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Slepian et al.

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[54] **METHOD AND APPARATUS FOR OPTIMIZING VEHICLE OPERATION**

[75] Inventors: **Harvey Slepian**, Peoria; **Loran Sutton**, East Peoria, both of Ill.

[73] Assignee: **TAS Distributing Co., Inc.**, Peoria, Ill.

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[58] Field of Search 701/1, 121, 123, 701/101, 102, 103, 104, 96, 300; 123/478, 480, 351, 481; 340/903, 425.5, 426, 436, 438
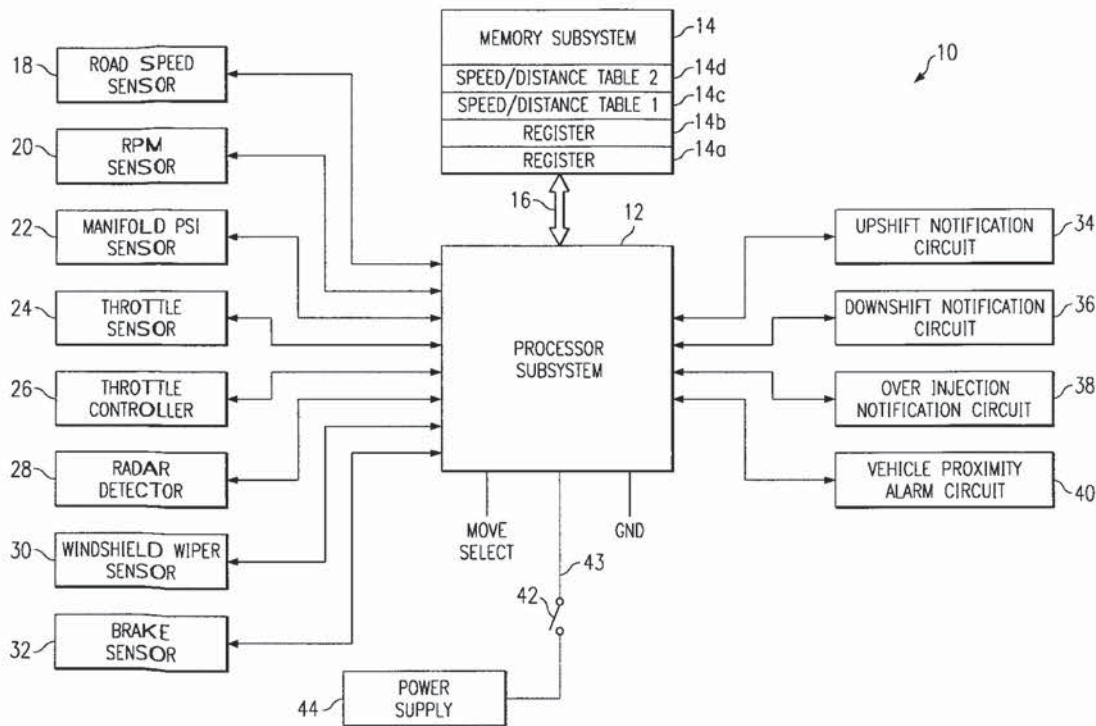
[56] **References Cited**

U.S. PATENT DOCUMENTS

4,492,112	1/1985	Igarashi et al.	73/117.3
4,542,460	9/1985	Weber	364/424
4,631,515	12/1986	Blee et al.	340/62
4,701,852	10/1987	Ulveland	364/424.1
4,752,883	6/1988	Asakura et al.	364/424.1
4,853,673	8/1989	Kido et al.	340/439
4,868,756	9/1989	Kawanabe et al.	364/442
4,901,701	2/1990	Chasteen	123/478
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Primary Examiner—William A. Cuchlinski, Jr.
Assistant Examiner—Gertrude Arthur
Attorney, Agent, or Firm—Haynes and Boone, LLP

[57] **ABSTRACT**

Apparatus for optimizing operation of an engine-driven vehicle. The apparatus includes a processor subsystem, a memory subsystem, a road speed sensor, an engine speed sensor, a manifold pressure sensor, a throttle position sensor, a radar detector for determining the distance separating the vehicle from an object in front of it, a windshield wiper sensor for indicating whether a windshield wiper of the vehicle is activated, a brake sensor for determining whether the brakes of the vehicle have been activated, a fuel over-injection notification circuit for issuing notifications that excessive fuel is being supplied to the engine of the vehicle, an upshift notification circuit for issuing notifications that the engine of the vehicle is being operated at an excessive engine speed, a downshift notification circuit for issuing notifications that the engine of the vehicle is being operated at an insufficient engine speed, a vehicle proximity alarm circuit for issuing an alarm that the vehicle is too close to an object in front of the vehicle and a throttle controller for automatically reducing the amount of fuel supplied to the engine if the vehicle is too close to the object in front of it. Based upon data received from the sensors and data stored in the memory subsystem, the processor determines whether to activate the fuel overinjection notification circuit, the upshift notification circuit, the downshift notification circuit, the vehicle proximity alarm circuit or the throttle controller.
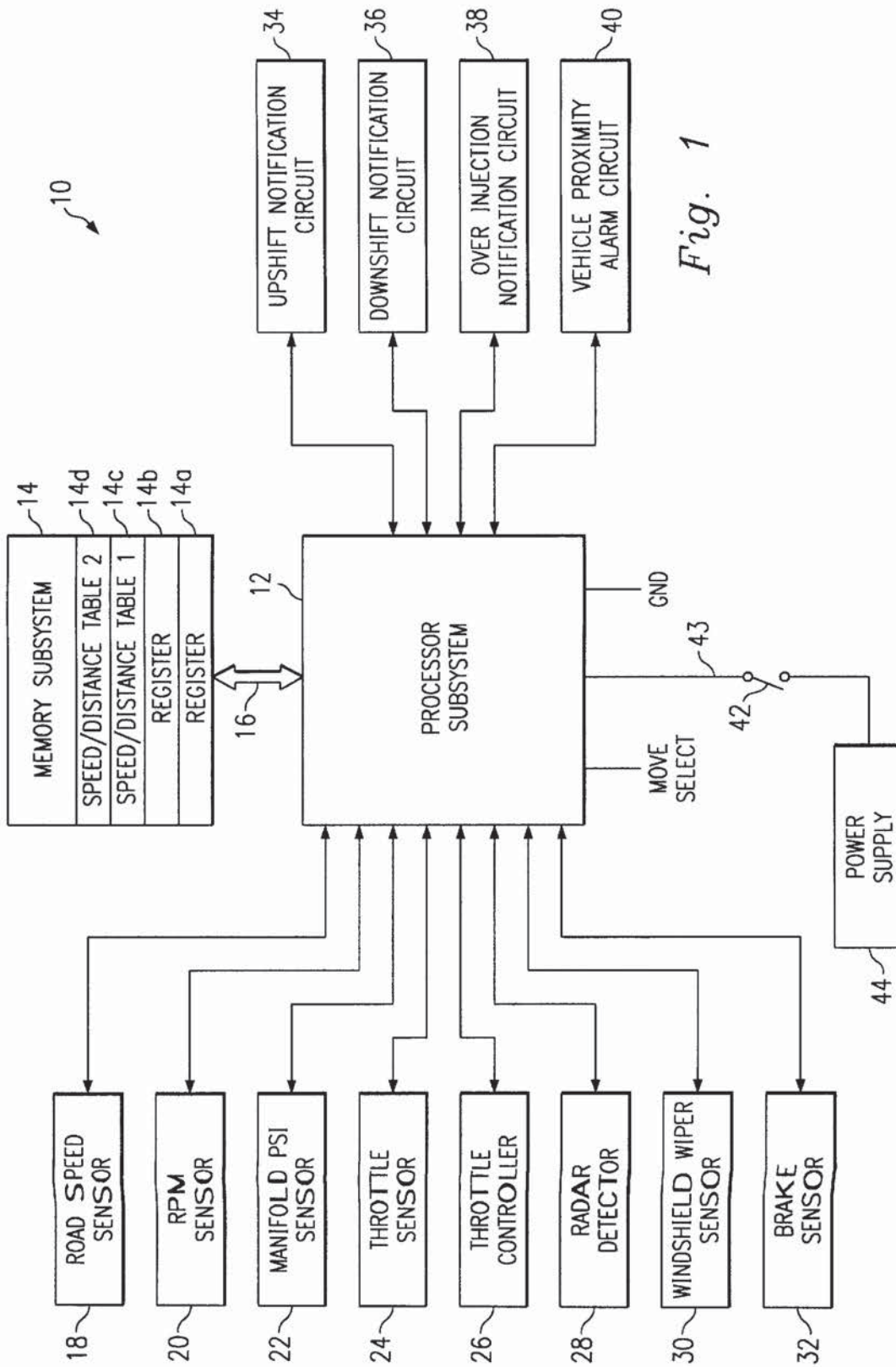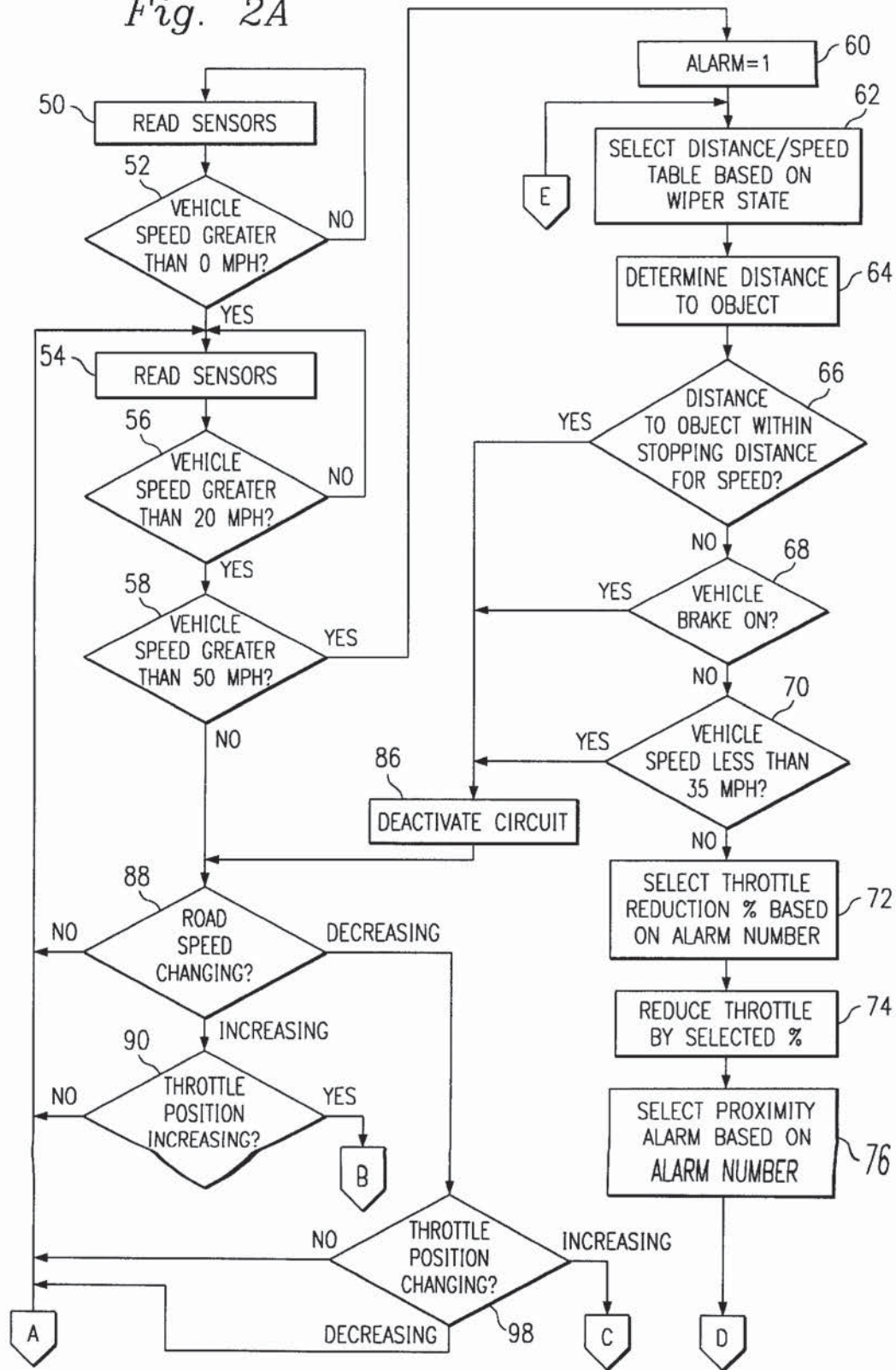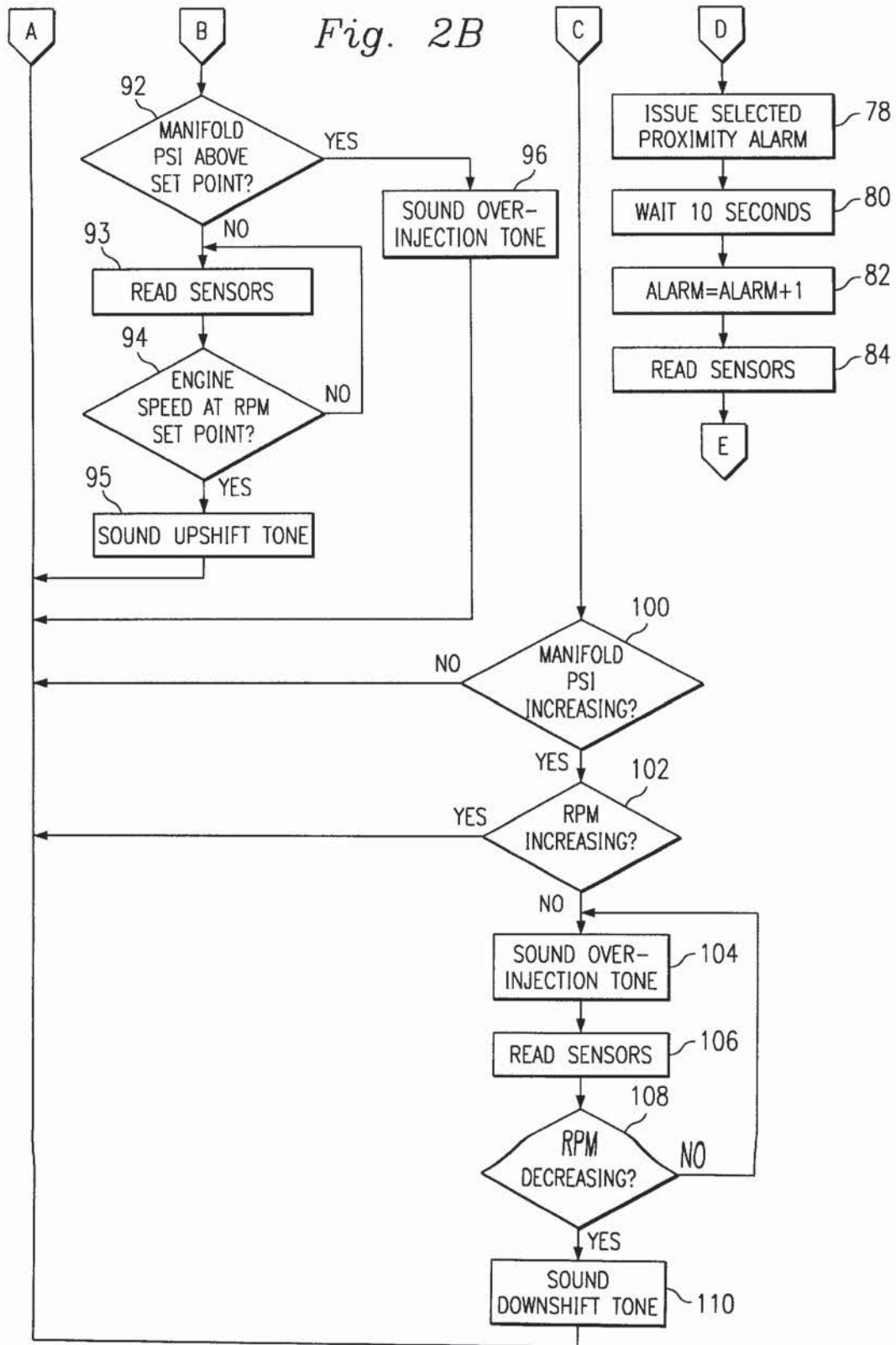
32 Claims, 3 Drawing Sheets

Fig. 1

Fig. 2A

50 READ SENSORS

52 VEHICLE SPEED GREATER THAN 0 MPH? — NO

YES

54 READ SENSORS

56 VEHICLE SPEED GREATER THAN 20 MPH? — NO

YES

58 VEHICLE SPEED GREATER THAN 50 MPH? — YES

NO

88 ROAD SPEED CHANGING? — NO / DECREASING

INCREASING

90 THROTTLE POSITION INCREASING? — NO / YES → B

A

86 DEACTIVATE CIRCUIT

THROTTLE POSITION CHANGING? — NO / INCREASING → C / DECREASING 98

60 ALARM=1

E

62 SELECT DISTANCE/SPEED TABLE BASED ON WIPER STATE

64 DETERMINE DISTANCE TO OBJECT

66 DISTANCE TO OBJECT WITHIN STOPPING DISTANCE FOR SPEED? — YES

NO

68 VEHICLE BRAKE ON? — YES

NO

70 VEHICLE SPEED LESS THAN 35 MPH? — YES

NO

72 SELECT THROTTLE REDUCTION % BASED ON ALARM NUMBER

74 REDUCE THROTTLE BY SELECTED %

76 SELECT PROXIMITY ALARM BASED ON ALARM NUMBER

D

Fig. 2B

A

B

C

D

92 MANIFOLD PSI ABOVE SET POINT?
— YES →
96 SOUND OVER-INJECTION TONE

NO
93 READ SENSORS

94 ENGINE SPEED AT RPM SET POINT?
— NO →

YES
95 SOUND UPSHIFT TONE

78 ISSUE SELECTED PROXIMITY ALARM

80 WAIT 10 SECONDS

82 ALARM=ALARM+1

84 READ SENSORS

E

100 MANIFOLD PSI INCREASING?
NO ←

YES
102 RPM INCREASING?
YES ←

NO
104 SOUND OVER-INJECTION TONE

106 READ SENSORS

108 RPM DECREASING?
NO →

YES
110 SOUND DOWNSHIFT TONE

METHOD AND APPARATUS FOR OPTIMIZING VEHICLE OPERATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to an apparatus for optimizing vehicle operation and, more particularly, relates to a system which both notifies the driver of recommended corrections in vehicle operation and, under certain conditions, automatically initiates selected corrective action.

2. Description of Related Art

It has long been recognized that the improper operation of a vehicle may have many adverse effects. For example, the fuel efficiency of a vehicle may vary dramatically based upon how the vehicle is operated. More specifically, operating a vehicle at excessive speed, excessive RPM and/or excessive manifold pressure will result in both reduced fuel economy and increased operating costs. The aforementioned increased operating costs can be quite considerable, particularly for an owner or operator of a fleet of vehicles. To correct these types of improper vehicle operations are often surprisingly simple. For example, upshifting the drive gear will typically eliminate an excessive RPM condition. However, even when the solution is quite simple, oftentimes, the driver will be unaware of the need to take corrective action.

A variety of patents have disclosed systems, commonly referred to as "shift prompters", which monitor the operation of a vehicle and advises the operator of the vehicle when to take certain actions. Numerous ones of these devices include sensors which measure engine speed and vehicle speed. See, for example, U.S. Pat. No. 4,492,112 to Igarashi et al., U.S. Pat. No. 4,631,515 to Blee et al. and U.S. Pat. No. 4,701,852 to Ulveland. Certain ones, however, disclose the use of other types of sensors as well. For example, U.S. Pat. No. 4,524,460 to Weber is directed to a driving aid indicator which includes vehicle speed, manifold pressure, throttle position and engine speed sensors. U.S. Pat. No. 4,752,883 to Asakura et al. and U.S. Pat. No. 4,868,756 to Kawanabe et al. are directed to upshift notification devices which include sensors for measuring engine speed, vehicle speed, manifold pressure and cooling water temperature. Finally, U.S. Pat. No. 4,853,673 to Kido et al. discloses a shift indicator system which includes sensors for measuring engine speed and throttle position. Generally, the above-listed patents all provide displays intended to enable the driver to operate the vehicle in a manner leading to uniform performance and maximum fuel economy. However, Blee et al. discloses the use of audible warnings as well as a speed controller to prevent further increases in engine speed if the driver ignores previously issued warnings.

Improper vehicle operation has other adverse effects as well. It is well known that the faster a vehicle travels, the longer it takes to stop. Thus, what may be a safe separation distance between successive vehicles when a vehicle is traveling at 35 mph may be unsafe if that vehicle is traveling at 50 mph. Road conditions also play a role in determining the safe separation distance between vehicles. For example, greater separation distances are generally recommended when roads are wet. As a result, therefore, based on the combination of a vehicle's speed, the distance separating the vehicle from a second vehicle in front of it and road conditions, many vehicles are operated unsafely. To correct this situation, a reduction in operating speed, an increase in vehicle separation or some combination thereof, is required.

It may be readily seen from the foregoing that it would be desirable to provide a system which integrates the ability to

issue audible warnings which advise the driver to correct operation of the vehicle in a manner which will enhance the efficient operation thereof with the ability to automatically take corrective action if the vehicle is being operated unsafely. It is, therefore, the object of the invention to provide such a system.

SUMMARY OF THE INVENTION

In one embodiment, the present invention is directed to an apparatus for optimizing operation of an engine-driven vehicle. The apparatus includes a processor subsystem, a memory subsystem, plural sensors, including road speed, manifold pressure and throttle position sensors, for collectively monitoring operation of the vehicle and a fuel overinjection notification circuit for issuing notifications that excessive fuel is being supplied to the engine of the vehicle. The processor subsystem receives data from the sensors and, from the received data, determines when to activate the fuel overinjection circuit. In one aspect thereof, the processor subsystem determines when road speed for the vehicle is increasing, determines when throttle position for the vehicle is increasing, compares manifold pressure and a manifold pressure set point stored in the memory subsystem and activates the fuel overinjection notification circuit if both road speed and throttle position for the vehicle are increasing and manifold pressure for the vehicle is above the manifold pressure set point.

In further aspects thereof, the sensors may include an engine speed sensor and the processor subsystem may determine when road speed for the vehicle is decreasing, when throttle position for the vehicle is increasing, when manifold pressure for the vehicle is increasing, when engine speed for the vehicle is decreasing and may activate the fuel overinjection notification circuit if both throttle position and manifold pressure for the vehicle are increasing and road speed and engine speed for the vehicle are decreasing.

In still further aspects thereof, the apparatus may also include an upshift notification circuit, activated by the processor subsystem based upon data received from the sensors, which issues notifications that the engine of the vehicle is being operated at excessive engine speeds. In this aspect, the processor subsystem determines when road speed for the vehicle is increasing, when throttle position for the vehicle is increasing, compares manifold pressure to a manifold pressure set point stored in the memory subsystem, compares engine speed to an RPM set point stored in the memory subsystem and activates the upshift notification circuit if both road speed and throttle position for the vehicle are increasing, manifold pressure for the vehicle is at or below the manifold pressure set point and engine speed for the vehicle is at or above the RPM set point.

In still yet further aspects thereof, the apparatus may also include a downshift notification circuit, activated by the processor subsystem based upon data received from the sensors, which issues a notification that the engine of the vehicle is being operated at an insufficient engine speed. The processor subsystem may determine when road speed for the vehicle is decreasing, when throttle position for the vehicle is increasing, when manifold pressure for the vehicle is increasing, when engine speed for the vehicle is decreasing and may activate the downshift notification circuit if both road speed and engine speed are decreasing and both throttle position and manifold pressure for the vehicle are increasing.

In still further aspects thereof, the fuel overinjection circuit, the upshift notification circuit or the downshift

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