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(54) **AUTONOMOUS VEHICLE WITH
UNOBTRUSIVE SENSORS**

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6, 2015.

(57)

ABSTRACT

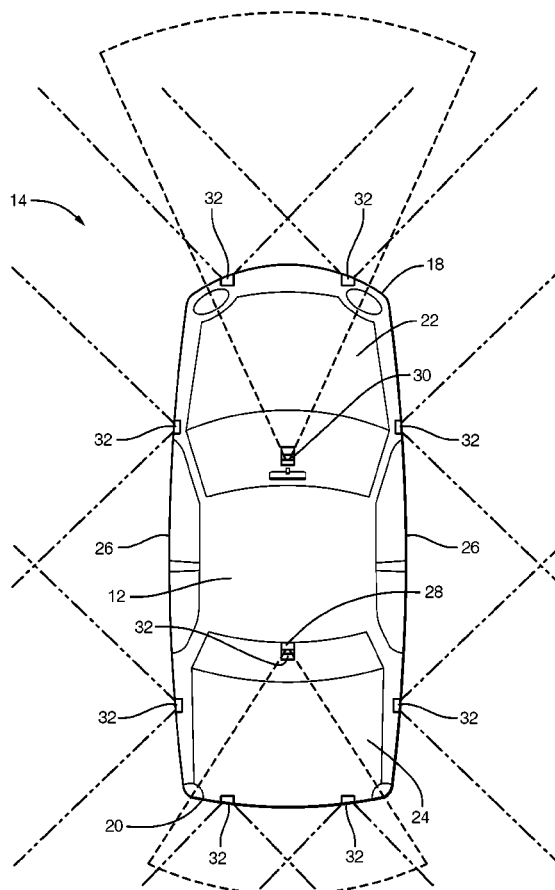
Publication Classification

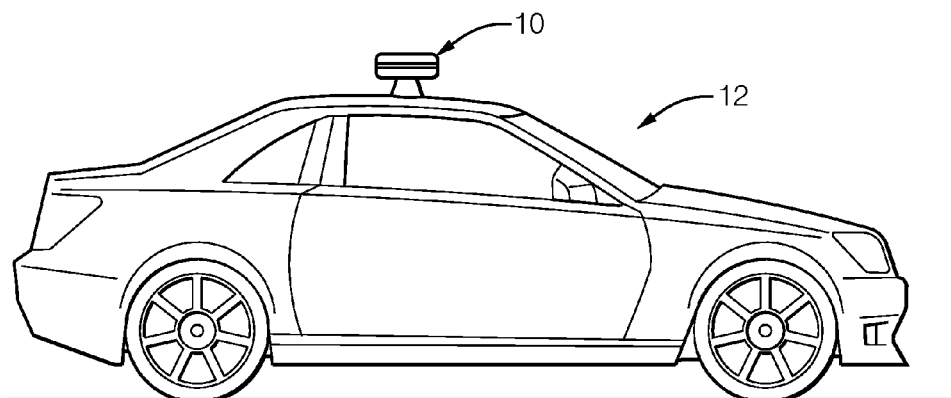
(51) **Int. Cl.**

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G01S 13/86 (2006.01)

A vehicle having an array of sensors mounted entirely within
and without protrusion beyond a pre-existing exterior sur-
face of a vehicle, sufficient to give a substantially complete
360 degree perimeter sweep of data collection for operating
an autonomously driven vehicle.





PRIOR ART
FIG. 1

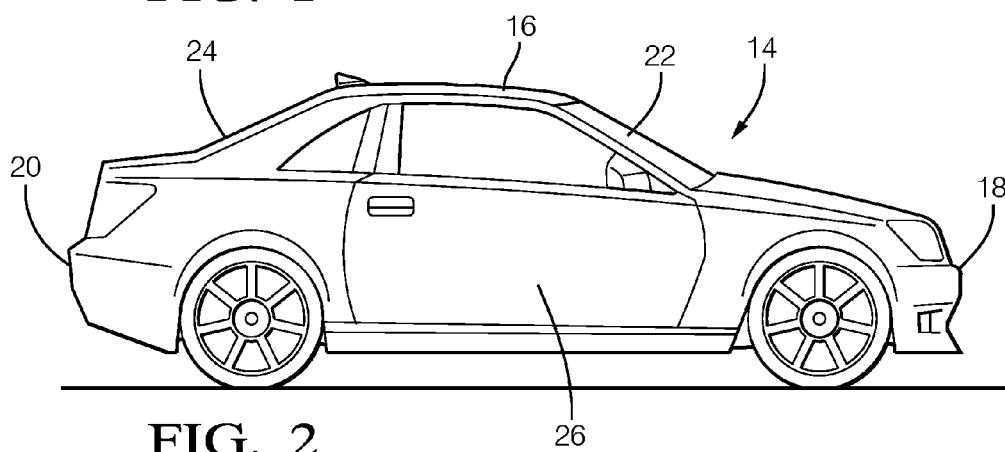


FIG. 2

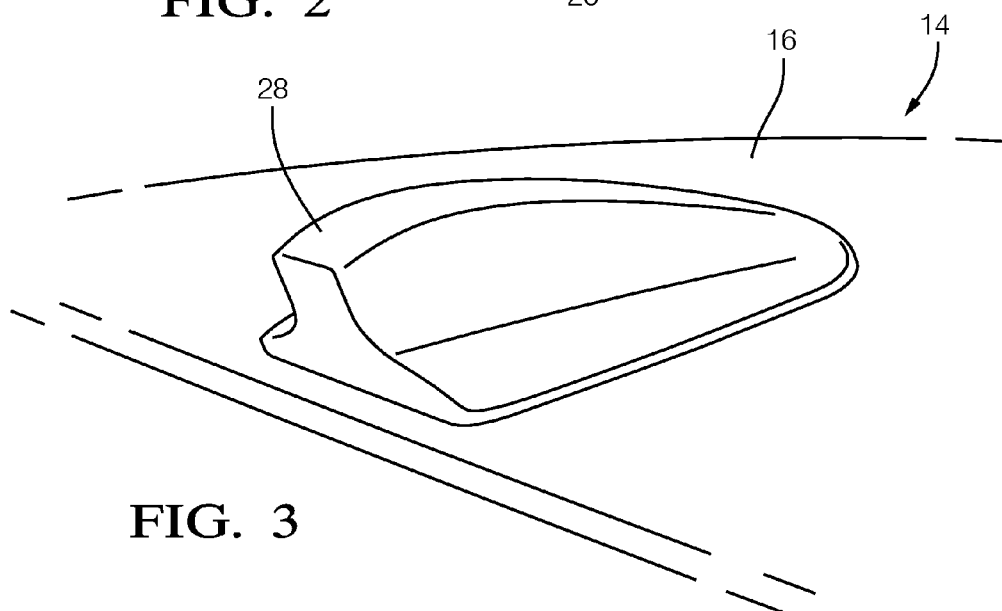


FIG. 3

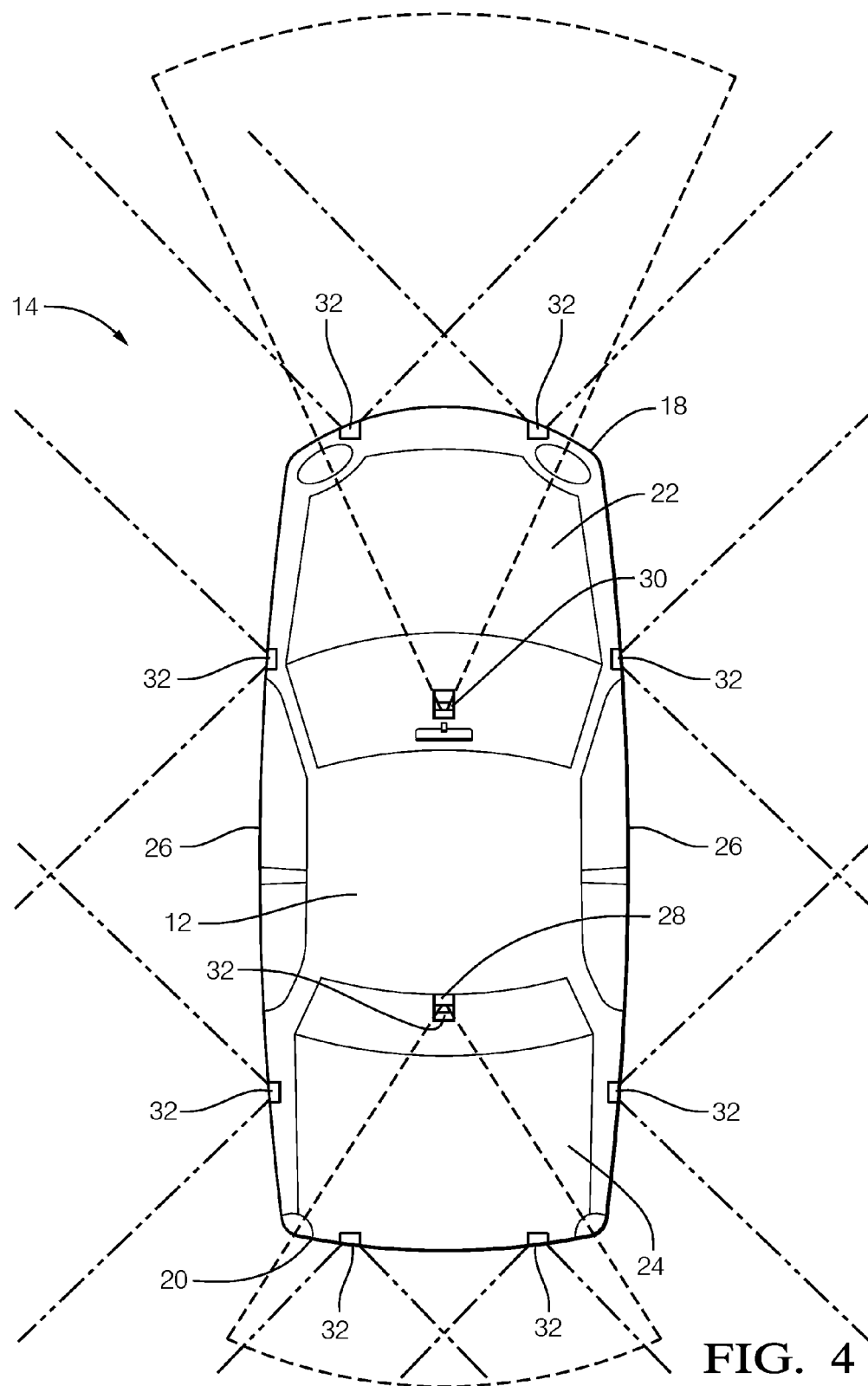


FIG. 4

AUTONOMOUS VEHICLE WITH UNOBTRUSIVE SENSORS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit under 35 U.S.C. §371 of published PCT Patent Application Number PCT/US2015/64283, filed 7 Dec. 2015 and published as WO2016/126322 on 11 Aug. 2016, which claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 62/112783, filed 6 Feb. 2015, the entire disclosure of which is hereby incorporated herein by reference.

TECHNICAL FIELD OF INVENTION

[0002] The invention relates to a configuration for an autonomously driven vehicle in which the sensors do not intrude physically beyond the conventional, existing exterior surface or skin of the vehicle.

BACKGROUND OF THE INVENTION

[0003] An autonomously driven vehicle requires that the surroundings of the vehicle be sensed more or less continually and, more importantly, for 360 degrees around the perimeter of the car.

[0004] A typical means for sensing is a relatively large LIDAR unit (a sensor unit using pulsed laser light rather than radio waves). An example of a known-vehicle 12 is shown in FIG. 1, showing a large LIDAR unit 10 extending prominently above the roof line of the known-vehicle 12. The size and elevation and 360 degree shape of the unit 10 make it feasible to generate the data needed, but it is clearly undesirable from the standpoint of aesthetics, aerodynamics, and cost.

SUMMARY OF THE INVENTION

[0005] The present disclosure provides an autonomously driven car in which the sensors used to provide the 360 degrees of sensing do not extend beyond the pre-existing, conventional outer surface or skin of the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The subject matter which is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0007] FIG. 1 is side view of a known-vehicle;

[0008] FIG. 2 is side view of a vehicle;

[0009] FIG. 3 is an enlarged view of the back roof line of the vehicle;

[0010] FIG. 4 is a schematic top view of the vehicle showing the range of coverage of the various sensors.

DETAILED DESCRIPTION

[0011] Referring now to the Figures, the invention will be described with reference to specific embodiments, without limiting same. Where practical, reference numbers for like components are commonly used among multiple figures.

[0012] Referring first to FIGS. 2 and 3, a conventional vehicle 14, hereafter referred to as the vehicle 14, has a pre-determined exterior surface comprised generally of

body sections including roof 16, front bumper section 18, rear bumper section 20, front windshield 22, rear window 24, vehicle-sides 26. Such are rather arbitrary distinctions and delineations in what is basically a continuous outer surface or skin comprised thereof. However, a typical car owner or customer will recognize that there is a basic, conventional outer surface, desirably free of severe obtrusions therebeyond, both for aesthetic and aerodynamic reasons. In addition, an antenna housing 28 on the roof, commonly referred to as a “shark fin,” has become commonplace and accepted, and can be considered part of a conventional outer surface, though it might have been considered an obtrusion at one point in time.

[0013] Referring next to FIG. 4, a car that can potentially be autonomously driven will need sensing of the environment continually, and, just as important, 360 degrees continuously around. That is easily achieved by a large, top mounted LIDAR unit, but that is undesirable for the reasons noted above. In the preferred embodiment disclosed here, several technologies owned by the assignee of the present invention enable the need to be met in an aesthetically non objectionable fashion, with no use of a LIDAR unit. Mounted behind and above the front windshield 22 is a camera-radar fusion unit 30 of the type disclosed in co-assigned U.S. Pat. No. 8,604,968, incorporated herein by reference. Camera-radar fusion unit 30 has unique and patented features that allow it to be mounted directly and entirely behind front windshield 22, and so “see” and work through, the glass of front windshield 22, with no alteration to the glass. The camera-radar fusion unit 30 is capable of providing and “fusing” the data from both a camera and a radar unit, providing obstacle recognition, distance and motion data, and to cover a large portion of the 360 degree perimeter. More detail on the advantages can be found in the US patent noted, but, for purposes here, the main advantage is the lack of interference with or alteration of the exterior or glass of the vehicle 14.

[0014] Still referring to FIG. 4, several instances of radar units 32 may be mounted around the rest of the perimeter of vehicle 14, shown in the preferred embodiment as two in front bumper section 18, two in rear bumper section 20, four evenly spaced around the vehicle-sides 26. The number disclosed is exemplary only, and would be chosen so as to sweep out the entire 360 degree perimeter without significant overlap. Radar units 32 disclosed in several co pending and co assigned patent applications provide compact and effective units that can be easily unobtrusively mounted, without protrusion beyond the exterior vehicle surface, such as behind bumper fascia, in side mirrors, etc. By way of example, U.S. Ser. No. 14/187,404, filed Mar. 5, 2014, discloses a compact unit with a unique antennae array that improves detection range and adds elevation measurement capability. U.S. Ser. No. 14/445,569, filed Jul. 29, 2014, discloses a method for range-Doppler compression. In addition, U.S. Ser. No. 14/589,373, filed Jan. 5, 2015, discloses a 360 degree radar capable of being enclosed entirely within the antenna housing 28, which would give a great simplification. Fundamentally, the sensors would be sufficient in number to give essentially a complete, 360 degree perimeter of coverage.

[0015] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Within the broad objective

of providing 360 degree sensor coverage, while remaining within the exterior envelope of the car, other compact or improved sensors could be used.

1. A vehicle having a pre-determined exterior surface comprised of body sections and at least a front windshield, said vehicle further including sensors capable of providing data from a substantially 360 degree perimeter of said vehicle all of said sensors being mounted without protrusion beyond said exterior surface.

2. A vehicle according to claim 1, in which said sensors include at least one radar-camera fusion unit mounted entirely behind said front windshield and operating through said front windshield.

3. A vehicle according to claim 1, in which said sensors include one or more radar units mounted entirely within said exterior surface.

4. A vehicle according to claim 1, in which said sensors include both a camera-radar fusion unit and at least one radar unit.

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