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(54) **VEHICLE FRONT IMPACT SENSOR WITH IMPACT RESISTANT CARRIAGE**

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G01S 7/02 (2006.01)
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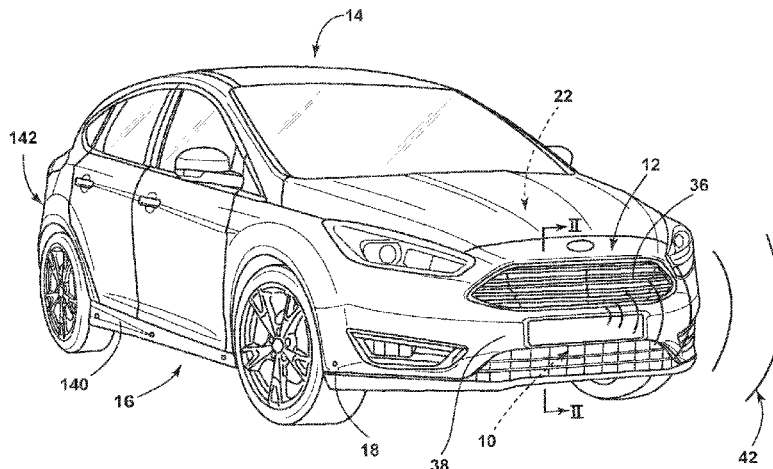
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(57) **ABSTRACT**

A vehicular radar assembly includes a radar mount positioned proximate an engine compartment within a vehicle. A radar carriage is slidably coupled to the radar mount and having a radar module coupled thereto. A biasing mechanism biases the radar carriage away from the radar mount toward a use position. Imposition of an impact force against the radar module temporarily overcomes the biasing mechanism and biases the radar carriage toward the radar mount.

20 Claims, 6 Drawing Sheets



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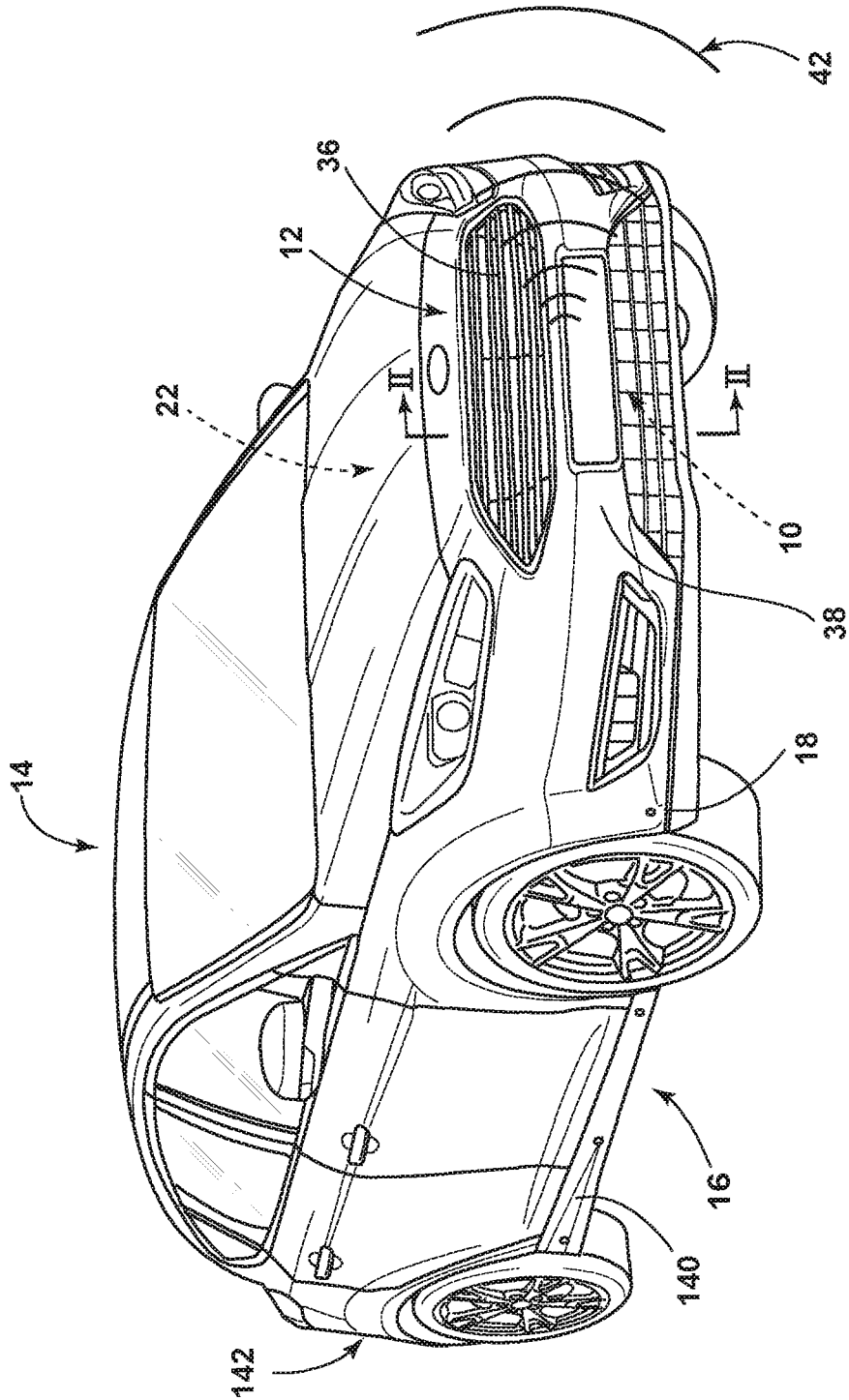


FIG. 1

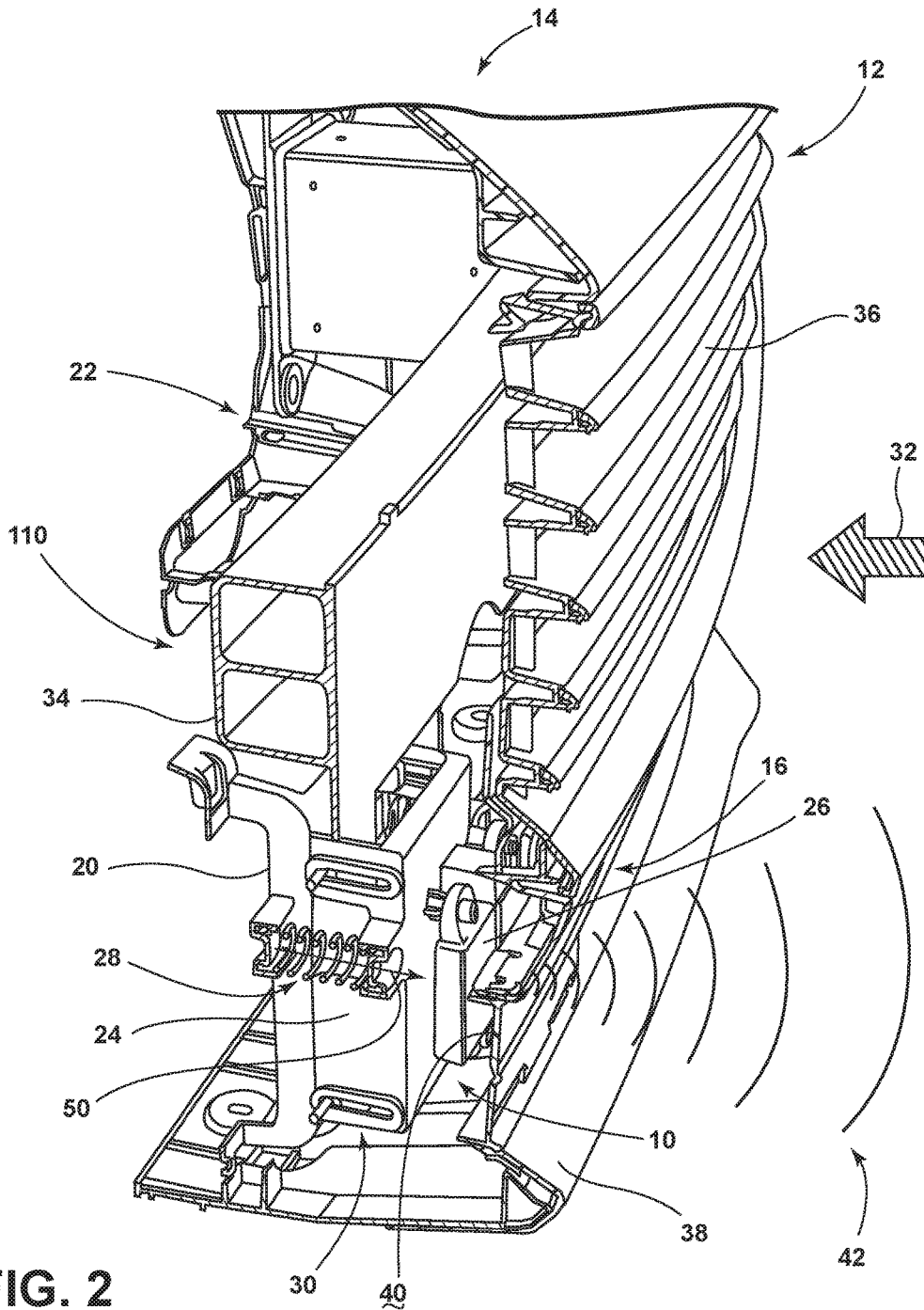


FIG. 2

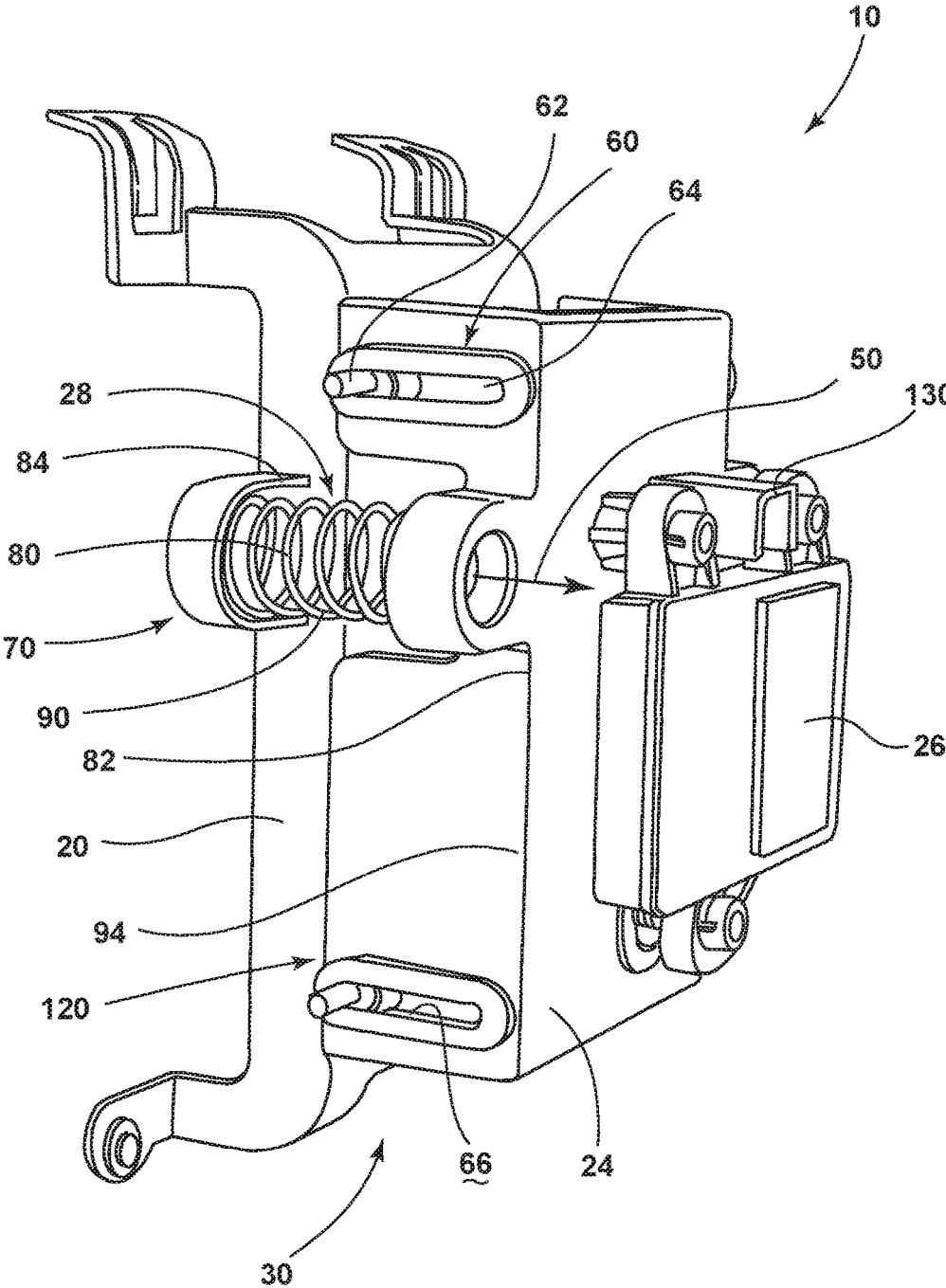


FIG. 3

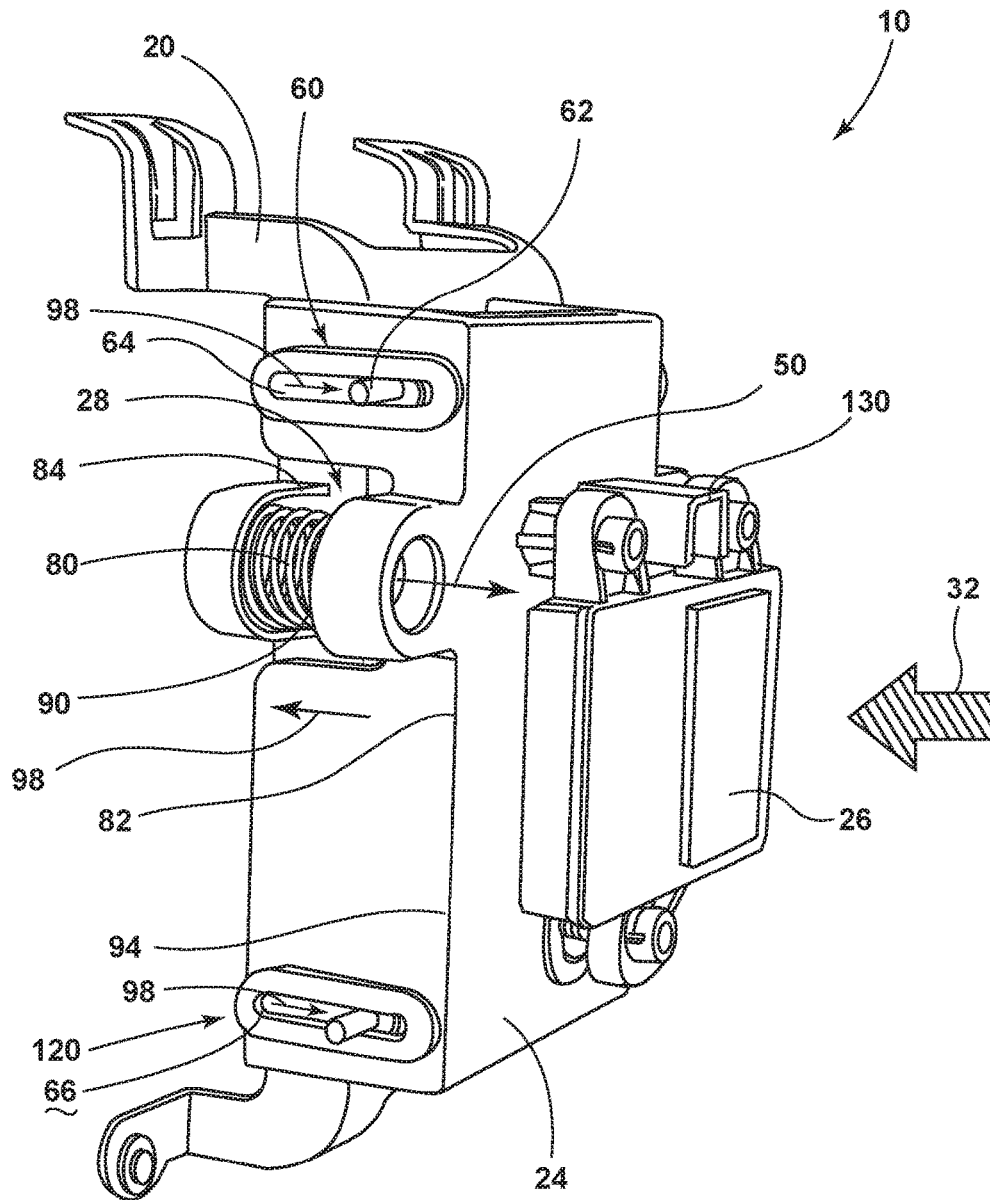


FIG. 4

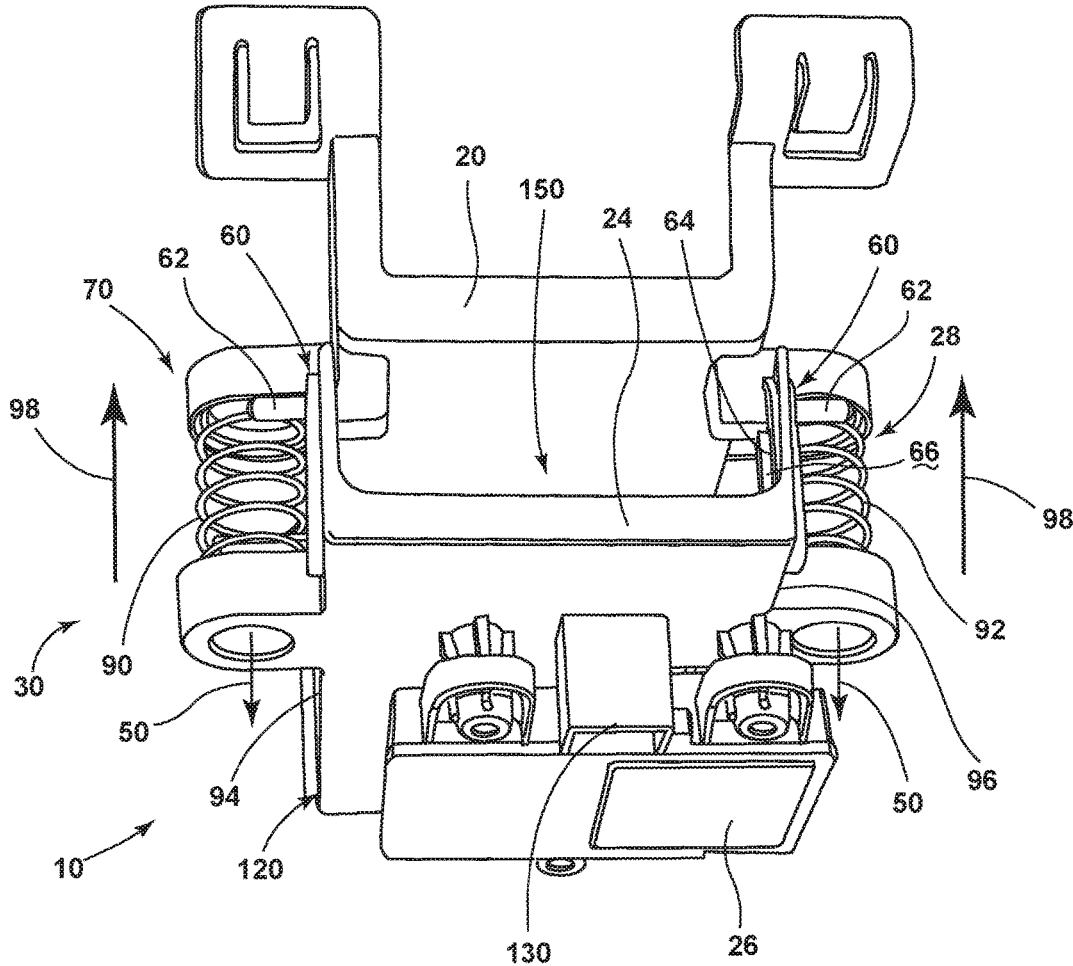


FIG. 5

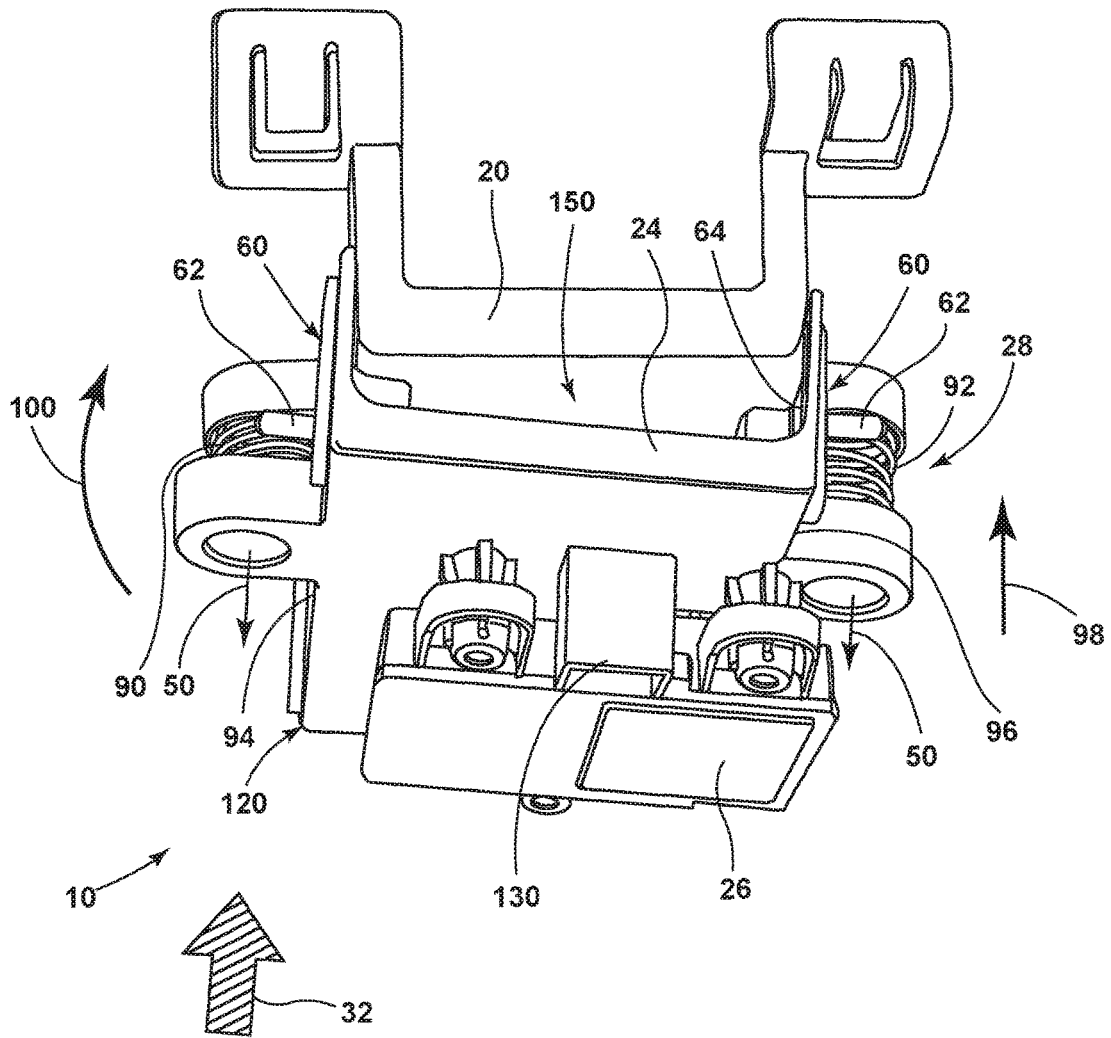


FIG. 6

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VEHICLE FRONT IMPACT SENSOR WITH IMPACT RESISTANT CARRIAGE

FIELD OF THE INVENTION

The present invention generally relates to vehicle proximity sensors, and more specifically, a front braking sensor that is mounted behind a frontal impact surface of a vehicle.

BACKGROUND OF THE INVENTION

Various vehicles include proximity sensors that are mounted around the perimeter of a vehicle. These sensors inform users of the vehicle about objects that are within a certain distance of the vehicle.

SUMMARY OF THE INVENTION

According to one aspect of the present invention, a vehicular radar assembly includes a radar mount positioned proximate an engine compartment within a vehicle. A radar carriage is slidably coupled to the radar mount and has a radar module coupled thereto. A biasing mechanism biases the radar carriage away from the radar mount toward a use position. Imposition of an impact force against the radar module temporarily overcomes the biasing mechanism and biases the radar carriage toward the radar mount.

According to another aspect of the present invention, a vehicle includes a radar mount coupled to a frame. A radar carriage is biased away from the radar mount to a use position. A radar module is coupled to the radar carriage. When an impact force is exerted against the radar module, the radar carriage is biased toward the radar mount until the impact force is removed, and the radar carriage is returned to the use position.

According to another aspect of the present invention, a vehicle radar assembly includes a radar module attached to a radar carriage. A radar mount slidably engages the radar carriage, wherein the radar carriage is biased away from the radar mount to a use position. A sliding assembly is defined between the radar mount and the radar carriage that defines a generally linear movement of the radar carriage in the event of an impact force exerted against the radar module.

These and other aspects, objects, and features of the present invention will be understood and appreciated by those skilled in the art upon studying the following specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a front perspective view of a vehicle that incorporates an aspect of the impact-resistant radar module;

FIG. 2 is a cross-sectional view of the vehicle of FIG. 1 taken along line II-II and showing the impact-resistant radar assembly in a use position;

FIG. 3 is a side perspective view of the impact-resistant radar assembly shown in the use position;

FIG. 4 is a side perspective view of the impact-resistant radar assembly of FIG. 3 shown in a biased position;

FIG. 5 is a top perspective view of the impact-resistant radar assembly of FIG. 3; and

FIG. 6 is a top perspective view of the impact-resistant radar assembly of FIG. 5 shown in a biased position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

For purposes of description herein, the terms "upper," "lower," "right," "left," "rear," "front," "vertical," "horizon-

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tal," and derivatives thereof shall relate to the invention as oriented in FIG. 1. However, it is to be understood that the invention may assume various alternative orientations, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

As shown in FIGS. 1-6, reference numeral 10 generally refers to an impact-resistant radar assembly that can be mounted within a front portion 12 of a vehicle 14. In this position, the impact-resistant radar assembly 10 uses various positioning signals 42 (radar, light waves, lasers, sonic frequencies, and others) to monitor the proximity of objects relative to the front portion 12 of the vehicle 14. The impact-resistant radar assembly 10 can be part of a vehicular radar system 16 that can be defined within the front portion 12 of the vehicle 14 or around the entire outer perimeter 18 of the vehicle 14. The impact-resistant radar assembly 10 can include a radar mount 20 that is positioned proximate an engine compartment 22 within a vehicle 14. A radar carriage 24 is slidably coupled to the radar mount 20. A radar module 26 is coupled to the radar carriage 24 such that the radar carriage 24 is slidably operable with respect to the radar mount 20. A biasing mechanism 28 serves to bias the radar carriage 24 away from the radar mount 20 and toward a use position 30 of the radar module 26. It is contemplated that the imposition of an impact force 32, typically a minimal impact force 32, against the front portion 12 of the vehicle 14 serves to temporarily overcome the biasing mechanism 28. This impact force 32 serves to bias the radar carriage 24 toward the radar mount 20.

Referring again to FIGS. 1 and 2, the radar mount 20 can be a rigid bracket that is fixedly attached to a metal bumper beam 34 mounted behind a front grill 36 of the vehicle 14. The radar mount 20 is positioned on the metal bumper beam 34 and can be oriented such that the positioning signals 42 used for sensing object proximity can be emitted from and received by the radar module 26 of the impact-resistant radar assembly 10. The radar module 26 is positioned behind a frontal impact surface 38 of the vehicle 14. The frontal impact surface 38 is typically positioned near the front grill 36. This frontal impact surface 38 is designed to absorb minimal impact forces 32 that may be experienced at low speeds. Such low speed collisions typically result in little to no permanent exterior body damage. The types of impact forces 32 contemplated are those experienced at low speeds, such as below 10 miles per hour and typically below five miles per hour.

As exemplified in FIGS. 2-6, as the frontal impact surface 38 absorbs the force of this minimal impact, the frontal impact surface 38 can deflect inward and toward the radar module 26. The backside 40 of frontal impact surface 38 can engage the radar module 26 and can transfer the impact force 32 against the radar module 26. This impact force 32 overcomes the outward biasing force 50 exerted by the biasing mechanism 28 and serves to operate the radar module 26 and the radar carriage 24 inward toward the radar mount 20. When the frontal impact force 32 is removed, the biasing mechanism 28 continues to exert the outward biasing force 50. This outward biasing force 50 returns the radar carriage 24 and the radar module 26 to the use position 30,

as the frontal impact surface **38** returns to its original shape, or substantially its original shape, after the impact force **32** is removed.

Through the use of the impact-resistant radar assembly **10**, minimal impacts that are absorbed by the frontal impact surface **38** can also be absorbed through the sliding engagement of the radar mount **20** and the radar carriage **24** to prevent or substantially prevent damage to the radar module **26** during such minimal impact. Additionally, the impact-resistant radar assembly **10** allows for placement of the radar module **26** at an extreme forward position of the vehicle **14**. This forward positioning provides for more effective sensing operation for determining the proximity of objects exterior of the vehicle **14**.

Referring again to FIGS. 2-6, a sliding assembly **60** can be defined between the radar mount **20** and the radar carriage **24**. The sliding assembly **60** defines the use position **30** and guides the sliding operation of the radar carriage **24** relative to the radar mount **20** during imposition and removal of the frontal impact force **32**. This sliding assembly **60** can include a tab **62** that extends between the radar mount **20** and radar carriage **24**. This tab **62** can extend through a guide slot **64** that is defined within the other of the radar mount **20** and the radar carriage **24**. Typically, the tab **62** can extend from the radar mount **20** and pass through a guide slot **64** that is defined within the radar carriage **24**. It should be understood that the tab **62** can extend from the radar carriage **24** and can extend through a guide slot **64** that is defined within the radar mount **20**. Other similar sliding and guide mechanisms can be incorporated to control the movement of the radar carriage **24** with respect to the radar mount **20**.

As exemplified in FIGS. 2-6, the biasing mechanism **28** can cooperate with the sliding assembly **60** to at least partially load the biasing mechanisms **28** to define the use position **30**. By partially loading the biasing mechanism **28**, the radar carriage **24** is maintained in a substantially stable position relative to the radar mount **20**. In the pre-loaded state **70**, or partially-loaded state, a portion of the tabs **62** is held against a portion of the slot **64**. The outward biasing force **50** of the biasing mechanism **28** holds the tabs **62** against the outer surface **66** that defines the slot **64**. In this manner, the pre-loaded state **70** of the biasing mechanism **28** can serve to minimize vibration and wobble of the sliding carriage and the radar module **26** during use of the vehicle **14**. Accordingly, the pre-loaded state **70** of the biasing mechanism **28** serves to maintain the radar module **26** in a substantially consistent position to accurately measure proximity of various objects that may be positioned around the vehicle **14** during use.

Referring to FIGS. 3-6, the biasing mechanism **28** can include at least one spring **80**, such as at least one compression spring, and typically includes two or more springs **80** that are spaced along outer edges **82** of the radar mount **20** and radar carriage **24**. The radar mount **20** and radar carriage **24** can each include a spring seat **84**. Each spring **80** of the biasing mechanism **28** is adapted to be seated within corresponding spring seats **84** of the radar mount **20** and radar carriage **24**. The biasing mechanism **28** in the use position **30** can be at least partially compressed between the radar mount **20** and the radar carriage **24** in the pre-loaded state **70** while mounted within the various spring seats **84** of the impact-resistant radar assembly **10**.

Typically, the biasing mechanism **28** may include first and second springs **90**, **92**. The first spring **90** can be positioned along a first edge **94** of the impact-resistant radar assembly **10** to extend between the spring seats **84** defined within the radar mount **20** and radar carriage **24**. A second spring **92**

can be positioned along an opposing second edge **96** of the impact-resistant radar assembly **10** to extend between the spring seats **84** defined within the radar mount **20** and the radar carriage **24**. By using first and second springs **90**, **92**, the radar carriage **24** can slidably operate relative to the radar mount **20** in more than just a linear movement **98**.

By way of example, and not limitation, as exemplified in FIGS. 5 and 6, where a frontal impact force **32** is received by the frontal impact surface **38** off-center or at an angle, the frontal impact force **32** may be transmitted to the radar module **26** and/or the radar carriage **24** at a similar angle or along only one of the first and second edges **94**, **96** of the impact-resistant radar assembly **10**. In such an asymmetric imposition of the frontal impact force **32**, the radar carriage **24** can be biased toward the radar mount **20** in a generally rotational movement **100**. This generally rotational movement **100** may be achieved when only one of the first and second springs **90**, **92** is biased away from the use position **30**. In such an embodiment, the radar carriage **24** is capable of linear and rotational movement **98**, **100** with respect to the radar mount **20**.

Referring again to FIGS. 2-6, the radar mount **20** can be coupled to various portions of the frame **110** of the vehicle **14**. Such members of the frame **110** can include the metal bumper beam **34**, but are also contemplated to include various other members of the frame **110** of the vehicle **14**. The radar carriage **24** is coupled to the radar mount **20** and is biased away from the radar mount **20** to define the use position **30**. The radar module **26** is coupled to the radar carriage **24**. When an impact force **32**, typically a frontal impact force **32**, is exerted against the radar module **26** and/or the radar carriage **24**, the radar carriage **24** is biased toward the radar mount **20** until the impact force **32** is removed. When the frontal impact force **32** is removed, the radar carriage **24** is biased back to the use position **30** through the use of the biasing mechanism **28** that extends between the radar mount **20** and the radar carriage **24**. As discussed above, the biasing mechanism **28** is at least partially loaded, or partially compressed when the impact-resistant radar assembly **10** is placed in use position **30**.

Referring again to FIGS. 2-6, the sliding assembly **60** that is defined between the radar mount **20** and the radar carriage **24** cooperates with the biasing mechanism **28** to provide a generally linear movement **98** of the radar carriage **24** away from and toward the use position **30**. As discussed above, the use of multiple springs **80** within the biasing mechanism **28** can serve to provide a generally rotational movement **100** of the radar carriage **24** relative to the radar mount **20** as well. Accordingly, the radar carriage **24** can define a series of linear and rotational movements **98**, **100** away from and toward the use position **30** during the imposition and removal of the frontal impact force **32**.

Referring again to FIGS. 2-6, the sliding assembly **60** cooperates with the biasing mechanism **28** to define the use position **30** and also define the movement of the radar carriage **24** relative to the radar mount **20**. The sliding assembly **60** can include a plurality of guide slots **64** that are defined within the radar carriage **24**. The plurality of guide slots **64** are typically spaced about a perimeter **120** of the radar carriage **24**. A plurality of mating tabs **62** that extend outward from the radar mount **20** are adapted to extend through each of the guide slots **64**, respectively. In various embodiments, the radar carriage **24** can include four guide slots **64** that are adapted to receive four corresponding mating tabs **62** that extend outward from the radar mount **20**. The sliding movement of the mating tabs **62** within the respective guide slot **64** serves to guide the linear and

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rotational movement **98**, **100** of the radar carriage **24** with respect to the radar mount **20**. The biasing mechanism **28** provides a substantially constant outward biasing force **50** that tends the radar carriage **24** and the radar module **26** toward the use position **30**. As discussed above, the biasing mechanism **28** holds the tabs **62** against an outer surface **66** of the slots **64** to maintain the radar module **26** in the use position until the impact force **32** is experienced. In turn, the sliding assembly **60** directs the outward biasing force **50** imposed by the biasing mechanism **28** to substantially return the radar carriage **24** to the use position **30** after the frontal impact force **32** has been removed.

In various embodiments, the tabs **62** can include a palnut or other enlarged area at the outer end of each tab **62**. This enlarged area can serve to prevent the tab **62** from sliding out of engagement with the slot **64** during the imposition of an impact force **32**. The enlarged area, typically in the form of a palnut, can be attached to each tab **62** after the tabs **62** are inserted through a corresponding slot **64**. The enlarged area included within one or more of the tabs **62** can also be in the form of a molded portion of the tab **62** that is shaped to prevent passage of the tab **62** out of engagement with the slot **64**.

This configuration of the radar mount **20** and radar carriage **24** that are connected by the biasing mechanism **28** and sliding assembly **60** serves to protect or substantially protect the radar module **26** in the event of a low speed impact. Accordingly, the radar module **26** is configured to allow for absorption of the impact force **32**. This serves to limit the need for replacement of the radar module **26** after each low-speed impact. Additionally, this device allows the radar module **26** to be positioned at an extreme forward position and immediately behind the frontal impact surface **38** of the vehicle **14**. This positioning can increase the effectiveness of the radar module **26**.

As exemplified in FIGS. 2-6, the impact-resistant radar assembly **10** of the vehicle radar system can include a radar module **26** that is attached to a radar carriage **24**. The radar mount **20** is adapted to slidably engage the radar carriage **24**. Through this engagement, the radar carriage **24** is biased away from the radar mount **20** to a use position **30** of the radar module **26** with respect to the radar mount **20**. A sliding assembly **60** defined between the radar mount **20** and the radar carriage **24** defines a generally linear movement **98** and also a generally rotational movement **100** of the radar carriage **24** with respect to the radar mount **20** in the event of an impact force **32** exerted against the radar module **26** and/or the radar carriage **24**.

According to the various embodiments, as exemplified in FIGS. 2-6, it is contemplated that the radar carriage **24** can include an impact member **130** that extends forward of the radar module **26**. In such an embodiment, the impact member **130** is adapted to receive at least a portion of the impact force **32** from the backside **40** of the frontal impact surface **38**. As this frontal impact force **32** is exerted against, or at least partially against, the impact member **130** of the radar carriage **24**, portions of the frontal impact force **32** can be directed away from the radar module **26**. These frontal impact forces **32** can be directed through the impact member **130** and be transmitted through the radar carriage **24** to operate the radar carriage **24** and the radar module **26** away from the use position **30** and toward the radar mount **20**. It is contemplated that the impact member **130** of the radar carriage **24** is positioned so as not to interfere with the operation of the radar module **26** in transmitting and receiving various frequencies of sound for determining the proximity of objects that are exterior to the vehicle **14**.

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Referring again to FIGS. 1-6, the impact-resistant radar assembly **10** can be positioned as a front braking module adapted to be positioned proximate and behind a front grill **36** of the vehicle **14**. It is also contemplated that the impact-resistant radar assembly **10** can be positioned along one of the side panels **140** or along the rear **142** of the vehicle **14**, such that any minimal impact experienced by the vehicle **14** proximate one of the radar modules **26** can be absorbed through operation of the biasing mechanism **28** and sliding assembly **60** of the radar mount **20** and radar carriage **24**.

The biasing mechanism **28** of the impact resistant radar module **26** can include first and second springs **90**, **92** that are positioned at opposing first and second edges **94**, **96** of the impact-resistant radar assembly **10**. It is also contemplated that additional springs **80** or similar biasing mechanisms **28** can be positioned around a perimeter of the impact-resistant radar assembly **10**, as needed. Additional springs **80** may be included for vehicles **14** that may experience greater vibration or rugged road conditions, such as sport utility vehicles, pick-up trucks, and other similar vehicles **14** that may experience severe driving conditions. It is also contemplated that the biasing mechanism **28** for the impact-resistant radar assembly **10** can include a single spring **80** that is centrally positioned between the radar mount **20** and the radar carriage **24**. In such an embodiment, the spring seats **84** of the radar mount **20** and radar carriage **24** can be positioned within the gap **150** defined between the radar mount **20** and the radar carriage **24** when the impact-resistant radar assembly **10** is in the use position **30**. Typically, the biasing mechanisms **28** will be positioned outside of the gap **150** between the radar module **26** and the radar carriage **24** and proximate the perimeter **120** of the radar mount and carriage **20**, **24**.

It is contemplated that the biasing mechanism **28** can include compression springs, coil springs, elastomeric members, cushioning members, combinations thereof and other similar biasing mechanisms **28** that can bias the radar carriage **24** towards the use position **30** and also be biased away from the use position **30** during the imposition of a frontal impact force **32**.

It is to be understood that variations and modifications can be made on the aforementioned structure without departing from the concepts of the present invention, and further it is to be understood that such concepts are intended to be covered by the following claims unless these claims by their language expressly state otherwise.

What is claimed is:

1. A vehicular radar assembly comprising:
 - a radar mount positioned proximate an engine compartment within a vehicle;
 - a radar carriage slidably coupled to the radar mount and having a radar module coupled thereto; and
 - a biasing mechanism that biases the radar carriage away from the radar mount toward a use position; wherein imposition of an impact force against the radar module temporarily overcomes the biasing mechanism and biases the radar carriage toward the radar mount.
2. The vehicular radar assembly of claim 1, wherein removal of the impact force results in the biasing mechanism returning the radar carriage to the use position.
3. The vehicular radar assembly of claim 1, further comprising:
 - a sliding assembly defined between the radar mount and the radar carriage, wherein the sliding assembly defines the use position and guides a sliding operation of the radar carriage relative to the radar mount.

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4. The vehicular radar assembly of claim 3, wherein the sliding assembly includes a tab that extends from the radar mount through a guide slot defined in the radar carriage.

5. The vehicular radar assembly of claim 4, wherein the use position is defined by a partially-loaded state of the biasing mechanism.

6. The vehicular radar assembly of claim 1, wherein the biasing mechanism includes at least one compression spring.

7. The vehicular radar assembly of claim 1, wherein the radar mount and radar carriage each includes a spring seat, wherein a spring of the biasing mechanism is seated within the spring seats of the radar mount and radar carriage, and wherein the biasing mechanism in the use position is at least partially compressed between the radar mount and radar carriage.

8. A vehicle comprising:

a radar mount coupled to a frame;

a radar carriage biased away from the radar mount to a use position; and

a radar module coupled to the radar carriage; wherein when an impact force is exerted against the radar module, the radar carriage is biased toward the radar mount until the impact force is removed, wherein the radar carriage is returned to the use position.

9. The vehicle of claim 8, further comprising:

a biasing mechanism extending between the radar mount and the radar carriage, the biasing mechanism biasing the radar carriage toward the use position.

10. The vehicle of claim 9, further comprising:

a sliding assembly defined between the radar mount and the radar carriage, wherein the sliding assembly cooperates with the biasing mechanism to provide a generally linear movement of the radar carriage away from and toward the use position.

11. The vehicle of claim 8, wherein the radar carriage includes an impact member that extends forward of the radar module, wherein the impact member is adapted to receive at least a portion of the impact force.

12. The vehicle of claim 8, wherein the radar module is a front braking module and the radar mount is attached to the frame proximate a front grill of the vehicle.

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13. The vehicle of claim 9, wherein the biasing mechanism includes two compression springs.

14. The vehicle of claim 13, wherein the use position is defined by the compression springs being at least partially loaded.

15. The vehicle of claim 10, wherein the sliding assembly includes a plurality of guide slots defined within the radar carriage, the plurality of guide slots spaced about a perimeter of the radar carriage, wherein a plurality of mating tabs of the radar mount extend through each of the guide slots, respectively.

16. The vehicle of claim 15, wherein the radar carriage includes four guide slots.

17. The vehicle of claim 15, wherein the biasing mechanism includes first and second springs that are positioned proximate each guide slot of the plurality of guide slots, respectively.

18. A vehicle radar assembly comprising:

a radar module attached to a radar carriage;

a radar mount that slidably engages the radar carriage, wherein the radar carriage is biased away from the radar mount to a use position; and

a sliding assembly defined between the radar mount and the radar carriage that defines a generally linear movement of the radar carriage when an impact force is exerted against the radar module.

19. The vehicle radar assembly of claim 18, further comprising:

a plurality of biasing mechanisms that cooperate with the sliding assembly to bias the radar carriage to the use position, wherein after the impact force is exerted and the radar carriage is biased along the sliding assembly away from the use position, the plurality of biasing mechanisms bias the radar carriage and the radar module back to the use position.

20. The vehicle radar assembly of claim 18, wherein the radar module is a front braking module adapted to be positioned proximate a front grill of a vehicle.

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