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Bernhard

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[54] **METHOD FOR PROVIDING GUIDING ASSISTANCE FOR A VEHICLE IN CHANGING LANE**

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[30] **Foreign Application Priority Data**

Apr. 26, 1993 [DE] Germany 43 13 568.4

[51] **Int. Cl.**[6] **B60Q 1/00**; G08G 1/16

[52] **U.S. Cl.** **340/438**; 340/435; 340/436; 340/901; 340/903; 180/167; 180/169; 364/424.01; 364/461

[58] **Field of Search** 340/438, 436, 340/901–905, 435; 180/167–169, 271; 348/143, 148, 149, 169; 364/461, 460, 424.01, 424.02

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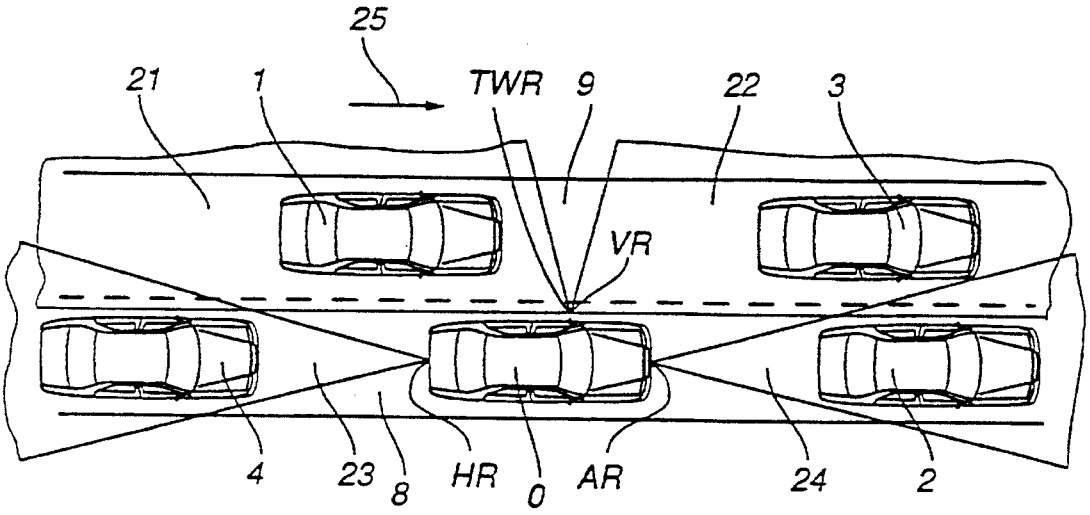
Attorney, Agent, or Firm—Evenson, McKeown, Edwards & Lenahan

[57] **ABSTRACT**

Method of assisting a motor vehicle in changing from a current lane to an adjacent target lane. The space in front and the space behind the vehicle at least in the adjacent target lane is monitored, the distance of objects (in particular vehicles) detected there, and their speeds are measured, and safety distances calculated therefrom. If all the measured distances are greater than the calculated safety distances, a possible lane change is signalled.

14 Claims, 3 Drawing Sheets



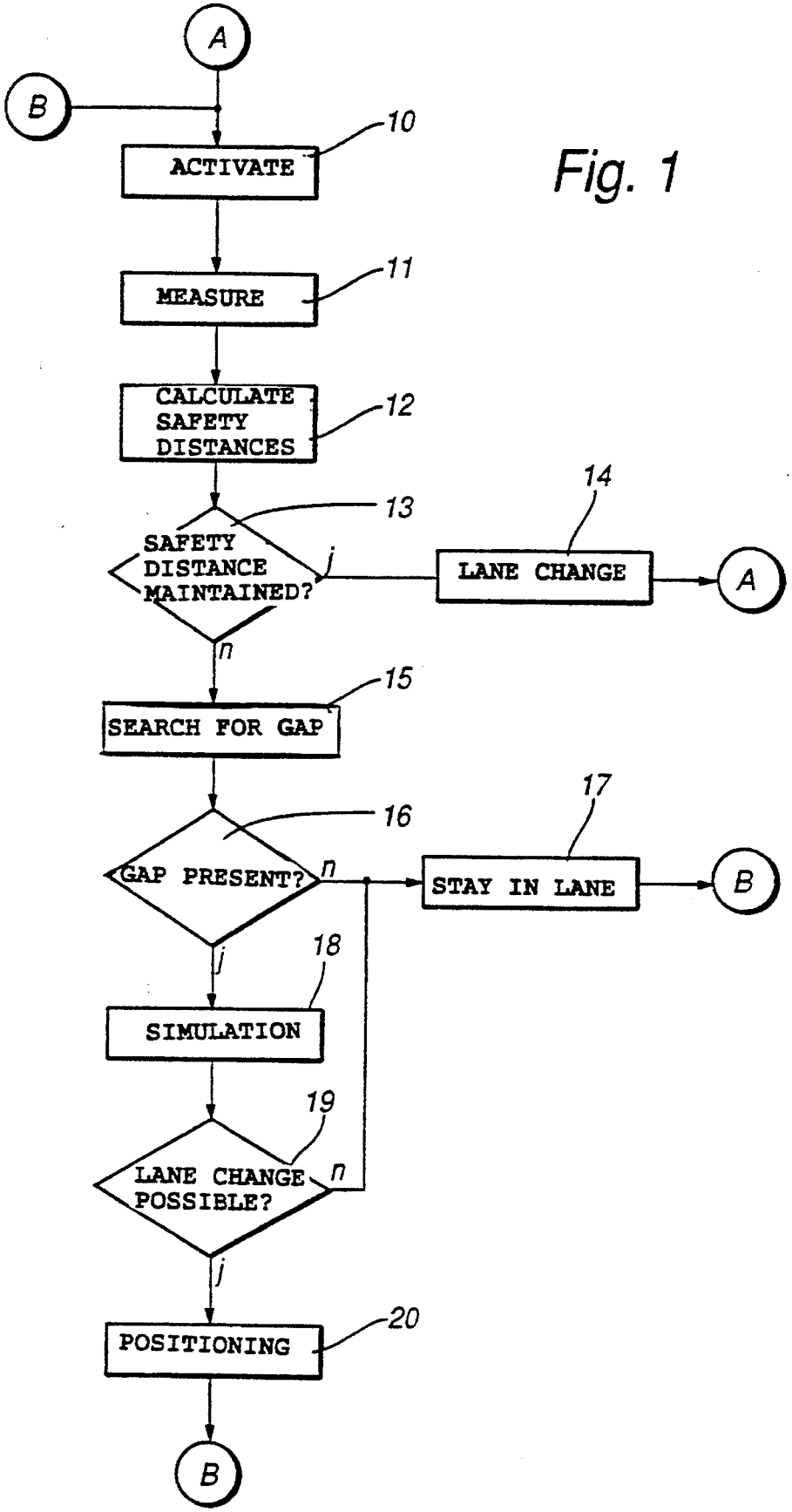


Fig. 1

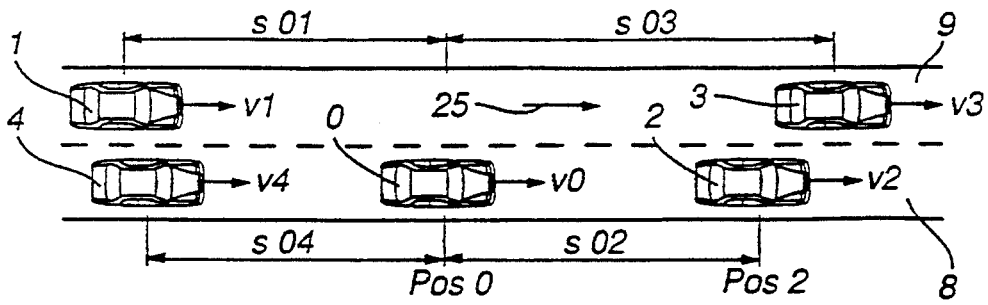


Fig. 2

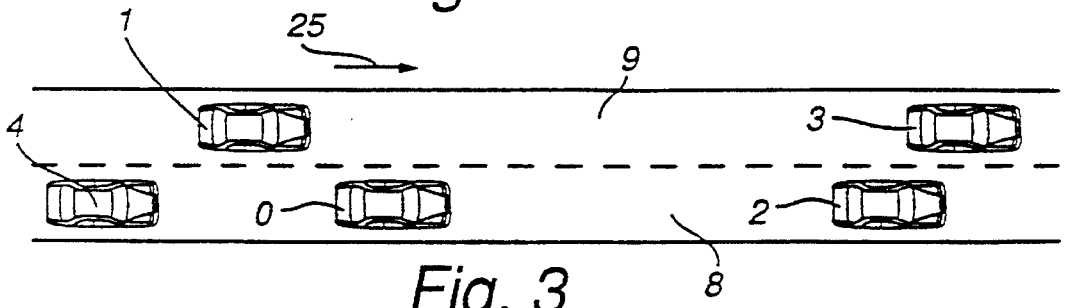


Fig. 3

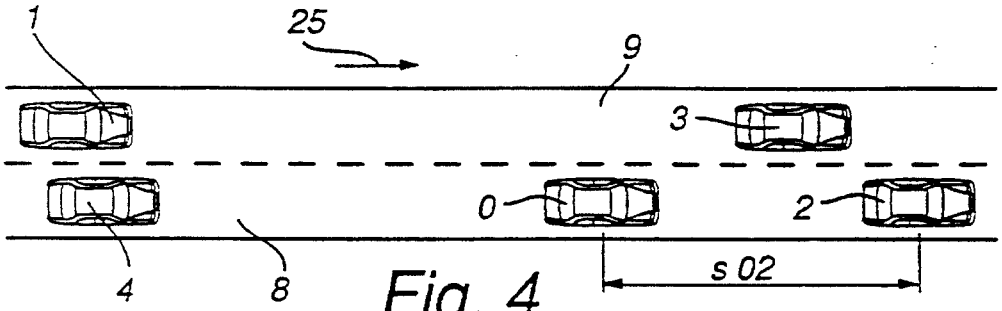


Fig. 4

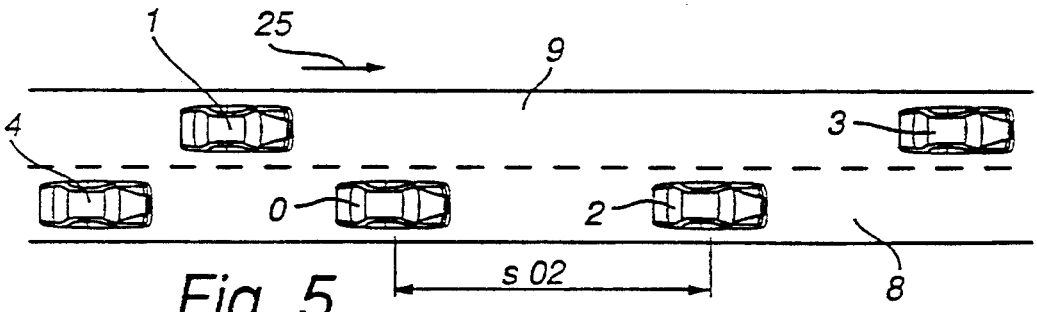


Fig. 5

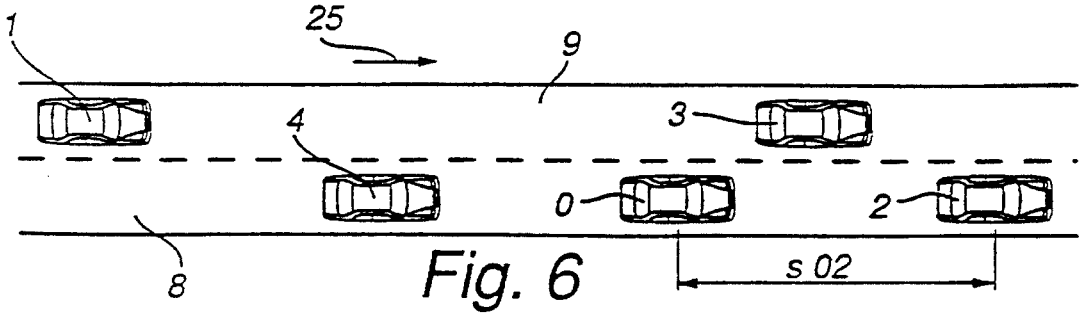
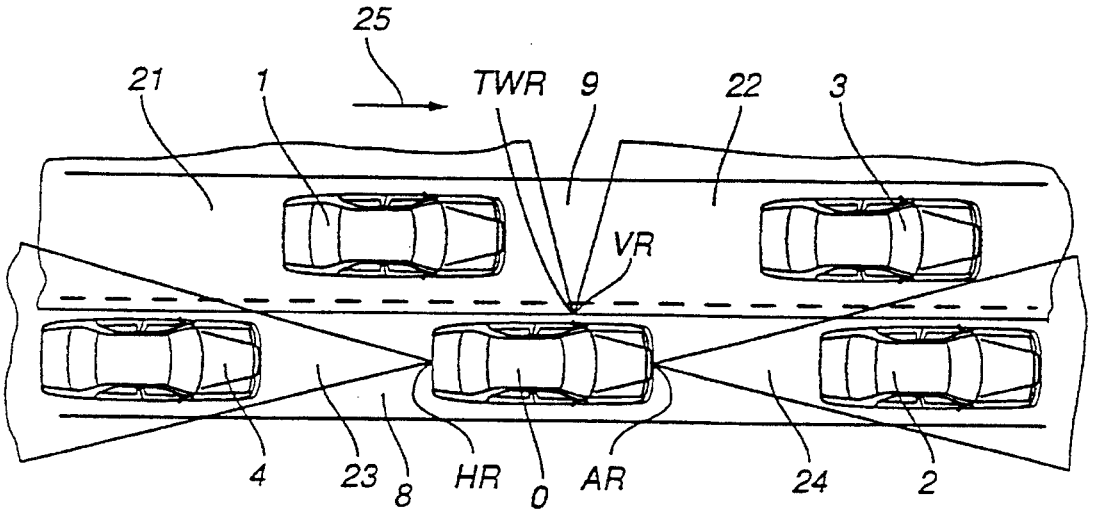


Fig. 6

Fig. 7



METHOD FOR PROVIDING GUIDING ASSISTANCE FOR A VEHICLE IN CHANGING LANE

BACKGROUND AND SUMMARY OF THE INVENTION

The invention relates to a process for providing guidance assistance for a vehicle in changing lanes from a current lane to an adjacent lane. In particular, the method according to the invention assists the driver of the motor vehicle when changing lanes (for example entering or exiting a motorway or passing a slower vehicle) by taking over, at least partially, certain monitoring requirements for this maneuver, and by evaluating the data acquired during the monitoring to help determine whether a risk-free lane change is possible.

German Patent Document DE 40 05 444 A1 discloses, for example, an arrangement in which the space behind the vehicle is monitored for the presence of objects, (principally, vehicles travelling behind) and the distance and speed of any such objects are determined. From this information, the deceleration which would have to be performed by a trailing vehicle when the driver's own vehicle changes lanes, and an associated evaluation index is formed. Incremental values of this index are displayed to provide the driver with audible or visual information on the effect of a possible lane change on the traffic behind. A laser-impulse distance measuring device serves to monitor the space behind.

In addition to ultrasonic and infrared systems (see for example DE 38 32 720 A1), the use of radar devices as monitoring detectors is also known. In addition to their use for monitoring the so-called blind-spot area (see for example DE 39 02 852 A1), the latter are also widely used for measuring distances from vehicles travelling ahead, such as for example for driving with automatic distance control (see F. Ackermann, Distance Control Using Radar, Spektrum d. Wiss., June 1980, pp. 25 et seq.) or for making recommendations with respect to passing, such as in the case of DE 36 22 447 C1 (monitoring of space in front by radar).

DE 36 22 091 A1 discloses a lane change warning system in which a monitoring detector can be switched between monitoring of a blind-spot area and monitoring of a space in front. Monitoring of the blind spot behind is selected during a lane change warning mode of operation, and monitoring of the space in front is selected in a distance warning operation mode, coupled to the switching of a fog lamp.

DE 30 28 077 C2 discloses a device for warning the vehicle driver of a vehicle travelling ahead of him in the current lane. In this arrangement, the space in front in the current lane is monitored by means of a radar device to detect the presence of a vehicle travelling ahead, and to determine its distance from the driver's own vehicle and its relative speed. As a function of these parameters and the speed of the driver's own vehicle (and, if appropriate, further parameters such as the state of the carriageway and brakes), a safe distance between the two vehicles is calculated and compared with the measured distance. If the measured distance is smaller than the safe distance, a warning signal is produced and/or the risk of an impact is displayed on a visual display panel.

In a variant of this known device, additional provision is made for detecting the risk of a collision in changing lanes, by monitoring the respective space behind in adjacent lanes as well as the space in front in the current lane. The detected data are evaluated in a manner analogous to that for the

only takes into account the current situation in the space behind in a possible target lane.

The object of the present invention is to provide a process for assisting the operator of a motor vehicle when changing lanes, which process is capable of deciding automatically as to the advisability of a present or future lane change, and largely relieves the driver of the task of observing the surroundings and estimating distances and speeds.

This problem is achieved according to the invention by monitoring in the target lane both the spaces behind and in front of the driver's own vehicle, by determining the distance and speed of such objects (vehicles), and taking into account risk-preventing safety distances to be observed. This method is capable of detecting whether a sufficient gap is present in the target lane for a desired lane change. Thus, the driver does not need to observe the space behind or the space in front in the target lane, nor does he need to estimate the distances and speeds of the vehicles in it. Instead, he is informed by appropriate warning indications and/or instructions from the computer-controlled guiding assistance method of the presence of a sufficient gap in the target lane to accommodate a desired lane change.

According to the invention it is also possible to detect whether, if not in the current vehicle situation, a gap which is potentially suitable for lane change is possible in the target lane. That is, it is possible to detect the presence of a gap, permitting a lane change, in the target lane obliquely in front of, or obliquely behind the driver's own vehicle, and to indicate this to the driver. The driver can then attempt by means of suitable maneuvers (acceleration or deceleration of his vehicle) to align his vehicle with the gap and carry out the lane change. This relieves the driver of the vehicle in a particularly advantageous manner of the tasks of observing and evaluating the driving situation in the space in front and behind in the target lane.

In another embodiment of the invention, vehicles in the lane in which the driver's own vehicle is located before a lane change, are also included as factors to be considered. The search for a gap in this embodiment detects not only whether a suitable gap is present in the target lane, but also whether the position of the driver's own vehicle in the current lane (relative to vehicles which may be located there in the space in front or behind) permits him to reach such a gap, so that the driver is also relieved of the task of evaluating the driving situation in the current lane.

Advantageously, the question as to whether a detected gap, in the target lane, which is in principle sufficient for a lane change, can in practice even be reached by the driver maneuvering his car can also be taken into account. Thus, in another embodiment of the invention, possible future driving behavior for reaching the gap is analyzed in a computer simulation and tested as to whether the gap is actually reachable. In a further embodiment the acceleration or deceleration values necessary to accomplish a reachable lane change are displayed to the driver; or, alternatively, to further increase driving comfort, such information is passed on directly to a longitudinal movement controller device, which device is capable of automatically controlling the movement of the vehicle in the direction of travel without the intervention by the driver.

A particularly high level of driving comfort with respect to the control of the vehicle can be achieved by signaling to a device for controlling transverse movement of the vehicle that a gap which permits a lane change has been reached.

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