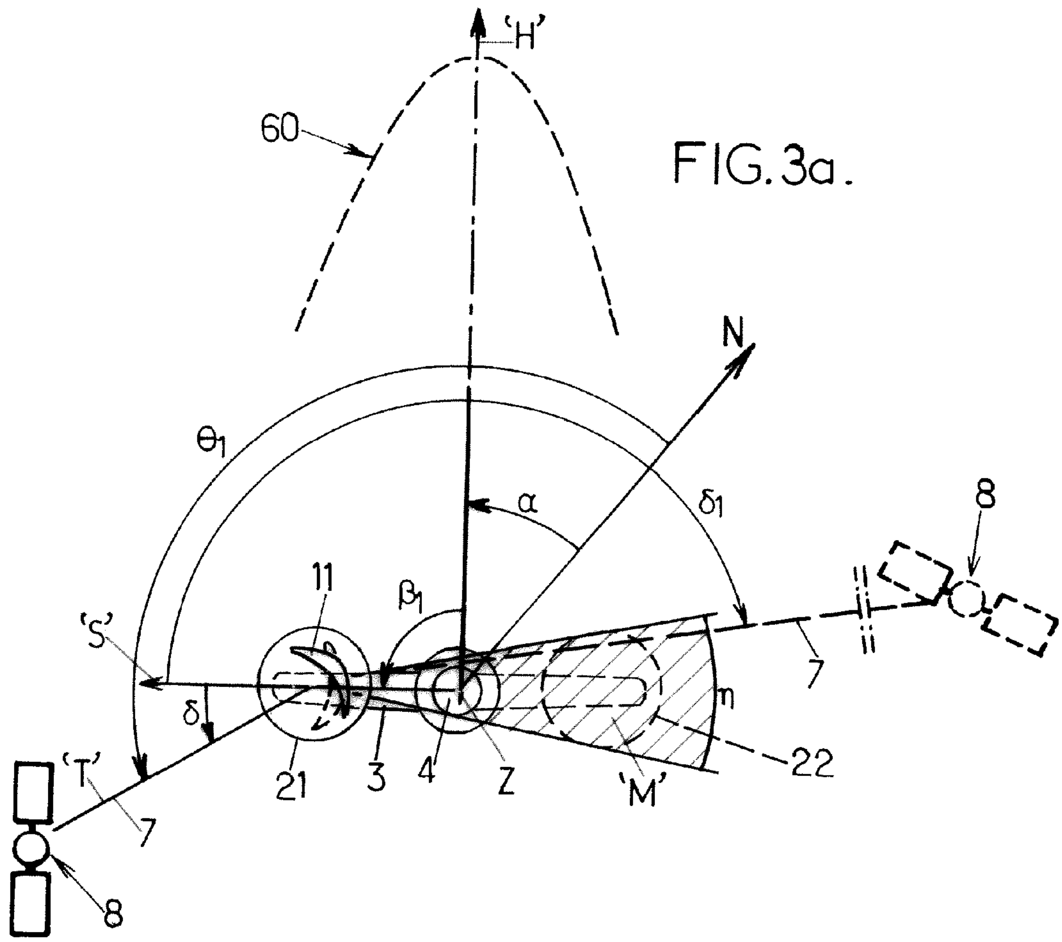

'H'
60
N
θ1
α
δ1
8
11
β1
'S'
δ
'T'
7
21
3
4
Z
'M'
22
η
8

FIG.3a.

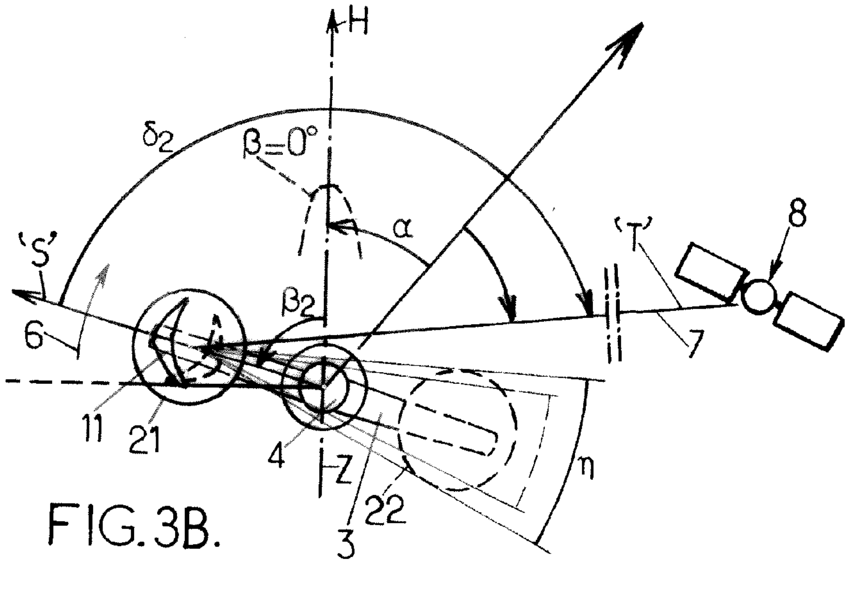

H
δ2
β=0°
α
'S'
'T'
8
β2
6
7
11
21
4
Z
22
3
η

FIG.3B.

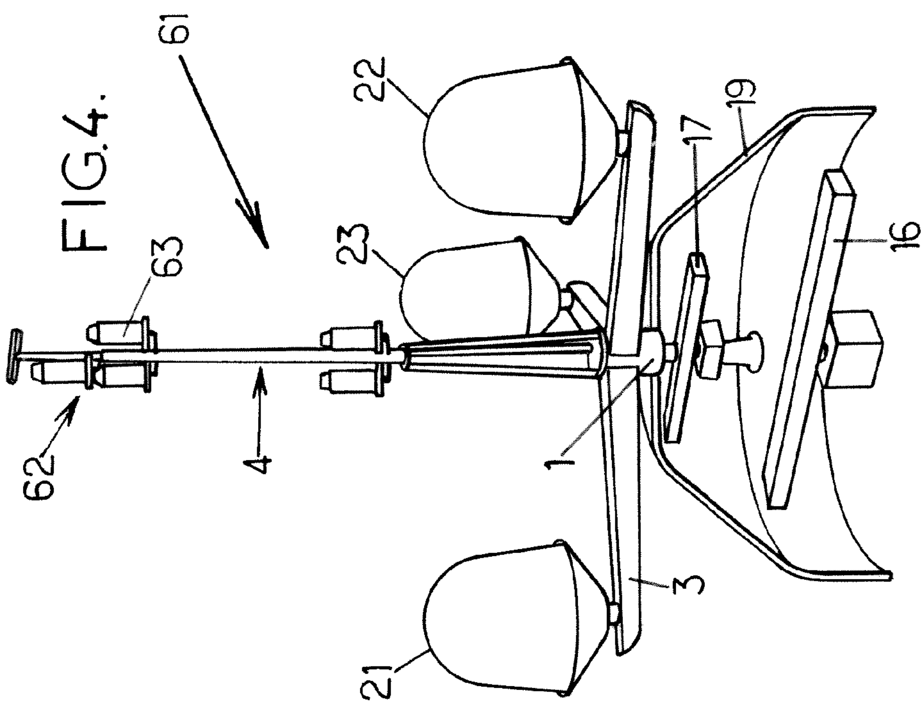


FIG.4.

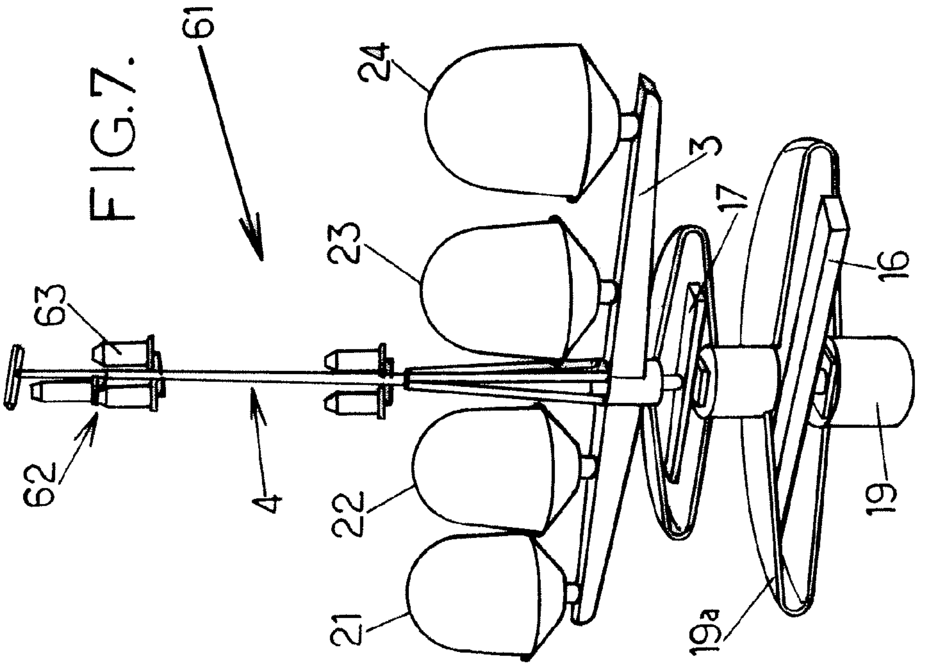
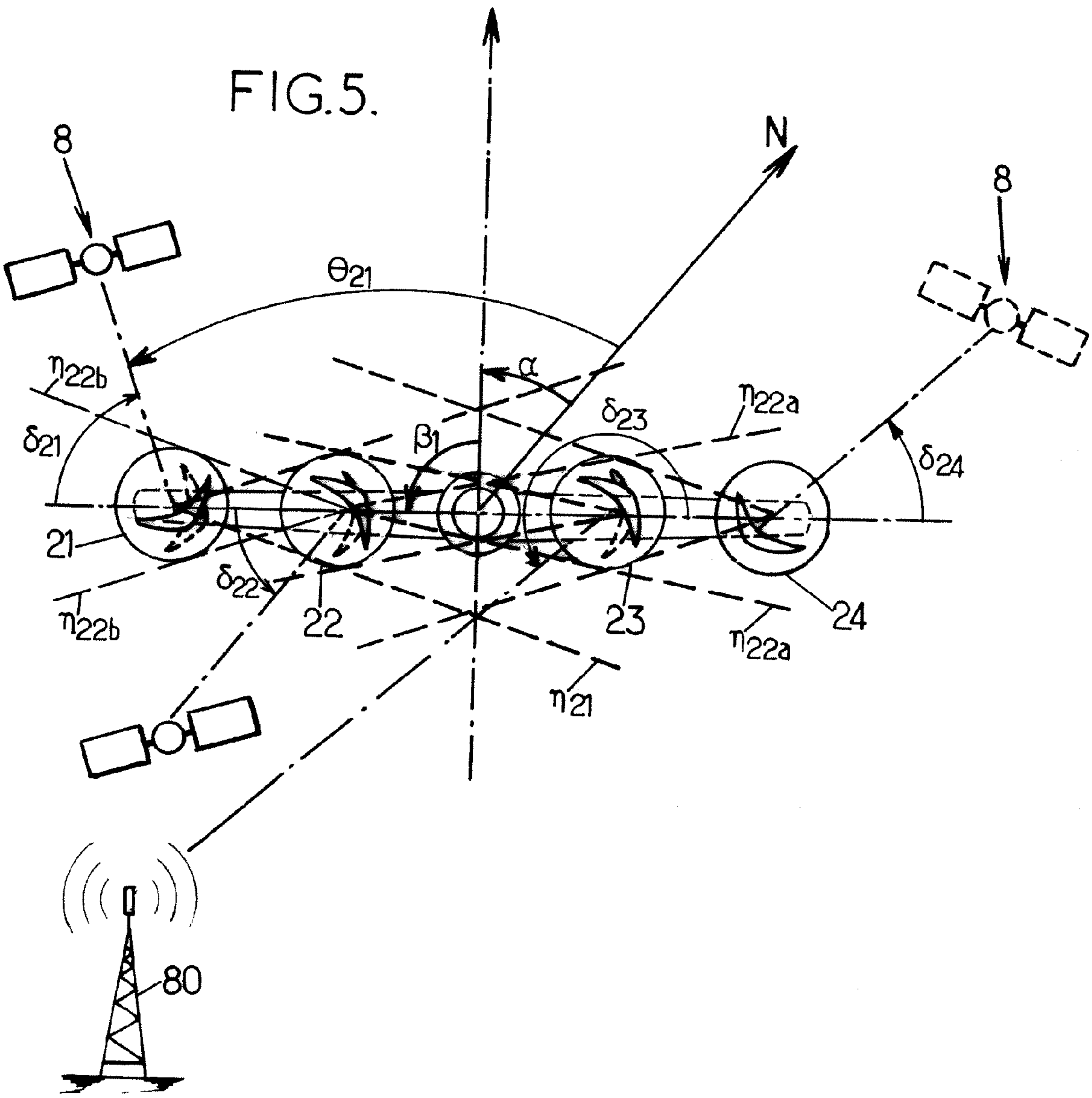


FIG.7.

FIG.5.



8
N
8
Θ21
α
η22b
η22a
δ21
β1
δ23
δ24
21
22
23
24
δ22
η22b
η22a
η21
80

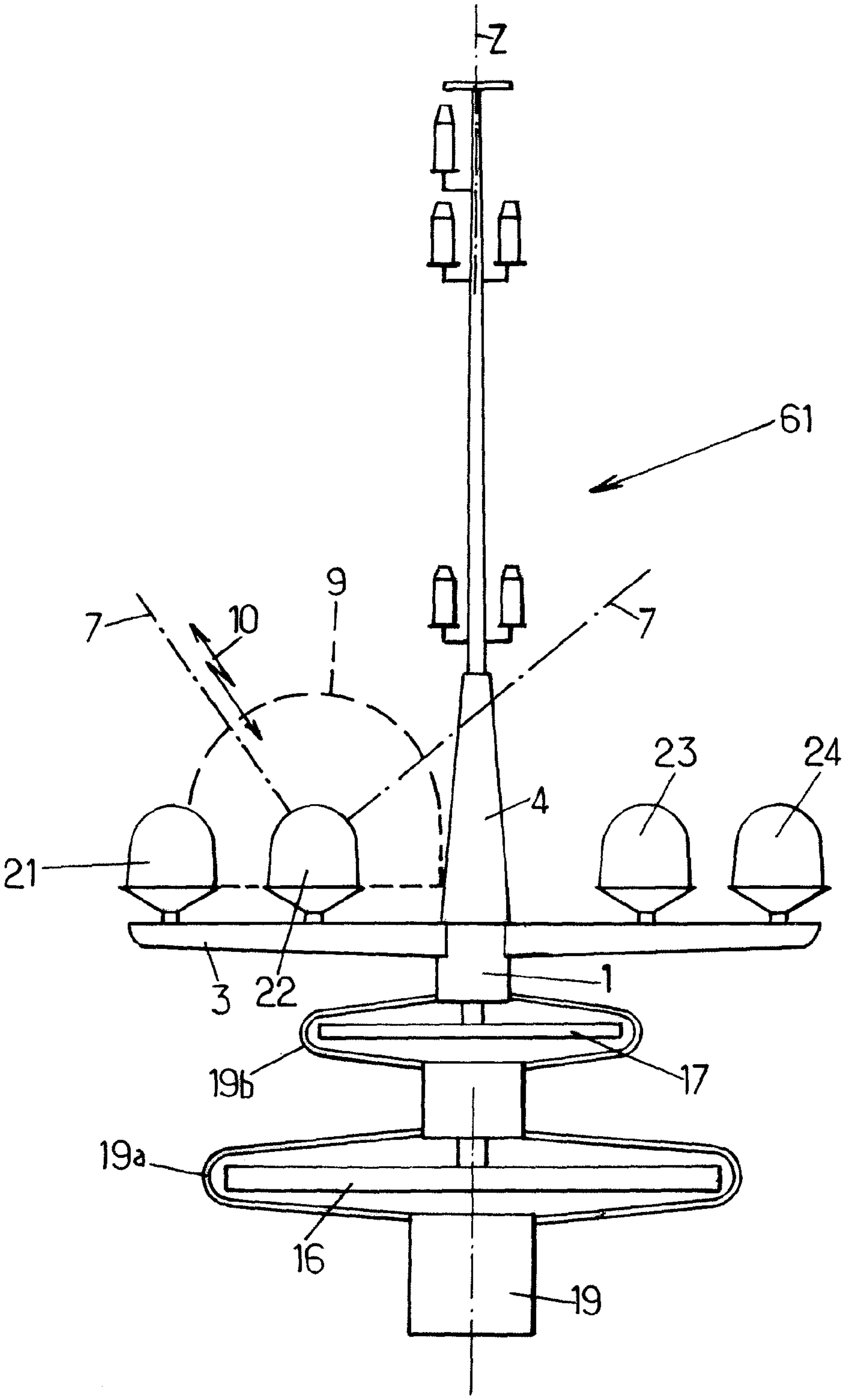


FIG.6.

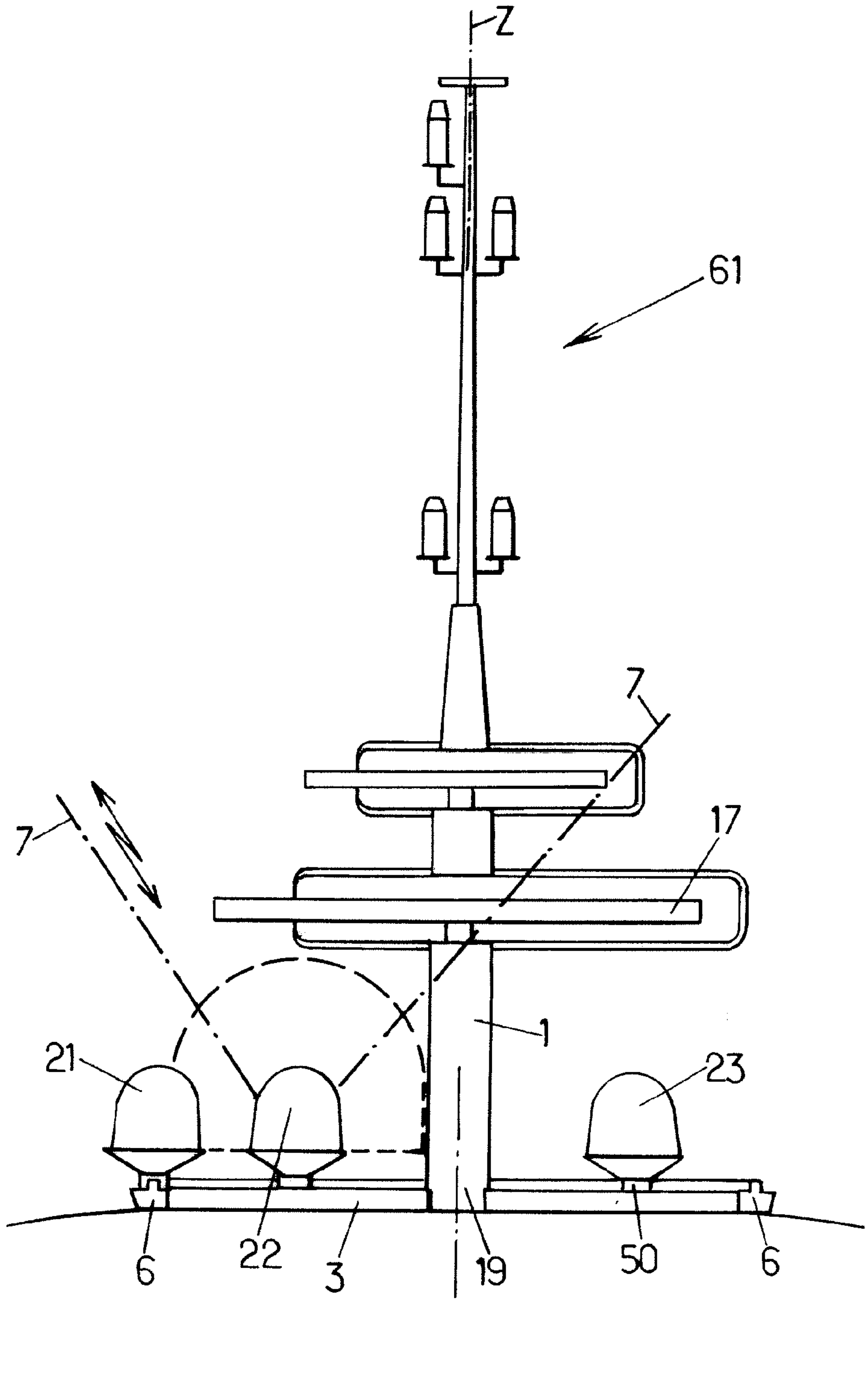


FIG.8.

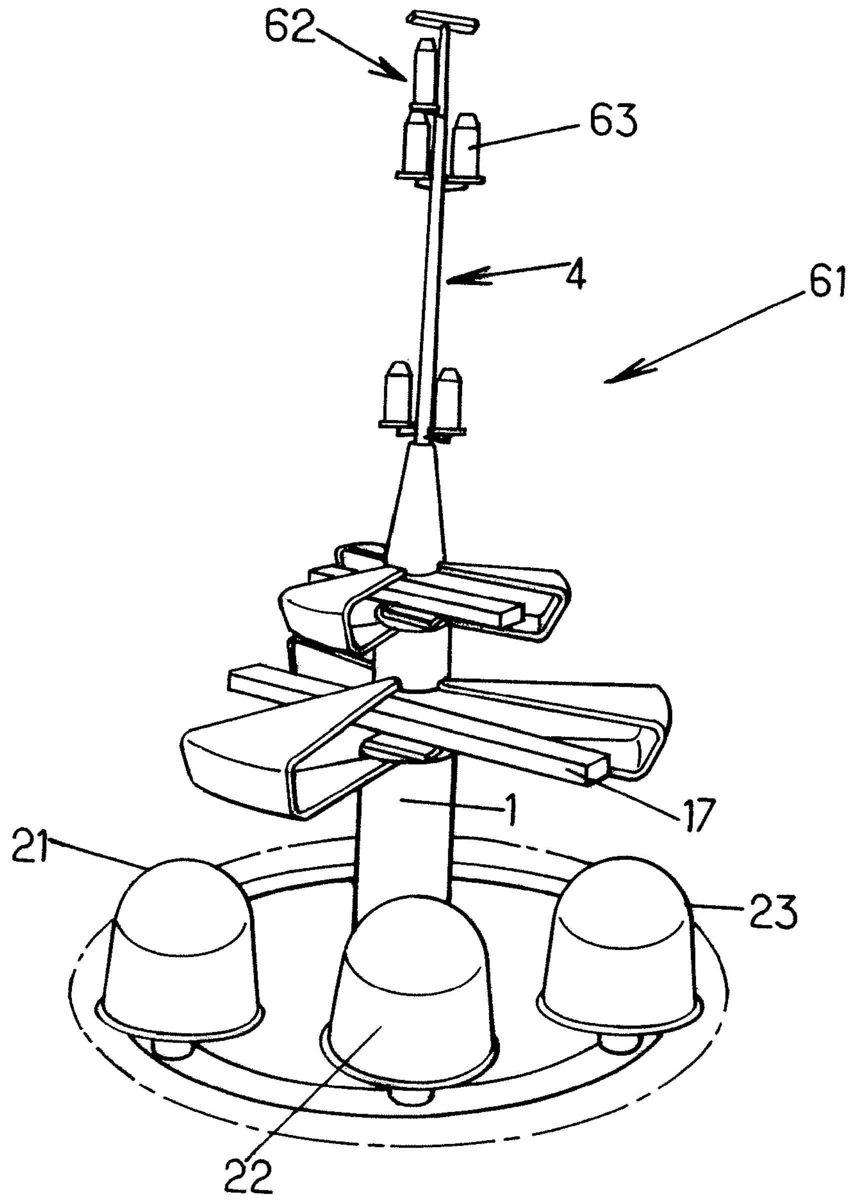


FIG. 10.

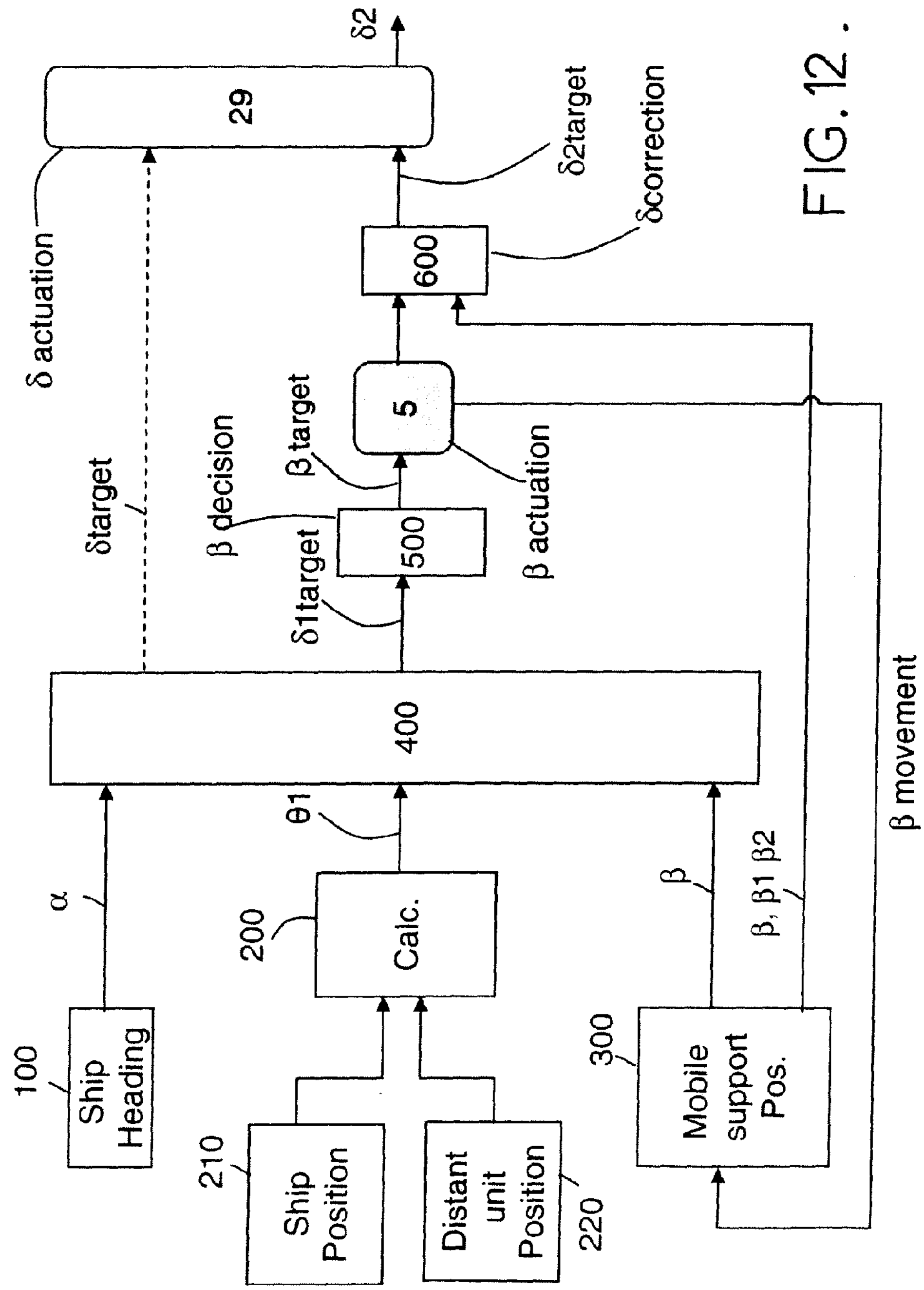

100
Ship Heading
210
Ship Position
220
Distant unit Position
200
Calc.
300
Mobile support Pos.
α
θ1
β
β, β1 β2
400
δ1target
500
β decision
β target
5
β actuation
600
δcorrection
δ2target
29
δ2
δ actuation
δtarget
β movement

FIG. 12.

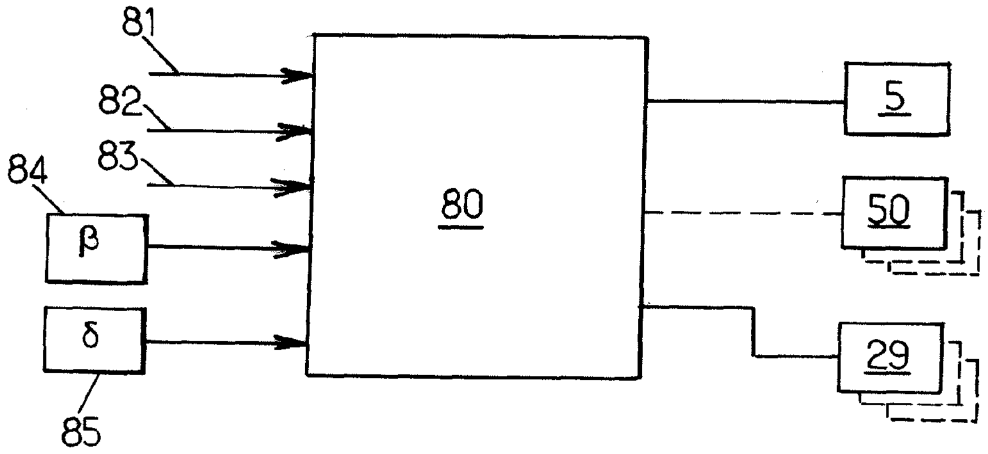


FIG.11.

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 30 5530

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 2 432 458 A (BOEING CO [US]) 23 May 2007 (2007-05-23) * the whole document *	1-15	INV. H01Q1/34 H01Q3/02 H01Q3/04
A	EP 0 154 240 A (COMSAT TELESYSTEMS INC [US]) 11 September 1985 (1985-09-11) * figures 3-6 *	1-15	
A	US 5 291 211 A (TROPPER MATTHEW B [US]) 1 March 1994 (1994-03-01) * abstract *	1-15	
A	US 4 694 773 A (SPARKES LAURIE R [US] ET AL) 22 September 1987 (1987-09-22) * abstract *	1-15	
A	HERTELENDY C ET AL: "The U.S. Navy strategic systems programs consolidated support ship (USNS WATERS) and its capabilities as an at-sea navigation test vehicle" POSITION LOCATION AND NAVIGATION SYMPOSIUM, IEEE 1998 PALM SPRINGS, CA, USA 20-23 APRIL 1998, NEW YORK, NY, USA,IEEE, US, 20 April 1998 (1998-04-20), pages 344-351, XP010276800 ISBN: 978-0-7803-4330-6 * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC) H01Q
A	TIMPE G L ET AL: "NOMAD buoys: an overview of forty years of use" OCEANS '95. MTS/IEEE. CHALLENGES OF OUR CHANGING GLOBAL ENVIRONMENT. C ONFERENCE PROCEEDINGS. SAN DIEGO, CA, USA 9-12 OCT. 1995, NEW YORK, NY, USA,IEEE, US, vol. 1, 9 October 1995 (1995-10-09), pages 309-315, XP010197396 ISBN: 978-0-933957-14-5 * figures 2a,2b *	1-15	

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	4 August 2009	Wattiaux, Véronique

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 30 5530

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

04-08-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2432458 A	23-05-2007	US 2007126647 A1	07-06-2007
EP 0154240 A	11-09-1985	CA 1247234 A1 WO 8503811 A1	20-12-1988 29-08-1985
US 5291211 A	01-03-1994	NONE	
US 4694773 A	22-09-1987	NONE	

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 59015308 B **[0003]**