US009725060B1

(12) **United States Patent**
Daniel et al.

(10) **Patent No.: US 9,725,060 B1**
(45) **Date of Patent: Aug. 8, 2017**

(54) **REDUCING SURFACE RIGIDITY OF A VEHICLE**

(71) Applicant: **Waymo LLC**, Mountain View, CA (US)

(72) Inventors: **Thomas Daniel**, San Francisco, CA (US); **Daniel Lynn Larner**, San Jose, CA (US); **Felix Jose Alvarez Rivera**, Tarzana, CA (US); **Atul Gupta**, San Jose, CA (US)

(73) Assignee: **Waymo LLC**, Mountain View, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/844,607**

(22) Filed: **Sep. 3, 2015**

(51) **Int. Cl.**

B60R 19/02	(2006.01)
B60R 21/34	(2011.01)
B60R 21/0134	(2006.01)
B60R 19/00	(2006.01)

(52) **U.S. Cl.**
CPC ***B60R 21/0134*** (2013.01); ***B60R 19/02*** (2013.01); ***B60R 21/34*** (2013.01); *B60R 2019/007* (2013.01); *B60R 2021/343* (2013.01)

(58) **Field of Classification Search**
CPC B60R 19/02; B60R 21/0134; B60R 21/34; B60R 2019/007; B60R 2021/343
USPC 701/45
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

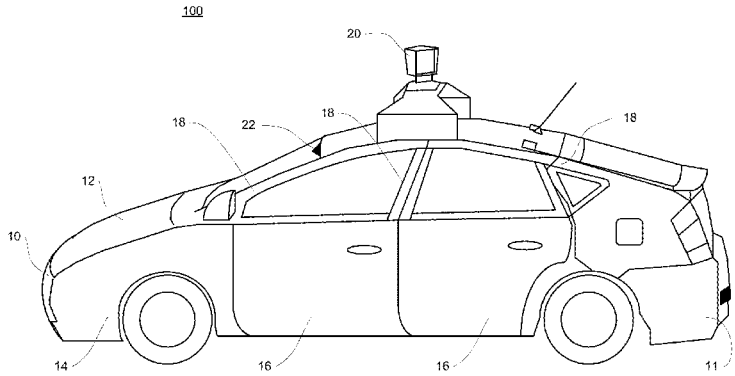
1,539,873	A	6/1925	Schiesari	
1,701,308	A	2/1929	Rosenberg	
3,614,148	A	10/1971	Favary	
4,616,866	A	10/1986	Loren et al.	
7,669,685	B2 *	3/2010	Takahashi	B60R 21/0134 180/271
2006/0060408	A1 *	3/2006	Kalliske	B60R 21/38 180/274
2006/0103061	A1 *	5/2006	Kennedy	C08G 18/10 267/116
2006/0232051	A1 *	10/2006	Morris	B60R 21/02 280/732
2009/0056230	A1 *	3/2009	Flendrig	B60J 5/0405 49/502
2009/0206618	A1 *	8/2009	Ralston	B60R 19/18 293/120
2010/0244484	A1 *	9/2010	Nakaura	B60R 21/38 296/187.04
2011/0091273	A1 *	4/2011	Sayre	C08G 18/10 404/6
2011/0210579	A1 *	9/2011	Marur	B60N 2/42709 296/187.03
2012/0073884	A1 *	3/2012	Guthrie	B60G 11/00 177/225
2012/0125699	A1 *	5/2012	Guthrie	B60G 11/00 177/225

(Continued)

Primary Examiner — Atul Trivedi

(74) *Attorney, Agent, or Firm* — Lerner, David, Littenberg, Krumholz & Mentlik, LLP

(57) **ABSTRACT**

Aspects of the disclosure relate altering the rigidity of a vehicle's surface. More particularly, the vehicle may contain tension members that are arranged so that a change in tension across one or more of the tension members will alter the rigidity of the vehicle's surface. The vehicle may identify and respond to a potential collision by altering the tension that is applied to one or more tension members, thereby altering the rigidity of the vehicle's surface.

20 Claims, 9 Drawing Sheets