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(54) ANTENNA MODULE AND ROOF STRUCTURE FOR A VEHICLE AND VEHICLE COMPRISING A ROOF STRUCTURE

(57) The invention is related to a roof structure (RFS) for a vehicle (V) comprising an antenna module (1) and a vehicle roof (101) wherein the antenna module (1) is mountable to at least one opening (102; 103) of the vehicle roof (101), wherein in a mounted position (MP) of the antenna module (1) the head (51) of the fixation unit (50) is received in a first opening (102) and the antenna carrier (3) is received in a second opening (103) of the vehicle roof (101) and both protrude beyond an upper surface (101a) of the vehicle roof (101), wherein the fixation unit (50) is pivoted in the housing (2), wherein in the mounted position (MP) and in a first turning position (FTP) of the fixation unit (50) the antenna module (1) is detachable pre-assembled to the vehicle roof (101) by the fixation unit (50), wherein the head (51) of the fixation unit (50) overlaps the vehicle roof (101) in first edge regions of the first opening (102) and is manually compressible to a compressed state to eliminate the overlapping and wherein in the mounted position (MP) and in a second turning position of the fixation unit (50) the antenna module (1) is locked to the vehicle roof (101) by the fixation unit (50), wherein the head (51) of the fixation unit (50) overlaps the vehicle roof (101) in second edge regions of the first opening (102) and the head (51) is compressed by the second edge regions (102c, 102d) of the vehicle roof (101) to the compressed state.

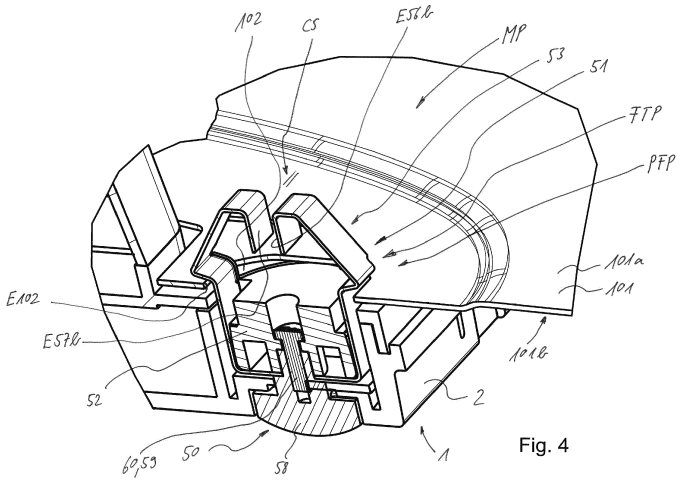

Fig. 4

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Description

FIELD OF THE INVENTION

[0001] The present disclosure relates to a roof structure for a vehicle comprising a vehicle roof and an antenna module and to a method for installation of an antenna module at a vehicle roof.

BACKGROUND OF THE INVENTION

[0002] For the installation of antenna modules different techniques are used. From US 2016/0172746 A1 an antenna module for installation at an opening of a vehicle roof is known, wherein the antenna module comprises a housing and an antenna carrier and a fixation unit, wherein the antenna carrier is arranged on a topside of the housing, wherein the fixation unit protrudes with a head above the topside of the housing, wherein in a mounted position of the antenna module the antenna carrier and the head of the fixation unit are received in the opening of the vehicle roof and protrude beyond an upper surface of the vehicle roof.

SUMMARY OF THE INVENTION

[0003] It is the object of the present disclosure to provide a roof structure for a vehicle and a method for installation of an antenna module at a vehicle roof which is improved in respect to reduce compression forces which are directed towards the vehicle roof during the installation.

[0004] This object is achieved in accordance with the present disclosure by a roof structure for a vehicle comprising an antenna module and a vehicle roof

- wherein the antenna module is mountable to at least one opening of the vehicle roof:
- wherein the antenna module comprises a housing and an antenna carrier and a fixation unit,
- wherein the antenna carrier is arranged on a topside of the housing,
- wherein the fixation unit protrudes with a head above the topside of the housing,
- wherein the roof structure is characterized in
- that in a mounted position of the antenna module the head of the fixation unit is received in a first opening and the antenna carrier is received in a second opening of the vehicle roof and both protrude beyond an upper surface of the vehicle roof,
- that the fixation unit is pivoted in the housing,
- that in the mounted position and in a first turning position of the fixation unit the antenna module is detachable pre-assembled to the vehicle roof by the fixation unit, wherein the head of the fixation unit overlaps the vehicle roof in first edge regions of the first opening and is manually compressible to a compressed state to eliminate the overlapping and
- that in the mounted position and in a second turning position of the fixation unit the antenna module is locked to the vehicle roof by the fixation unit, wherein the head of the fixation unit overlaps the vehicle roof in second edge regions of the first opening and the head is compressed by the second edge regions of the vehicle roof to the compressed state.

[0005] The locking of the fixation unit to the vehicle roof is reached by a rotation of the fixation unit from the first turning position to the second turning position, wherein this rotation will load the vehicle roof only with a torsional force and wherein the preceding compression force which is necessary for clicking the head of the fixation unit into the first opening of the vehicle roof in order to pre-assemble the antenna module to the vehicle roof is small. This means that the force which is necessary to lock the antenna module with its fixation unit to the vehicle roof is a torsional force which will not deform the vehicle roof like a compression force which is able to cause a dent on the vehicle roof.

[0006] The fixation unit comprises a body and a spring with two legs, wherein the spring is fixed to the body and wherein free ends of the spring legs protrude as the head over the body. A head which is consist of free ends of spring legs can be clicked in the opening of the vehicle roof with a very small pressure force since the free ends of the spring legs can flex away during the head is pushed into the opening.

[0007] According to a possible embodiment each spring leg is pre-bent in such a way that it protrudes with a middle part radially over the body and converges with an end part to an rotation axis of the body, wherein the end part of each spring leg is pre-bent in such a way that end portions of the end part lay opposite to each other like parallel planes. Spring legs that are pre-bent in such a way are able to engage the vehicle roof in the mounted position of the antenna module and are able to block each other in a preloaded state.

[0008] In accordance with the present disclosure the head of the fixation unit is formed by the middle part and the end part of the first leg of the spring and the middle part and the end part of the second leg of the spring. Thus the spring can be fixed with center parts of the legs to the body.

[0009] It is further proposed

- that the fixation unit comprises a locking device,
- wherein the housing comprises a first recess which opens to the topside of the housing,
- wherein the housing comprises a second recess which opens to a underside of the housing,
- wherein the body is received in the first recess,
- wherein the locking device is received in the second recess,
- wherein the recesses are connected by a passage running through the housing and
- wherein the body and the locking device are con-

nected through the passage.

[0010] Thus it is possible to structurally integrate the fixation unit with exception of its head into the housing wherein the housing works as seat for the body and as seat for the locking device and as pivot bearing for the fixation unit.

[0011] Additionally it is proposed

- that the locking device comprises a protrusion which reaches through the passage and is positively connected to the spring and is positively connected to the body in such a way that a rotation of the locking device provokes a rotation of the spring and of the body,
- that the body comprises a cavity which matches with the protrusion of the locking device,
- wherein the spring comprises a cutout which matches with the protrusion of the locking device and
- wherein center parts of the legs of the spring a positively connected to the body by running in axially oriented open channels of the body.

Thus the three components can be positively fixed together in order to transmit an operating torque from the locking device to the body and to the spring.

[0012] It is also proposed that the body and the locking device are secured to each other by a fastening element which reaches from the body into the locking device. Thus the body and the locking device are pivotable secured to the housing.

[0013] It is proposed that a bottom of the second recess which houses the locking device and a ring shaped area of the locking device which faces the bottom of the second recess work together as a latching mechanism which secures the fixation unit in its second turning position against any unwanted rotation. Thus the fixation unit can be secured to the housing in the second turning position in order to avoid an unwanted rotation of the fixation unit.

[0014] It is proposed that the first opening is designed in such a way that the fixation unit is in a pre-fix position snapped in the first opening of the vehicle roof and that the fixation unit is in a locking position locked with the vehicle roof after rotation of the fixation unit relative to the vehicle roof by 90° degrees around an axis which is orientated perpendicular to vehicle roof. Thus the antenna module is held in the mounted position on the vehicle roof independently of the position of the fixation unit.

[0015] It is proposed that the antenna module comprises at least one receiving slot and that the antenna module is fixed in the mounted position by this receiving slot additionally to the vehicle roof, wherein the receiving slot grips the vehicle roof at an edge of the second opening and wherein the receiving slot is positioned opposite to the fixation unit. Thus the antenna module can be fixed on opposite ends to the vehicle roof. This means that the antenna module will swing with the vehicle roof in the case of vehicle vibrations thus damage can be avoided.

[0016] Finally it is proposed

- that the first opening of the vehicle roof which receives the head of the fixation unit is shaped in a way that in the mounted position of the antenna module and in a first turning position of the head it provides a first gap for the spring legs and in second turning position of the head it provides a second gap for the spring legs,
- wherein the first gap is dimensioned to allow to snap the legs of the spring in or out and
- wherein the second gap is dimensioned to force the legs of the spring in such a way to each other that the legs block each other and the antenna module is mounted captive to the vehicle roof.

Thus a design of the opening of the vehicle roof is easy to produce and easy to adapt to different fixation units.

[0017] This object is achieved by a method for installation of an antenna module at a vehicle roof:

- wherein the antenna module comprises a housing and an antenna carrier and a fixation unit,
- wherein the antenna carrier is arranged on a topside of the housing,
- wherein the fixation unit comprises a head and the head protrudes above the topside of the housing,
- wherein the vehicle roof comprises at least one opening for the insertion of the antenna carrier and the head of the fixation unit,
- wherein in a mounted position of the antenna module the antenna carrier and the head of the fixation unit are received in the at least one opening of the vehicle roof and protrude beyond an upper surface of the vehicle roof,
- wherein the method is characterized by the steps
- that for mounting the antenna module to the vehicle roof the fixation unit is rotated to a first turning position and then the antenna module is inserted with the head in the first opening and with the antenna carrier in the second opening until the mounted position is reached,
- that during a mounting movement the head is increasingly pre-stressed by an edge of the first opening in order to snap into the first opening in a pre-fix position when the mounted position is reached, wherein the head overlaps the vehicle roof in this pre-fix position in first edge regions of the first opening,
- that in the mounted position the fixation unit is rotated form the first turning position to a second turning position, wherein during rotation the head is elastically deformed by the edge of the first opening, wherein the head of the fixation unit overlaps the vehicle roof in his second turning position on second edge regions of the first opening and stays in a pre-stressed condition.

[0018] The locking of the fixation unit to the vehicle roof is reached by a rotation of the fixation unit from the first turning position to the second turning position, wherein this rotation will load the vehicle roof only with a torsional force and wherein the preceding compression force which is necessary for clicking the head of the fixation unit into the first opening of the vehicle roof in order to pre-assemble the antenna module to the vehicle roof is small. This means that the force which is necessary to lock the antenna module with its fixation unit to the vehicle roof is a torsional force which will not deform the vehicle roof like a compression force which is able to cause a dent on the vehicle roof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The foregoing and other features and advantages of the present invention will become apparent to those skilled in the art to which the present invention relates upon reading the following description with reference to the accompanying drawing, in which:

Figure 1 shows a perspective view of an antenna module

Figure 2a shows a part of a vehicle roof with a first opening and a second opening;

Figure 2b: shows an enlarged view on the first opening of the vehicle roof shown in figure 2a

Figure 3: shows partially an inventive roof structure and partially an vehicle wherein a part of the vehicle roof known from figures 2a and 2b is shown and wherein the antenna module known from figure 1 is shown, wherein the antenna module is moved into its mounted position;

Figure 4: shows the roof structure of figure 3, wherein the antenna module is in the mounted position and the head of the fixation unit stands in a first turning position;

Figure 5a: shows the roof structure of figure 4, wherein the antenna module is in the mounted position and the head of the fixation unit stands in a second turning position;

Figure 5b: shows a detail of figure 5a

Figure 6a: shows a perspective view of the fixation unit in an assembled state;

Figure 6b: shows an exploded view of the fixation unit shown in figure 6b;

Figure 6c: shows a perspective view of the fastening element of the fixation unit;

Figure 6d: shows a perspective view of the spring of the fixation unit and

Figure 7: shows a perspective view on an underside of the housing of the antenna module, wherein a second recess can be seen which receives the locking device of the fixation unit.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Figure 1 shows a perspective view of an antenna module 1. The antenna module 1 is designed to be installed at a vehicle roof 101 (see figure 2a, 2b). The vehicle roof 101 comprises a first opening 102 and a second opening 103 which are arranged in a deep drawn area 104 of the vehicle roof 101 which forms a depression 105 on an upper surface 101a of the vehicle roof 101.

[0021] The antenna module 1 (see figure 1) comprises a housing 2 and an antenna carrier 3 and a fixation unit 50. Additionally the antenna module 1 comprises a cover which is not shown in the drawings and which is adapted in shape to the outline of the depression and will cover the antenna carrier 3 and the fixation unit 50. The antenna carrier 3 is arranged on a topside 2a of the housing 2 and the fixation unit 50 protrudes with a head 51 above the topside 2a of the housing 2. In a mounted position MP which means that the antenna module 2 is inserted with the antenna carrier 3 and with the fixation unit 50 into the openings 102, 103 of the vehicle roof 100 the fixation unit 50 protrudes with its head 51 above the upper surface 101a of the vehicle roof 101 (see figure 4).

[0022] In order to bring the antenna module 1 into the mounted position MP which is shown in figure 4 the antenna module 1 is inserted with the antenna carrier 3 and with the head 51 of the fixation unit 50 form a lower surface 101b of the vehicle roof 101 into the openings 102, 103 of the vehicle roof 101. Wherein the head 51 of the fixation unit 50 is inserted into the first opening 101 of the vehicle roof 101 and the antenna carrier 3 is inserted into the second opening 102 of the vehicle roof 101. The insertion is done with a pivoting movement, wherein the antenna module 1 comprises a receiving slot 4 (see figure 1) which is arranged opposite to the fixation unit 50. This means that the antenna module 1 is moved in a first step to a lower surface 101b of the vehicle roof 101 and is in a second step positioned with an inclined orientation with its receiving slot 4 to an edge 103a of the second opening 103 (see figure 2a) and is in a third step swiveled around the edge 103a in the mounted position MP which is shown in figure 4. Wherein figure 3 shows the inventive roof structure RFS for a vehicle V comprising the vehicle roof 101 and the antenna module 1. The antenna module 1 is shown in figure 3 in an intermediate position IP during the pivoting movement to the lower surface 101b of the vehicle roof 101. The above named intermediate position

IP shows how the antenna carrier 3 is moved into the second opening 103 and how the head 51 of the fixation unit 50 intrudes into the first opening 102. During the pivoting movement the fixing unit 50 is orientated in a first turning position FTP. An edge E102 of the fist opening 102 compresses the head 51 increasingly during the pivoting movement. After the pivoting movement of the antenna module 1 when the antenna module 1 has reached the mounted position MP the head 51 is snapped in into the first opening 102 in its pre-fix position PFP (compare figures 3 and 4). Out of this pre-fix position PFP the fixing unit 50 is rotated with its head 51 by a 90°-rotation to a lock position LP and is then orientated in a second turning position STP (see figures 5a, 5b).

[0023] In the mounted position MP of the antenna module 1 the head 51 is in this pre-fix-position PFP as long as the head 51 is oriented in the first turning position FTP (see figure 4). In the pre-fix position PFP of the head 51 the antenna module 1 is detachable pre-assembled to the vehicle roof 101 by the fixation unit 50, wherein the head 51 of the fixation unit 50 overlaps the vehicle roof 101 in first edge regions 102a, 102b of the edge E102 of the first opening 102 (see figures 4 and 3) and the head 51 is manually compressible to a compressed state CS to eliminate the overlapping, wherein the compressed state CS is schematically indicated in figure 4 by two parallel lines. Such the antenna module 1 is detachable from the vehicle roof 101.

[0024] In the mounted position MP and in a second turning position STP of the fixation unit 50 (see figures 5a, 5b) the antenna module 1 is locked to the vehicle roof 101 by the fixation unit 50, wherein the head 51 of the fixation unit 50 overlaps the vehicle roof 101 in second edge regions 102c, 102d of the edge E102 of the first opening 102 (see figures 3 and 2b) and the head 51 is compressed by the second edge regions 102c, 102d of the vehicle roof 101 to the compressed state CS. The first opening 102 is designed in such a way that the compression of the head 51 increases while the head 51 is rotated from its first turning position FTP to its second turning position STP (see figure 2b).

[0025] Figures 3 and 6a to 6d show that the fixation unit 50 comprises a body 52 and a spring 53 with two legs 54, 55, wherein the spring 53 is fixed to the body 52 and wherein free ends 56, 57 of the spring legs 54, 55 protrude as the head 51 over the body 52. Each spring leg 54, 55 is pre-bent (see figure 6d) in such a way that it protrudes with a middle part 56a, 57a radially over the body 52 and converges with an end part 56b, 57b to an rotation axis R52 of the body 52, wherein the end part 56b, 57b of each spring leg 54, 55 is pre-bent in such a way that end portions EP56b, EP57b of the end part 56b, 57b lay opposite to each other like parallel planes.

[0026] The head 51 of the fixation unit 50 is formed by the middle part 56a and the end part 56b of the first leg 54 of the spring 53 and the middle part 57a and the end part 57b of the second leg 55 of the spring 53 (see figure 6d).

[0027] The fixation unit 50 comprises additionally a locking device 58 (see figures 3, 6a to 6c).

[0028] The housing 2 of the antenna module 1 comprises a first recess 5 which opens to the topside 2a of the housing 2 and a second recess 6 which opens to an underside 2b of the housing 2 (see figures 1 and 3). The body 52 of the fixation unit 50 is received in the first recess 5 and the locking device 58 of the fixation unit 50 is received in the second recess 6.

[0029] The both recesses 5, 6 are connected by a passage 7 (see figure 3) running through the housing 2, wherein the body 52 and the locking device 58 are connected through the passage 7, wherein the locking device 58 comprises a hexagonal protrusion 58a (see figures 6d, 6c) which reaches through the passage 7 and is positively connected to the spring 53 and is positively connected to the body 52. Such a rotation of the locking device 58 provokes a rotation of the spring 53 and of the body 52.

[0030] The body 52 comprises a cavity 52a (see figure 3) which matches with the protrusion 58a of the locking device 58 and the spring 53 comprises a cutout 53a (see figure 6d) which matches with the protrusion 58a of the locking device 58a. The spring 53 is positively connected to the body 52 since the spring legs 54, 55 run in axially oriented open channels 52b, 52c of the body 52 (see figures 6a, 6b). The body 52 and the locking device 58 are secured to each other by a fastening element 59 (see figures 3 and 5d) which reaches from the body 52 into the locking device 58. As fasting element 59 a screw 60 is used wherein the locking device 58 comprises a female thread 58b (see figure 6c) for insertion of the screw 60. This means that the complete fixation unit 50 is rotatable fixed to the housing (see figure 3) and that the head 51 can be rotated by a rotation of the locking device 58. The body 52 of the fixation unit 50 is accommodated in the first recess 5 of the housing 2 and the locking device 58 is accommodated in the second recess 6 of the housing 2, wherein the body 52 and the locking device 58 are positively connected through the passage 7 running from the first recess 5 to the second recess 6.

[0031] Figure 7 shows a perspective view on the underside 2b of the housing 2 of the antenna module 1, wherein the second recess 6 can be seen which receives the locking device 58 of the fixation unit 50. A bottom 6a of the second recess 6 which houses the locking device 58 and a ring shaped area 58c (see figure 6c) of the locking device 58 which faces the bottom 6a of the second recess 6 work together as a latching mechanism 61 (see figures 3, 7). The latching mechanism 61 secures the fixation unit 50 in its second turning position STP against any unwanted rotation. The ring shaped area 58c of the locking device 58 shows two radially running ribs 62, 63 which are arranged symmetrically to the rotation axis R52 and shows. The ring shaped area 58c of the locking device 58 additionally shows two cams 64, 65 which are arranged opposite with respect to the rotation axis R52. When the locking device 58 is inserted into the

second recess 6 the cams 64, 65 are guided in arched grooves 8, 9 arranged on the bottom 6a of the recess 6. Such the rotatability of the locking device 58 is limited to 90°. For interaction with the ribs 62, 63 the bottom 6a of the second recess 6 shows a first and a second ramp 10, 11 and a first and a second blocking element 12, 13. For easier understanding figure 7 shows schematically a first position FP62 in which the first rib 62 is located when the locking device 58 respectively the fixation unit 50 stands in the first turning position FTP and a second position SP62 in which the first rib 62 is located when the locking device 58 respectively the fixation unit 50 stands in the second turning position STP (see figures 3 and 5b). During the rotation of the fixation unit 50 from its first turning position FTP to its second turning position STP the ramps 10, 11 will impede the movement since the connection between the locking device 58 and the body 52 will be stressed. This stress will suddenly stop when the ribs 62, 63 snap into a first gap 14 and a second gap 15 which are each arranged between the first ramp 10 and the first blocking element 12 and between the second ramp 11 and the second blocking element 13. A rotation of the fixation unit 50 form the second turning position STP to the first turning position FTP is blocked by the blocking elements 12, 13 and by edges 10a, 11a of the ramps 10, 11. Such the fixation unit 50 is secured in its second turning position STP against an unwanted release.

[0032] As shown in figure 4 the vehicle roof 101 comprises as cutouts a first opening 102 and a second opening 103 wherein the first opening 102 is designed in such a way that the fixation unit 50 is in the mounted position MP snapped in the first opening 102 of the vehicle roof 101 and is connected in this pre-fix position PFP detachable from the vehicle roof 101 by the spring legs 54, 55 of the spring 53 which forms the head 51 of the fixation unit 50. By a 90°-rotation of the fixation unit 50 around its rotation axis R52 into the lock position LP which is shown in figures 5a, 5b the antenna module 2 is locked to the vehicle roof 1 since the spring legs 54, 55 overlap the second edge regions 102c, 102d of the first opening 102 (see figure 2b) and the second edge regions 102c, 102d press the spring legs 54, 55 together so that end portions EP56b, EP57b contact each other (see figure 5b) and block any movement of the spring legs 54, 55 which would allow to reduce the overlap. The rotation axis R52 of the fixation unit is orientated perpendicular to the vehicle roof 101 (see figure 3).

[0033] As shown in figure 5a the antenna module 101 is fixed in the mounted position MP by the receiving slot 4 additionally to the vehicle roof 101, wherein the receiving slot 4 grips the vehicle roof 101 at an edge of the second opening 103 and wherein the receiving slot 4 is positioned opposite to the fixation unit 50. The first opening 102 of the vehicle roof 101 receives the head 51 of the fixation unit 51 and is shaped - as it can be seen in figure 2b - in a way that in the mounted position of the antenna module and in a first turning position FTP of the head 51 (see figure 4) it provides a first gap 106 for the spring legs 54, 55 and in second turning position STP of the head 51 it provides a second gap 107 for the spring legs 54, 55. The first gap 106 is dimensioned in such a way that it allows to snap the legs 54, 55 of spring 53 in or out. For snapping out the legs 54, 55 have to be pressed together until the end portions EP56b and EP57b contact each other and are then pressed down in y'-direction (see figure 3).

[0034] The second gap 107 is dimensioned in such a way that it forces the spring legs 54, 55 against each other so that the legs 54, 55 block each other by coming into contact with their end portions EP56b, EP57b (see figure 5b). The second gap 107 does not allow to snap the head 51 of the fixation unit 50 out of the first opening 102 without rotating the head 51 back into its first turning position FTP.

[0035] The spring 53 is designed as a one-piece spring wherein center parts 56c, 57c of the legs 54, 55 are connected and show the cutout 53a.

REFERENCE NUMERALS:

[0036]

1	antenna module
2	housing
2a	topside of 2
2b	underside of 2
3	antenna carrier
4	receiving slot
5	first recess of 2
6	second recess of 2
6a	bottom of 6
7	passage in 2
8, 9	arched groove in 6a
10, 11	first and second ramp of 6a
10a, 11a	edge of 10, 11
12, 13	first and second blocking element of 6a
14, 15	first and second gap between 10/12, 11/13
MP	mounted position of 1
IP	intermediate position of 1
50	fixation unit
51	head of 50
52	body of 50
52a	cavity in 52
52b, 52c	open channel of 52
53	spring of 50
53a	cutout in 53
54, 55	spring leg of 53
56, 57	free ends of 54, 55
56a, 57a	middle part of 56, 57
56b, 57b	end part of 56, 57
56c, 57c	center part of 54, 55
58	locking device of 50
58a	protrusion of 58

58b	female thread
58c	ring shaped area of 58
59	fastening element
60	screw
61	latching mechanism
62, 63	rib of 58c
64, 65	cam of 58c
EP56b	end portion of 56b
EP57b	end portion of 57b
PFP	pre-fix position of 50
FTP	first turning position of 50
LP	lock position of 50
STP	second turning position of 50
CS	compressed state of 51
R52	rotation axis
FP62	first position of 62
SP62	second position of 62
101	vehicle roof
101a	upper surface of 101
101b	lower surface of 101
102	first opening of 101
102a/b	first edge region of 102
102c/d	second edge region of 102
103	second opening of 101
103a	edge of 103
104	deep-drawn area of 101
105	depression on 101a
106	first gap of 102
107	second gap of 102
E102	edge of 102
V	vehicle
RFS	roof structure

Claims

1. Roof structure (RFS) for a vehicle (V) comprising an antenna module (1) and a vehicle roof (101) wherein the antenna module (1) is mountable to at least one opening (102; 103) of the vehicle roof (101):

- wherein the antenna module (1) comprises a housing (2) and an antenna carrier (3) and a fixation unit (50),
- wherein the antenna carrier (3) is arranged on a topside (2a) of the housing (2),
- wherein the fixation unit (50) protrudes with a head (51) above the topside (2a) of the housing (2),
- **characterized in**

- **that** in a mounted position (MP) of the antenna module (1) the head (51) of the fixation unit (50) is received in a first opening (102) and the antenna carrier (3) is received in a second opening (103) of the vehicle roof (101) and both protrude beyond an upper surface (101a) of the vehicle roof (101),
- **that** the fixation unit (50) is pivoted in the housing (2),

- **that** in the mounted position (MP) and in a first turning position (FTP) of the fixation unit (50) the antenna module (1) is detachable pre-assembled to the vehicle roof (101) by the fixation unit (50), wherein the head (51) of the fixation unit (50) overlaps the vehicle roof (101) in first edge regions (102a, 102b) of the first opening (102) and is manually compressible to a compressed state (CS) to eliminate the overlapping and
- **that** in the mounted position (MP) and in a second turning position (STP) of the fixation unit (50) the antenna module (1) is locked to the vehicle roof (101) by the fixation unit (50), wherein the head (51) of the fixation unit (50) overlaps the vehicle roof (101) in second edge regions (102c, 102d) of the first opening (102) and the head (51) is compressed by the second edge regions (102c, 102d) of the vehicle roof (101) to the compressed state (CS).

2. Roof structure (RFS) for a vehicle (V) according to claim 1, **characterized in that** the fixation unit (50) comprises a body (52) and a spring (53) with to legs (54, 55), wherein the spring (53) is fixed to the body (52) and wherein free ends (56, 57) of the spring legs (54, 55) protrude as the head (51) over the body (52) .

3. Roof structure (RFS) for a vehicle (V) according to claim 2, **characterized in that** each spring leg (54, 55) is pre-bent in such a way that it protrudes with a middle part (56a, 57a) radially over the body (52) and converges with an end part (56b, 57b) to an rotation axis (R52) of the body (52), wherein the end part (56b, 57b) of each spring leg (54, 55) is pre-bent in such a way that end portions (E56b, E57b) of the end part (56b, 57b) lay opposite to each other like parallel planes.

4. Roof structure (RFS) for a vehicle (V) according to at least one of the proceeding claims, **characterized in that** the head (51) of the fixation unit (50) is formed by the middle part (56a) and the end part (56b) of the first leg (54) of the spring (53) and the middle

part (57a) and the end part (57b) of the second leg (55) of the spring (53).

5. Roof structure (RFS) for a vehicle (V) according to at least one of the proceeding claims, **characterized in**

- **that** the fixation unit (50) comprise a locking device (58),
- wherein the housing (2) comprises a first recess (5) which opens to the topside (2a) of the housing (2),
- wherein the housing (2) comprises a second recess (6) which opens to a underside (2b) of the housing (2),
- wherein the body (52) is received in the first recess (5),
- wherein the locking device (58) is received in the second recess (6),
- wherein the recesses (5; 6) are connected by a passage (7) running through the housing (2) and
- wherein the body (52) and the locking device (58) are connected through the passage (7).

6. Roof structure (RFS) for a vehicle (V) according to at least one of the proceeding claims, **characterized in**

- **that** the locking device (58) comprises a protrusion (58a) which reaches through the passage (7) and is positively connected to the spring (53) and is positively connected to the body (52) in such a way that a rotation of the locking device (58) provokes a rotation of the spring (53) and of the body (52),
- **that** the body (52) comprises a cavity (52a) which matches with the protrusion (58a) of the locking device (58),
- wherein the spring (53) comprises a cutout (53a) which matches with the protrusion (58a) of the locking device (58) and
- wherein center parts (56c, 57c) of the legs (54, 55) of the spring (53) a positively connected to the body (52) by running in axially oriented open channels (52b, 52c) of the body (52).

7. Roof structure (RFS) for a vehicle (V) according to at least one of the proceeding claims, **characterized in that** the body (52) and the locking device (58) are secured to each other by a fastening element (59) which reaches from the body (52) into the locking device (58).

8. Roof structure (RFS) for a vehicle (V) according to at least one of the proceeding claims, **characterized in that** a bottom (6a) of the second recess (6) which houses the locking device (58) and a ring shaped area (58c) of the locking device (58) which faces the bottom (6a) of the second recess (6) work together as a latching mechanism (61) which secures the fixation unit (58) in its second turning position (STP) against any unwanted rotation.

9. Roof structure (RFS) for a vehicle (V) according to at least one of claims 1 to 8 **characterized in that** the first opening (102) is designed in such a way that the fixation unit (58) is in a pre-fix position (PFP) snapped in the first opening (102) of the vehicle roof (101) and that the fixation unit (58) is in a locking position (LP) locked with the vehicle roof (101) after rotation of the fixation unit (58) relative to the vehicle roof by 90° degrees around an axis (R52) which is orientated perpendicular to vehicle roof (101).

10. Roof structure (RFS) for a vehicle (V) according to claim 9, **characterized in that** the antenna module (1) comprises at least one receiving slot (4) and that the antenna module (1) is fixed in the mounted position (MP) by this receiving slot (4) additionally to the vehicle roof (101), wherein the receiving slot (4) grips the vehicle roof (101) at an edge (103a) of the second opening (103) and wherein the receiving slot (4) is positioned opposite to the fixation unit (58).

11. Roof structure (RFS) for a vehicle (V) according to claim 9 or 10, **characterized in**

- **that** the first opening (102) of the vehicle roof (101) which receives the head (51) of the fixation unit (50) is shaped in a way that in the mounted position (MP) of the antenna module and in a first turning position (FTP) of the head (51) it provides a first gap (106) for the spring legs (54, 55) and in second turning position of the head it provides a second gap for the spring legs,
- wherein the first gap (106) is dimensioned to allow to snap the legs (54, 55) of the spring (53) in or out and
- wherein the second gap (107) is dimensioned to force the legs (54, 55) of the spring (53) in such a way to each other that the legs (54, 55) block each other and the antenna module (1) is mounted captive to the vehicle roof (101).

12. Method for installation of an antenna module (1) at a vehicle roof (101):

- wherein the antenna module (1) comprises a housing (2) and an antenna carrier (3) and a fixation unit (50),
- wherein the antenna carrier (3) is arranged on a topside (2a) of the housing (2),
- wherein the fixation unit (50) comprises a head (51) and the head (51) protrudes above the topside (2a) of the housing (2),

- wherein the vehicle roof (101) comprises at least one opening (102; 103) for the insertion of the antenna carrier (3) and the head (51) of the fixation unit (50),
- wherein in a mounted position (MP) of the antenna module (1) the antenna carrier (3) and the head (51) of the fixation unit (50) are received in the at least one opening (102; 103) of the vehicle roof (101) and protrude beyond an upper surface (101a) of the vehicle roof (101),

characterized by the steps

- that for mounting the antenna module (1) to the vehicle roof (101) the fixation unit (50) is rotated to a first turning position (FTP) and then the antenna module (1) is inserted with the head (51) in the first opening (102) and with the antenna carrier (3) in the second opening (103) until the mounted position (MP) is reached,

  - that during a mounting movement the head (51) is increasingly pre-stressed by an edge (E102) of the first opening (102) in order to snap into the first opening (102) in a pre-fix position (PFP) when the mounted position (MP) is reached, wherein the head (51) overlaps the vehicle roof (101) in this pre-fix position (PFP) in first edge regions (102a, 102b) of the first opening (102),
  - that in the mounted position (MP) the fixation unit (50) is rotated form the first turning position (FTP) to a second turning position (STP), wherein during rotation the head (51) is elastically deformed by the edge (E102) of the first opening (102), wherein the head (51) of the fixation unit (50) overlaps the vehicle roof (101) in his second turning position (STP) on second edge regions (102c, 102d) of the first opening (102) and stays in a pre-stressed condition.

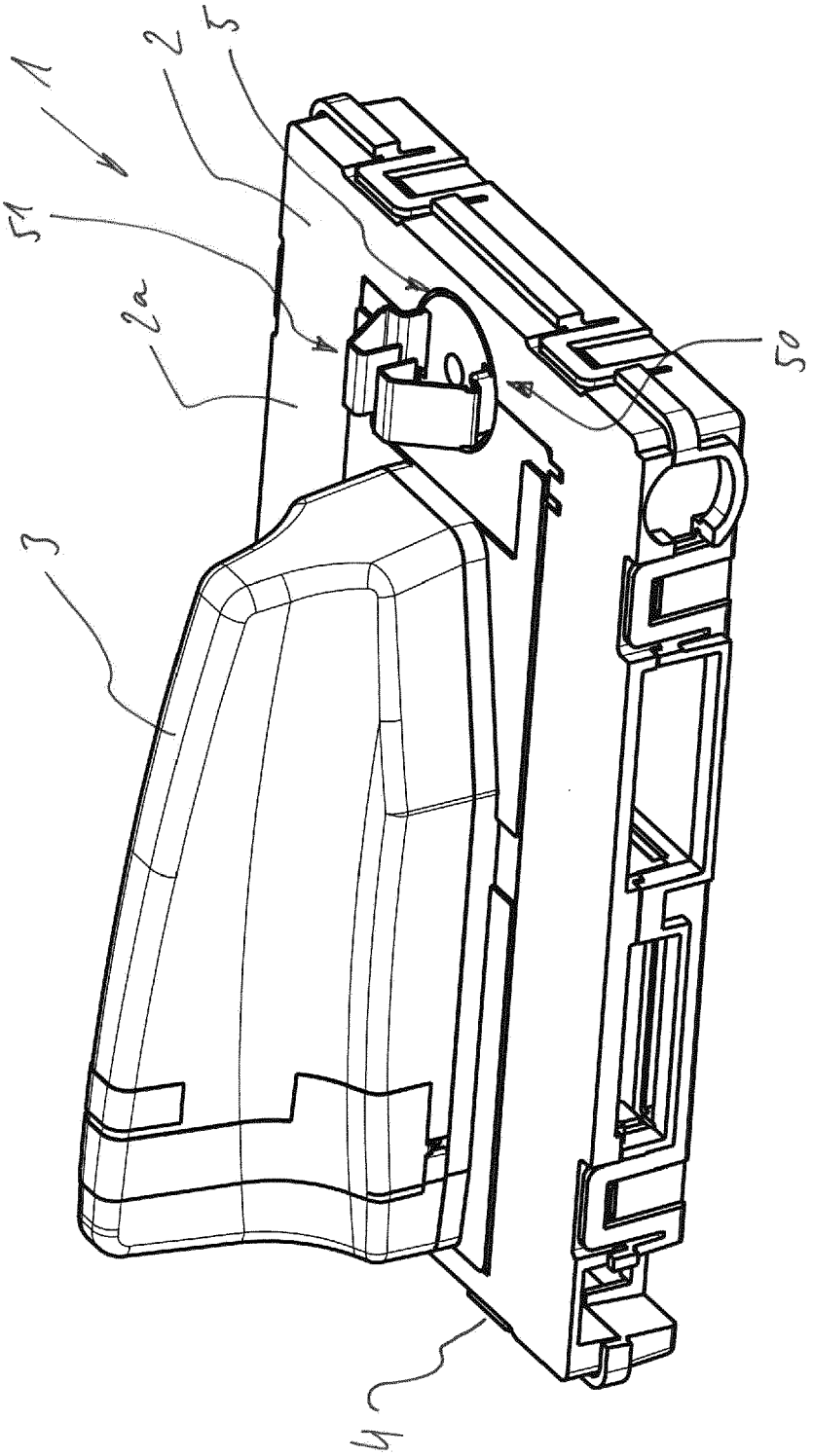

Fig. 1

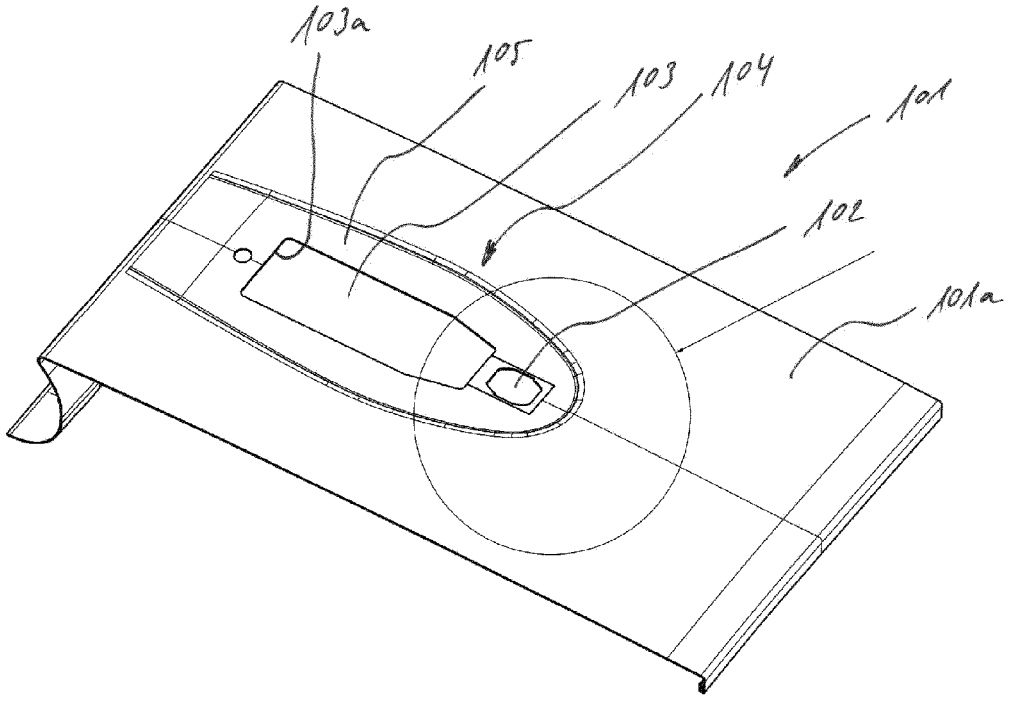
103a
105
103
104
101
102
101a

Fig. 2a

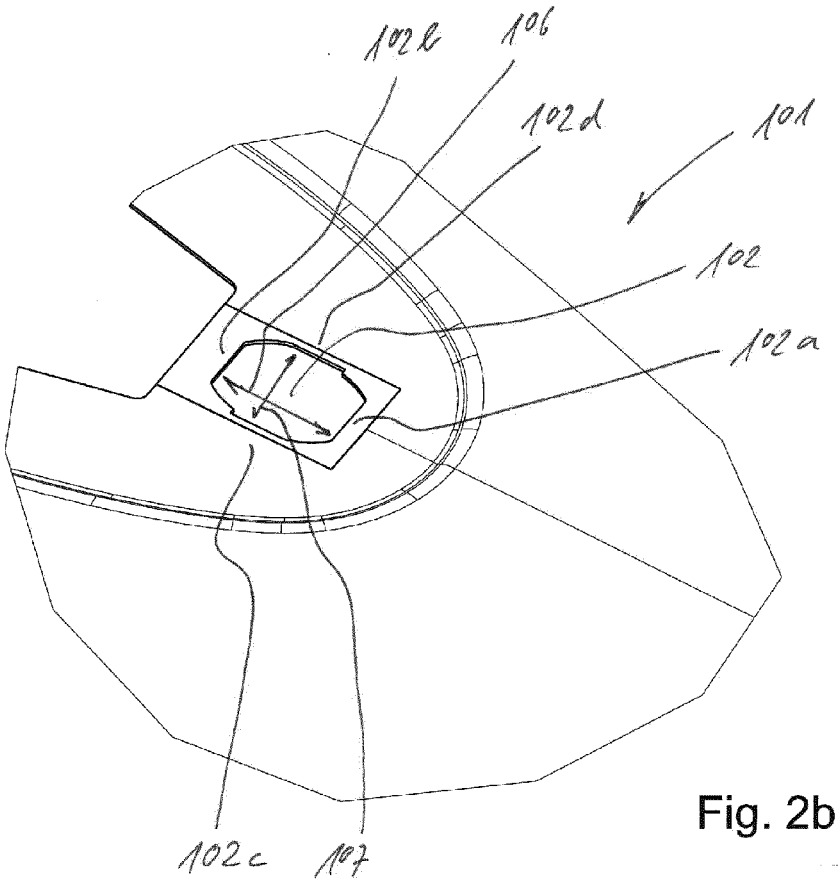
102b
106
102d
101
102
102a
102c
107

Fig. 2b

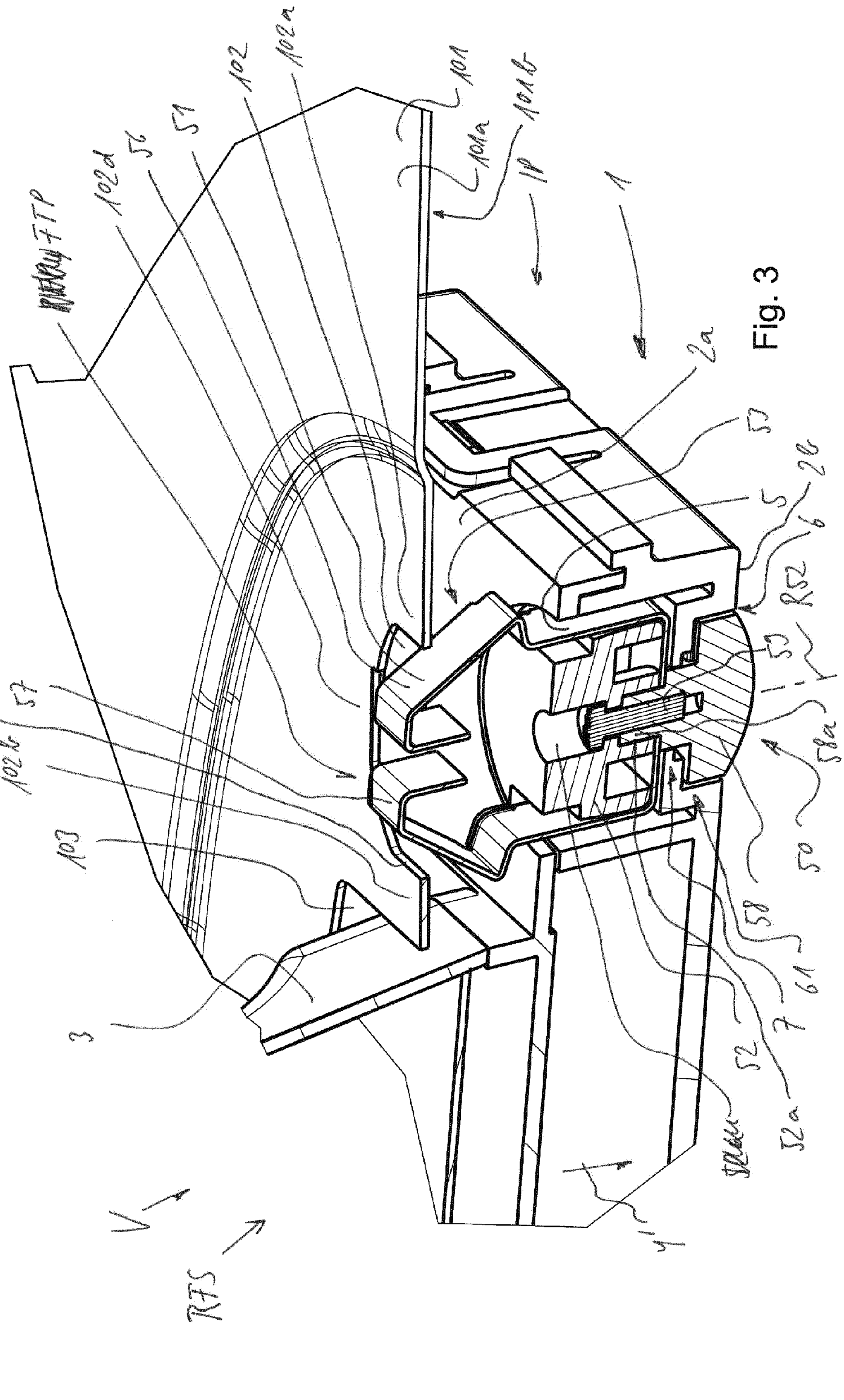
101
101a
101b
1P
1
102a
102
51
56
102d
FTP
2a
53
5
2b
6
R52
59
58a
50
58
61
7
52
52a
E102
57
102b
103
3
V
RFS
1'

Fig. 3

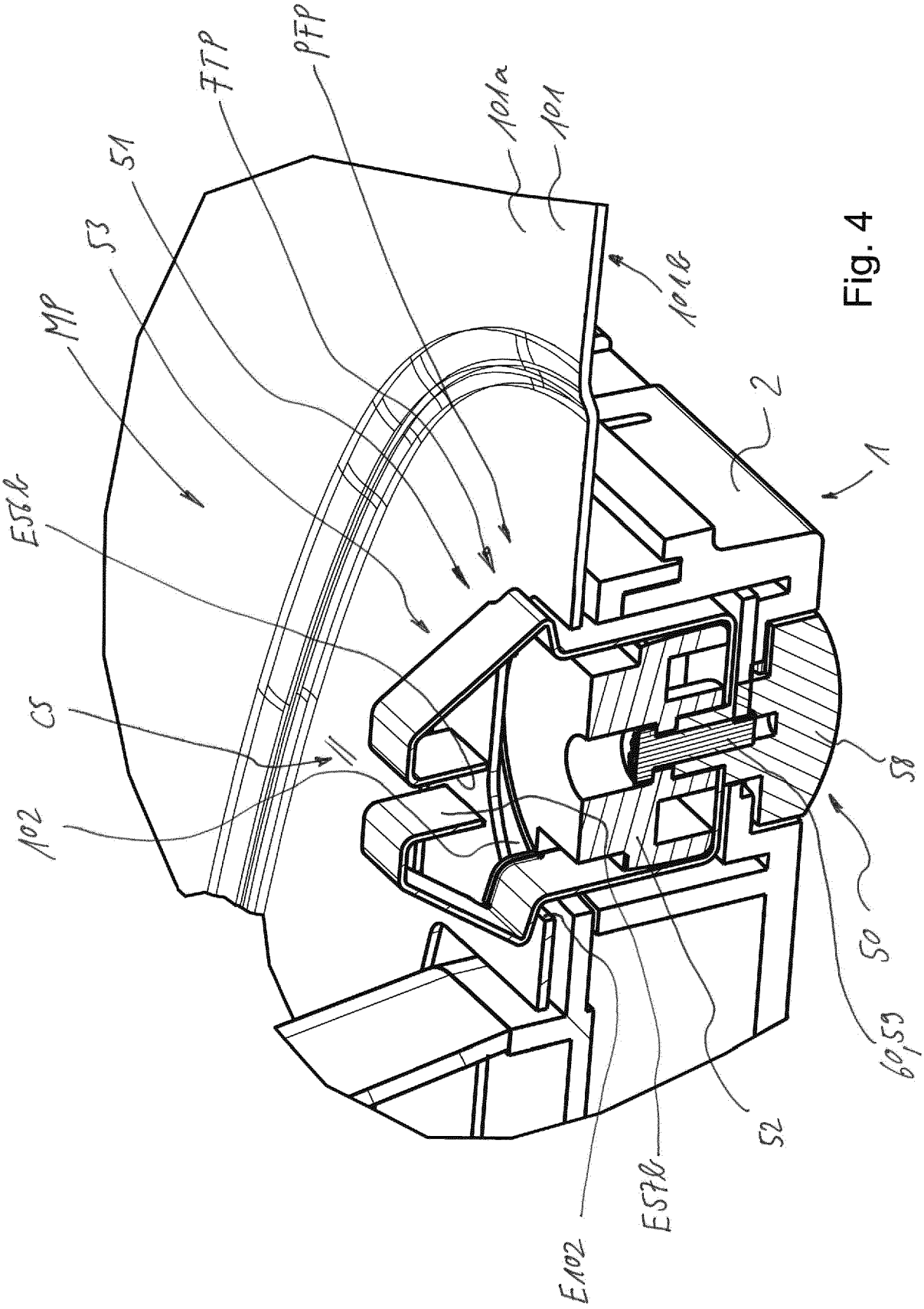
FTP
PFP
101a
101
S1
S3
MP
101b
2
1
ES1b
CS
102
S8
S0
60,S3
S2
ES1a
E102

Fig. 4

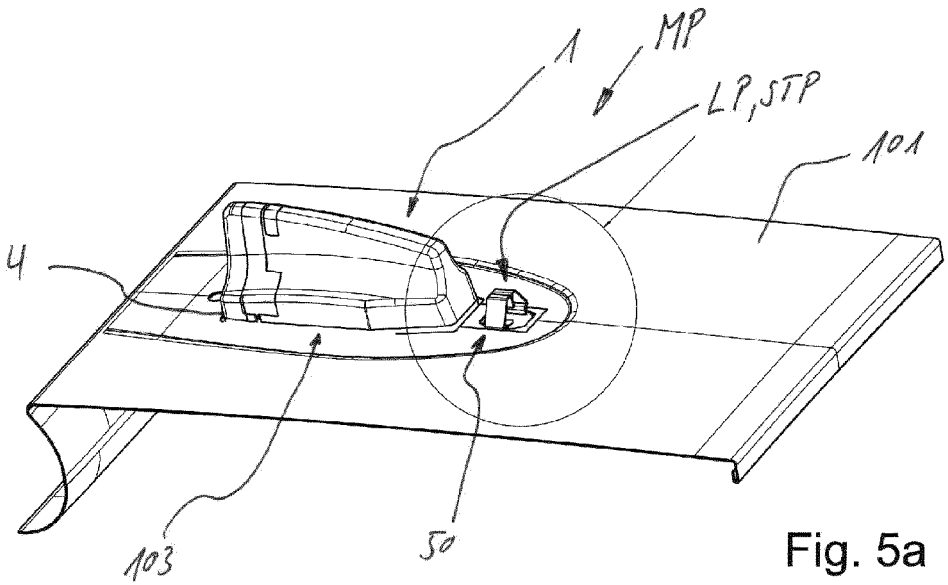

Fig. 5a

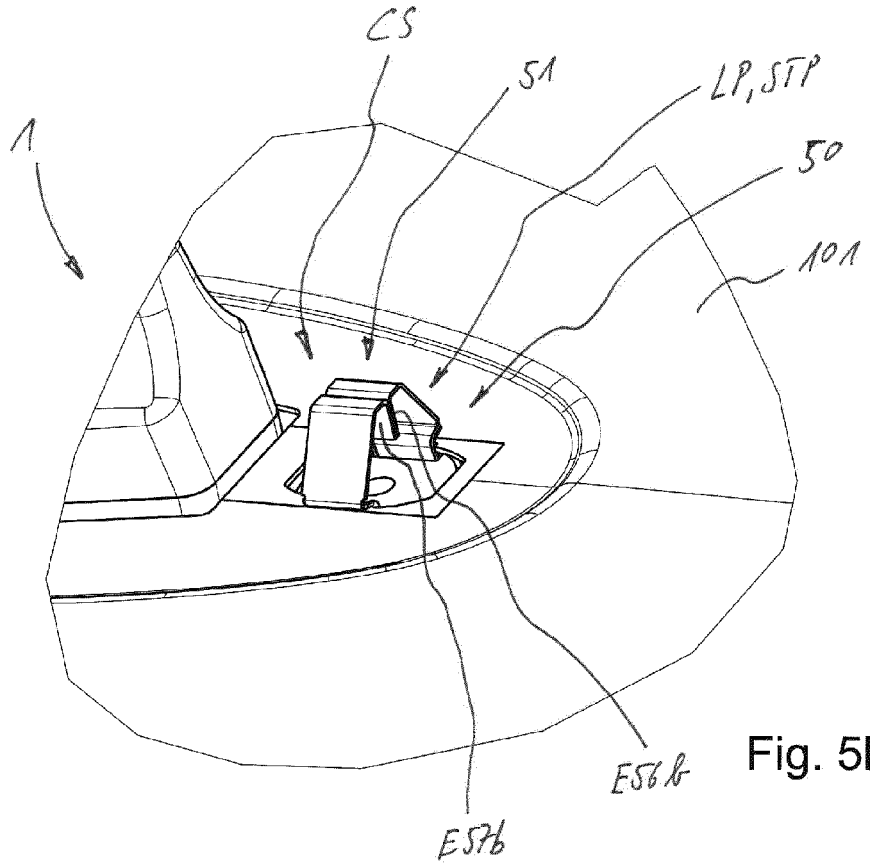

Fig. 5b

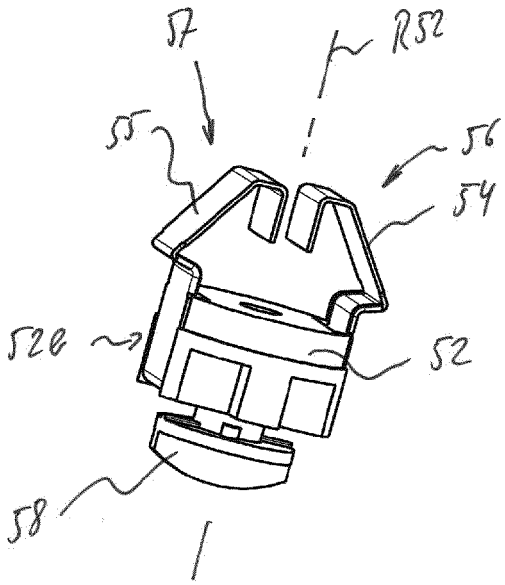

Fig. 6a

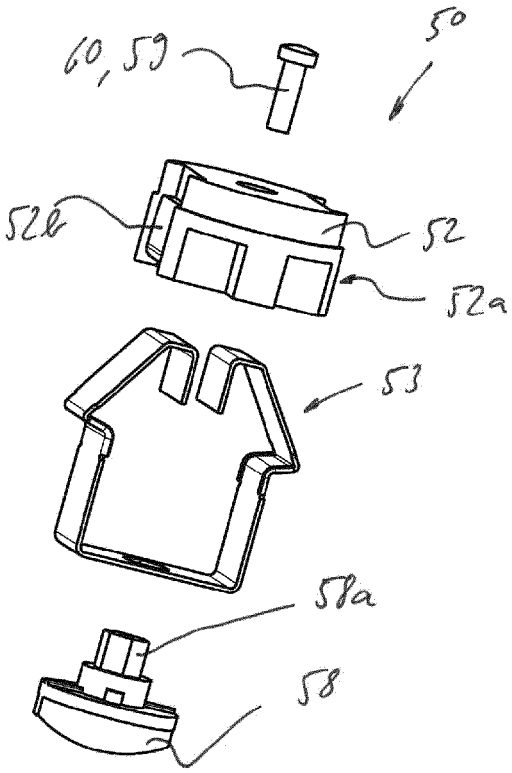

Fig. 6d

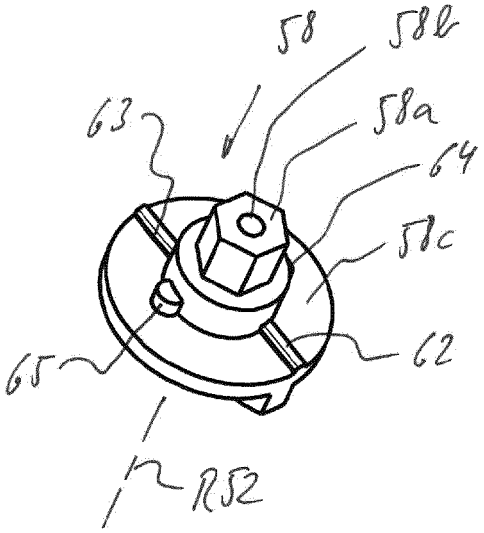

Fig. 6c

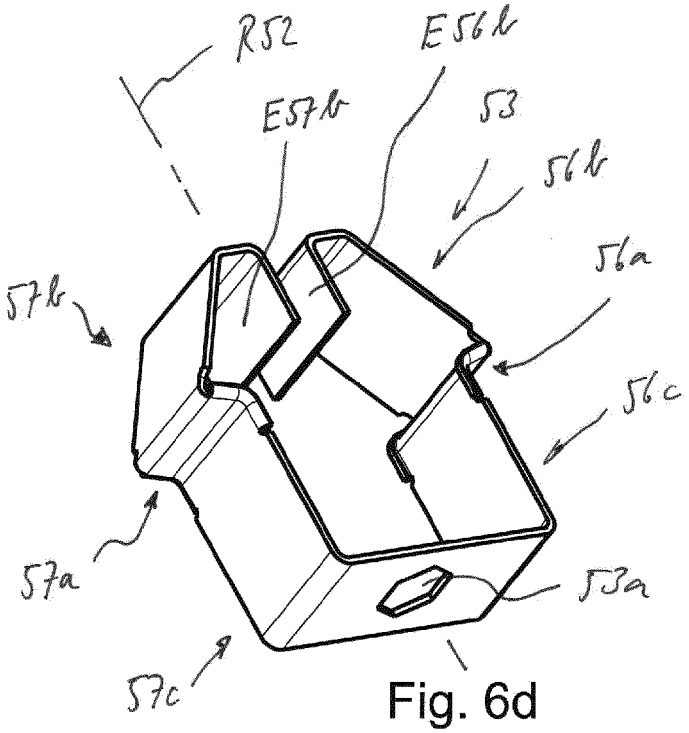

Fig. 6d

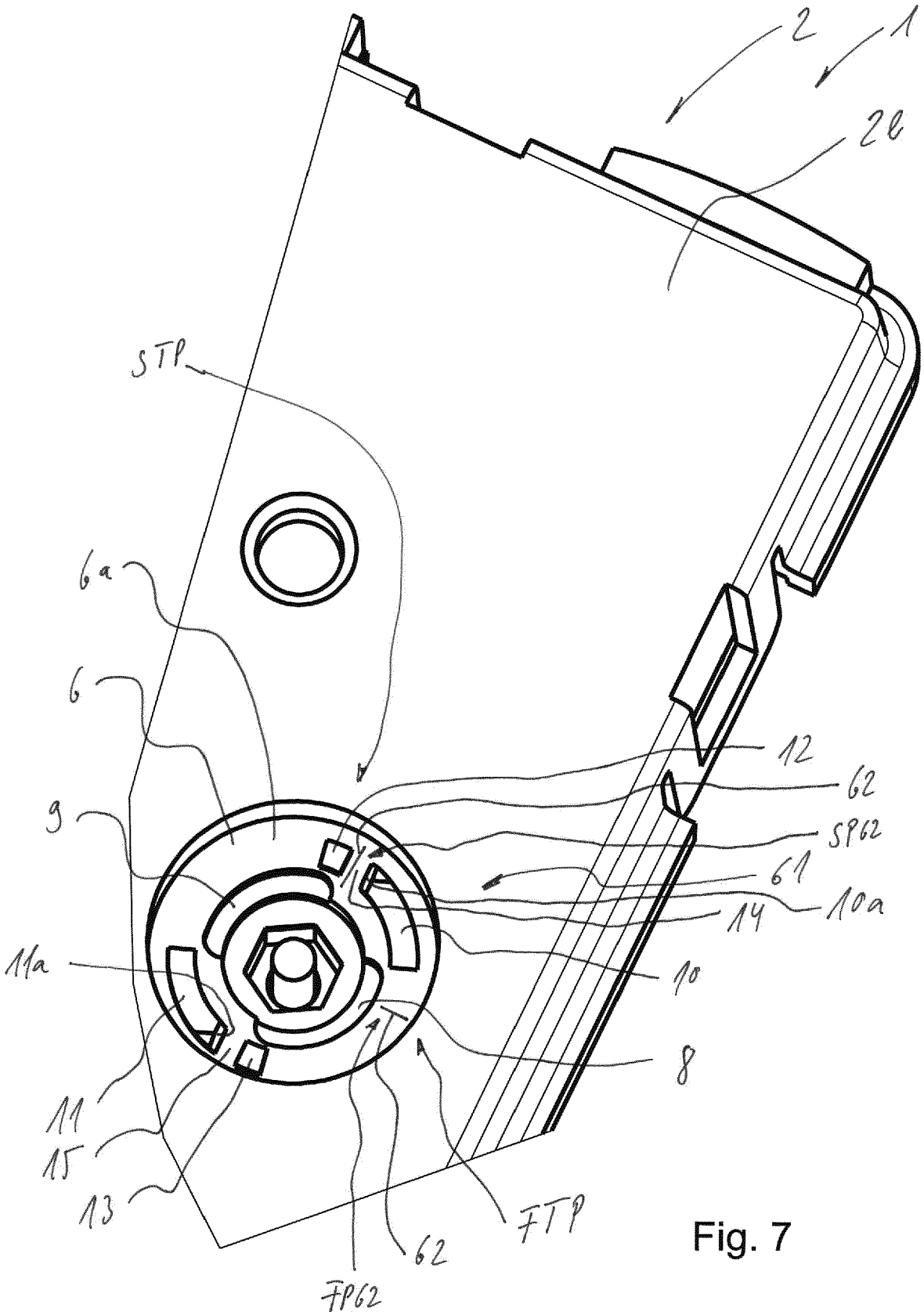

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 18 21 2812

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	24 April 2019	Topolski, Jan

CATEGORY OF CITED DOCUMENTS

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