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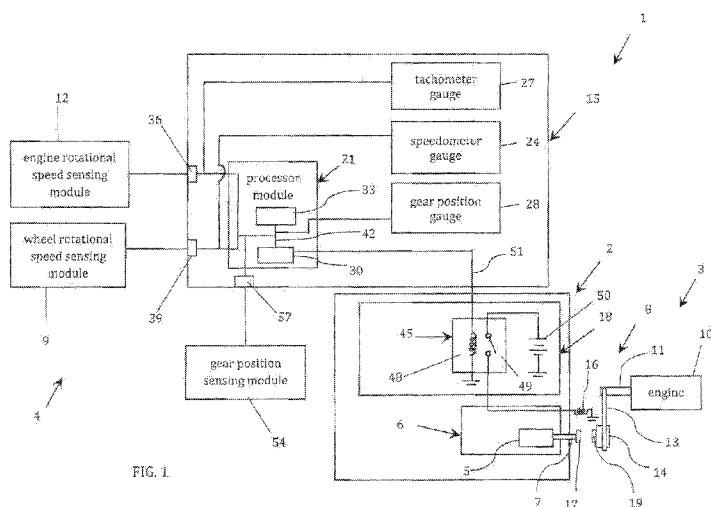
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(54) Title: LOW COST INSTRUMENT CLUSTER BASED HVAC POWER CONTROL



(57) Abstract: The application provides a control module for an engine-driven compressor of a vehicle. The control module includes a first port, a second port, and a processor. The first port is adapted for receiving at least two engine shaft rotational speed measurements. The second port is adapted for receiving at least two vehicle wheel rotational speed measurements. The processor is adapted for determining a first rate of increase according to the engine shaft rotational speed measurements and for determining a second rate of increase according to the vehicle wheel rotational speed measurements. The processor later determines a relationship between the first rate of increase and the second rate of increase and then compares the relationship with a predetermined engine overload threshold value. After this, the processor provides a control signal for disconnecting the compressor from the engine of the vehicle when the relationship exceeds the predetermined engine overload threshold value.

LOW COST INSTRUMENT CLUSTER BASED HVAC POWER CONTROL

The application relates to a control system for an air conditioner of a vehicle. More particularly, the application relates to a control system for a compressor of an air conditioner of a vehicle.

Passenger vehicles with a small engine capacity of less than about a thousand cubic centimeters (cc) are popular worldwide, especially in economically emerging markets due to their affordable prices. The driving performance of these vehicles is influenced by a number of factors, such as passenger load, cargo load, weather condition, road conditions, and air-conditioning load.

In certain circumstances, for examples, when the vehicle accelerates or moves up a steep slope, a driver of the vehicle can switch off the vehicle air-conditioner in order to attain a desired speed of the vehicle. Instead of the user manually switching off the air-conditioner, a control system can also be used to automatically switching off the air conditioner.

US4730520 discloses a control system for an engine-driven compressor for a vehicle that is equipped with an automatic transmission. The control system is adapted to interrupt power from an engine to the compressor under a predetermined condition, wherein an instantaneous value of a gear ratio, which is defined as the quotient of a rotation speed of an output shaft of a torque converter to a rotation speed of an input shaft of the torque converter, is within a predetermined range.

JPS58211915(A) discloses a control circuit for a compressor of an air conditioner of a vehicle. The control circuit is adapted for turning off the compressor if a revolving speed of

an engine of the vehicle exceeds a predetermined value. The compressor is turned on if the revolving speed drops below the predetermined value.

- 5 It is an objective of this application to provide an improved control system for a Heating, Ventilating, and Air conditioning (HVAC) unit of a vehicle.

The application provides an improved control module for an engine-driven compressor of a vehicle with an engine.

The vehicle refers to a car, a bus, or a truck, which has wheels for moving people and goods.

- 15 The vehicle has an engine, a Heating, Ventilating, and Air conditioning (HVAC) unit, and a drive unit. The drive unit selectively connects the engine to the HVAC unit, wherein the engine drives the HVAC unit and the wheels.

- 20 The HVAC comprises an air conditioner with a gas compressor. The gas compressor is intended for increasing pressure of a gaseous refrigerant that is used for lowering a temperature of an interior of the vehicle.

- 25 The engine is used for generating mechanical power. Examples of the engine includes an electric engine, which converts electrical energy to mechanical power and an internal combustion engine, which converts fuel, such as gasoline, to mechanical power.

30

The drive unit includes a clutch module with an improved control module. Parts of the clutch module are connected to the engine and the compressor. The control module selectively activates the clutch module for connecting the engine to the

compressor, wherein the mechanical power of the engine is directed for driving the compressor. The mechanical power of the engine is also used for driving the vehicle wheels.

- 5 The control module includes a first input port, a second input port, and a digital computing processor. The processor acts to process data from the first and the second input ports.

The first input port is adapted for receiving two or more rotational speed measurements of a revolving shaft of the engine. The rotational speed measurements can be expressed in number of revolutions per minute (RPM).

The second input port is adapted for receiving two or more vehicle wheel rotational speed measurements. The vehicle wheel rotational speed measurements can be expressed in number of revolutions per minute.

The computing processor then determines a first rate of increase according to the received engine shaft rotational speed measurements. The first rate of increase is often related to an expected rate of increase of the vehicle speed.

Similarly, the processor later determines a second rate of increase according to the received vehicle wheel rotational speed measurements. The second rate of increase is often related to an actual rate of increase of the vehicle speed.

After this, the processor determines a relationship between the first rate of increase and the second rate of increase of the vehicle speed.

The processor then compares the relationship with a predetermined engine overload threshold value. The engine overload

threshold value corresponds to an overload condition of the vehicle engine. The overload condition often occurs when the vehicle is accelerating or is travelling up a steep inclination in which the engine is operating beyond its engine operating capacity. The engine is then producing an excessively large mechanical power that exceeds its design. Operating the engine at this rate can damage the engine.

When the relationship exceeds the predetermined engine overload threshold value, the processor provides a declutching control signal for disconnecting the compressor from the engine of the vehicle.

The processor then sends out the declutching control signal to the clutch module.

This arrangement advantageously allows the engine to direct all of its mechanical power for rotating the vehicle wheels. In other words, the engine is not burdened with driving the compressor. The engine can then ceases operating in the overload condition, and can operate in the normal load condition.

The improved control module also advantageously detects the engine overload condition automatically and then interrupts the operation of the compressor automatically. This enhances driving safety of a driver of the vehicle as it allows the driver to concentrate on driving and not be burdened with switching off the compressor manually during driving. This is useful, especially for driving in a traffic congested area, which requires the driver to carefully move the vehicle.

The processor can be adapted for, when the relationship is within the predetermined engine overload threshold value, providing a clutching control signal to connect the compressor

to the engine of the vehicle. In a normal engine load condition, the engine is operating within its operating capacity and the relationship is within the predetermined engine overload threshold value. The compressor is then automatically
5 connected to the engine.

In short, the automatic connection of the compressor to the engine according to the engine loading condition enhances the driving safety of the driver.

10

Different ways of determining the relationship between the first rate of increase and the second rate of increase of the vehicle speed measurements are possible.

15 In one way, the processor determines a difference between the first rate and the second rate of increase. In another way, the processor determines a quotient of the first rate and the second rate of increase.

20 The application also provides an improved instrument cluster for a vehicle.

The improved instrument cluster includes a control module as described above, a speedometer, and a tachometer.

25

The control module is adapted for receiving two or more engine shaft rotational speed measurements and for receiving two or more vehicle wheel rotational speed measurements.

30 The speedometer is adapted for displaying a vehicle speed data according to the received vehicle wheel rotational speed measurements. The control module can derive the vehicle speed data from the received vehicle wheel rotational speed measurements

and later sends the derived vehicle speed data to the speedometer for displaying.

The tachometer is adapted for displaying the received engine
5 shaft rotational speed measurements.

The application also provides an improved drive unit for an engine-driven compressor of a vehicle with an engine.

10 The drive unit includes the above-mentioned control module and a clutch module.

The control module is adapted for providing a clutch control signal, which is used for actuating the clutch module.

15 The clutch module is adapted for selectively connecting the compressor with the engine according to the clutch control signal. In an engine overload condition, the clutch signal actuates the clutch module to disconnect the compressor from the
20 engine.

The clutch module can include a first clutch plate, a second clutch plate, and an electromagnetic coil.

25 The first clutch plate is used for fixedly connecting with the compressor while the second clutch plate is used for fixedly connecting with the engine.

The electromagnetic coil is adapted for receiving an electric
30 current. The electric current acts to energize the electromagnetic coil, which provides an electromagnetic field for actuating one of the first clutch plate and the second clutch plate for connecting with each other.

The drive unit often includes a pulley with a belt. The pulley is fixedly connected to the second clutch plate. The belt is mechanically engaged with the pulley and with a shaft of the engine for transferring a rotation motion of the engine shaft to a rotation motion of the pulley. This acts to transfer the mechanical power of the engine to the pulley.

The application also provides an improved vehicle.

The vehicle includes two or more wheels, an engine, a compressor, and a drive unit as described above. The drive unit is adapted for selectively connecting the compressor with the engine.

The engine is adapted for driving or rotating the wheels. The engine also drives the compressor when the drive unit connects the engine to the compressor.

The application provides an improved method for operating a control module of an engine-driven compressor of a vehicle with an engine.

The method includes a measurement step of receiving at least two engine shaft rotational speed measurements and at least two vehicle wheel rotational speed measurements.

In a subsequent computation step, the control module determines a first rate of increase according to the received engine shaft rotational speed measurements and determines a second rate of increase according to the received vehicle wheel rotational speed measurements.

Following the computation step, a comparison step of determining a relationship between the first rate of increase and the

second rate of increase of the vehicle speed measurements and comparing the relationship with a predetermined engine overload threshold value is performed.

- 5 When the relationship exceeds the predetermined engine overload threshold value, which indicates an engine overload condition, the control module disconnects the compressor from the engine of the vehicle.
- 10 The method often includes, when the relationship is within the predetermined engine overload threshold value, a step of connecting the compressor to the engine of the vehicle.

The determination of the relationship can be implemented in
15 different ways.

In one implementation, the relationship is performed by a step of determining a difference between the first rate of increase and the second rate of increase.

20

In another implementation, the relationship is done by a step of determining a quotient of the first rate of increase and the second rate of increase.

- 25 Fig. 1 illustrates a block diagram of an improved vehicle with an engine unit, a HVAC unit, and an instrument cluster, and

Fig. 2 illustrates a flow chart of a method of operating the improved vehicle of Fig. 1.

30

In the following description, details are provided to describe embodiments of the application. It shall be apparent to one skilled in the art, however, that the embodiments may be practiced without such details.

Some parts of the embodiments have similar parts. The similar parts may have the same names or similar part numbers with an alphabet symbol. The description of one part applies by reference to a similar part, where appropriate, thereby reducing repetition of text without limiting the disclosure.

Fig. 1 shows an improved vehicle 1.

The vehicle 1 includes an engine unit 3, an instrument cluster 15 with a control unit, a Heating, Ventilating, and Air conditioning (HVAC) unit 2, and a measurement unit 4. The instrument cluster 15 is electrically connected to the HVAC unit 2 and to the measurement unit 4. The HVAC unit 2 is connected to the engine unit 3.

The engine unit 3 includes a combustion engine 10 with a rotatable crankshaft 11, a belt 13, and a rotatable pulley 14. The belt 13 encloses the pulley 14 and the crankshaft 11 such that the belt 13 engages mechanically with the pulley 14 and with the crankshaft 11.

The measurement unit 4 includes a vehicle wheel rotational speed sensing module 9, an engine rotational speed sensing module 12, and a gear position sensing module 54.

The sensing module 9 is adapted to measure a rotational speed of a wheel of the vehicle 1. The sensing module 12 is adapted to measure a rotation speed of a shaft of an engine of the vehicle 1. The sensing module 54 is adapted to detect a gear position of a transmission of the vehicle 1. The transmission can refer to an automatic transmission or a manual transmission.

The instrument cluster 15 includes a plurality of ports, a plurality of instruments, and a digital computing processor module 21. The processor module 21 is electrically connected to the ports and to the instruments.

5

The ports include a tachometer input terminal 36, a speedometer input terminal 39, and a gear position input terminal 57.

The instruments include a speedometer gauge 24, a tachometer gauge 27, and a gear position gauge 28. The speedometer gauge 24 is electrically connected to the speedometer input terminal 39 while the tachometer gauge 27 is electrically connected to the tachometer input terminal 36. The gear position gauge 28 is electrically connected to the gear position input terminal 57.

10
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The processor module 21 includes a computing processor 30 and a memory module 33. The memory module 33 includes a non-volatile memory unit that stores a HVAC unit control software program. The non-volatile memory unit is adapted to store data even when its electrical power supply is removed. The memory module 33 is electrically connected to the computing processor 30 via a data bus 42.

20

The data bus 42 is also electrically connected to the input terminals 36, 39, and 57 as well as to the speedometer gauge 24, to the tachometer gauge 27, and to the gear position gauge 28.

25

Referring to the measurement unit 4, the tachometer input terminal 36 is electrically connected to the engine rotational speed sensing module 12 while the speedometer input terminal 39 is electrically connected to the vehicle wheel rotational

30

speed sensing module 9. The gear input terminal 57 is electrically connected to the gear position sensing module 54.

Referring to the HVAC unit 2, it includes a HVAC control module 18 and a refrigerant gas compressor unit 6, which is electrically connected to the HVAC control module 18.

The HVAC control module 18 includes a solenoid-actuated switch device 45, which is normally closed, and an electrical power source 50.

The switch device 45 includes a switch 49 and an electromagnetic coil 48, which is adapted to actuate the switch 49. An end of the switch 49 is electrically connected to the electrical power source 50 while another end of the switch 49 is electrically connected to the gas compressor unit 6. The coil 48 is electrically connected to the processor 30 of the instrument cluster 15 via a wire 51.

The gas compressor unit 6 includes a gas compressor 5 with a drive shaft 7, and an electromagnetic clutch 8. The electromagnetic clutch 8 is fixedly connected to the drive shaft 7 of the gas compressor 5.

The electromagnetic clutch 8 includes an electromagnetic coil 16 and a pair of rotatable clutch plate 17 and 19. The clutch plate 17 is fixedly connected to the drive shaft 7 of the gas compressor 5 while the clutch plate 19 is mounted to the pulley 14 of the engine unit 3. The electromagnetic coil 16 is connected to the switch 49. When energized, the coil 16 is adapted for providing a magnetic field that acts to couple the clutch plate 17 with the clutch plate 19.

In use, the vehicle 1 is used for transporting people or goods.

The vehicle wheel rotational speed sensing module 9 is intended for measuring a rotational speed of a wheel of the vehicle 1 and for transmitting the wheel rotational speed measurement data to the speedometer input terminal 39 of the instrument cluster 15.

10 The engine rotational speed sensing module 12 is used for measuring a rotational speed of the engine 10 of the vehicle 1 and for transmitting the engine rotational speed measurement data to the tachometer input terminal 36 of the instrument cluster 15.

15

The gear position sensing module 54 acts to detect a gear position of the transmission of the vehicle 1. It also serves to transmit the detected gear positional data to the gear position input terminal 57 of the instrument cluster 15.

20

Referring to the instrument cluster 15, the speedometer input terminal 39 receives the transmitted wheel rotational speed measurement data from the sensing module 9 and then transmits the received wheel rotational speed measurement data to the memory module 33 for storing.

25

The computing processor 30 later retrieves the stored wheel rotational speed measurement data from the memory module 33 for converting to a corresponding speed data of the vehicle 1.

30 The computing processor 30 later transmits the converted vehicle speed data to the speedometer gauge 24 for displaying to a user of the vehicle 1. The computing processor 30 also sends the converted vehicle speed data to the memory module 33 for storing.

Similarly, the tachometer input terminal 36 receives the transmitted engine rotational speed measurement data from the sensing module 12 and sends the received engine rotational speed measurement data to the memory module 33 for storing.

After this, the computing processor 30 retrieves the stored engine rotational speed measurement data from the memory module 33 and later transmits the engine rotational speed measurement data to the tachometer gauge 27 for displaying to the user of the vehicle 1.

Likewise, the gear position input terminal 57 receives the transmitted gear positional data from the sensing module 54 and transmits the gear positional data to the memory module 33 for storing.

The computing processor 30 afterward retrieves the stored gear positional data from the memory module 33 and then transmits the gear positional data to the gear position gauge 28 for displaying to the user of the vehicle 1.

The combustion engine 10 is intended for converting fuel to mechanical power for rotating the crankshaft 11.

The rotatable crankshaft 11 acts to rotate wheels of the vehicle 1. The crankshaft 11 also acts to rotate the pulley 14 via the belt 13.

The belt 13 is intended for transferring rotational motion of the crankshaft 11 to rotational motion of the pulley 14.

14

The pulley 14 acts to rotate the drive shaft 7 of the gas compressor 5, when the clutch plate 17 is mechanically coupled with the clutch plate 19.

5 The HVAC unit control software program is intended for instructing the computing processor 30 to detect degradation of engine performance according to the stored measurement data. The degradation of the engine performance occurs during an overload of the vehicle engine 10.

10

When the processor 30 detects an engine normal load condition, it serves to provide an electromagnetic clutch activation signal. The electromagnetic clutch activation signal does not energize the coil 48. This allows the switch 49 to be placed in
15 a normally closed state.

In the closed state, the switch 49 provides a closed circuit to allow an electric current to flow from the electrical power source 50, to the switch 49, and then to the electromagnetic
20 coil 16 of the electromagnetic clutch 8.

The electric current then energizes the electromagnetic coil 16 to provide a magnetic field to enable coupling of the clutch plate 17 with the clutch plate 19.

25

This coupling serves to transfer rotational motion of the pulley 14 to rotation motion of the drive shaft 7 of the gas compressor 5.

30 In effect, output power of the engine 10 is transmitted for rotating the wheels and for driving the gas compressor 5.

When the processor 30 detects an engine overload condition, it also acts to provide an electromagnetic clutch de-activation

signal. The electromagnetic clutch de-activation signal provides an electric current for energizing the coil 48.

The energized coil 48 then actuates the switch 49 to an open
5 state from the normally closed state.

In the open state, the switch 49 provides an open circuit that prevents an electric current of the electrical power source 50 from flowing to the electromagnetic coil 16.

10

This de-energizes the electromagnetic coil 16 such that the electromagnetic coil 16 does not generate any magnetic field. In absence of the magnetic field, the clutch plate 17 is decoupled or separated from the clutch plate 19, thereby stop-
15 ping the transfer of the rotational motion of the pulley 14 to the drive shaft 7.

The output power of the engine 10 is then not used for driving the gas compressor 5 and is used essentially for driving the
20 vehicle wheels.

This is useful, especially when the vehicle 1 is accelerating or moving up a steep slope, wherein the engine 10 can be subjected to an additional load. By not driving the gas compressor 5, essentially all output power of the engine 10 can be
25 directed to rotating the wheels of the vehicle 1. In other words, the engine 10 can drive the wheels without being overloaded. After the additional load is removed, the engine 10 can be engaged for driving the wheels and the gas compressor 5
30 of the vehicle 1.

Different methods of operating the vehicle 1 are possible.

Fig. 2 shows a flow chart 60 of an improved method of operating the vehicle 1 when the vehicle 1 is accelerating or moving up a slope.

- 5 The flow chart includes a measurement step 63, a computation step 65, a detection step 70, an engine overload step 78, and an engine normal load step 79.

10 In the measurement step 63, the measurement unit 4 obtains vehicle related readings, which include engine shaft rotational speed measurement, a gear position data, and vehicle wheel rotational speed measurement.

15 After the measurement step 63, the computation step 65 is performed.

In the computation step 65, the processor 30 derives rates of increases of the vehicle speed according to the vehicle related measurements.

20 The processor 30 computes a first rate of increase of the vehicle speed according to a rate of increase of the rotational speed measurements of the engine shaft and according to the gear position data, in a step 66. In other words, the rate of increase of the rotational speed measurements of the engine shaft is used to determine the rate of increase of the vehicle speed.

30 The gear position data is used to indicate any change of gear position during the increase of the vehicle speed.

In a special embodiment, the first rate of increase of the vehicle speed is computed according to just only the rate of in-

crease of the rotational speed measurements of the engine shaft.

The processor 30 later computes a second rate of increase of the vehicle speed according to a rate of increase of the wheel rotational speed measurements, in a step 69. Put differently, the rate of increase of the wheel rotational speed measurements is used to determine the rate of increase of the vehicle speed.

10

In short, the processor 30 determines different rates of increase of vehicle speed using two different types of data.

15

After the computation step 65, the detection step 70 is performed.

In the detection step 70, the processor 30 computes a difference between the first rate of increase and the second rate of increase of the vehicle speed, in a step 72.

20

After this, the processor 30 compares said difference with a predetermined engine overload threshold value, in a step 75. The engine overload threshold value indicates an overload condition of the vehicle engine 10. The engine overload condition occurs when the engine 10 is operating beyond its operating full capacity. In other words, the engine is providing more mechanical power than the engine 10 is designed to provide. Operating the engine 10 beyond its operating full capacity can damage the engine 10.

30

When the difference is more than the predetermined engine overload threshold value, the engine 10 is deemed to be experiencing the overload condition.

The engine rotational speed is increasing while the corresponding vehicle speed is increasing at a rate, which is below a predetermined expected rate of increase of the vehicle speed. In other words, the engine 10 has difficulties driving
5 both the gas compressor 5 and the vehicle wheel.

To cope with the engine overload, the transmission can be shifted to a lower gear position, wherein the engine rotational speed is higher for generating a greater engine output
10 torque. This then results in a higher rate of increase of the rotational engine shaft speed and a slower rate of increase of the wheel rotational speed.

The processor 30 later generates the electromagnetic clutch
15 de-activating signal, in a step 78. This electromagnetic clutch de-activating signal acts to direct essentially all the output power of the engine 10 to driving the wheels of the vehicle 1 for coping with the engine overload. The output power is not used for driving the gas compressor 5.

20

When the difference is less than the predetermined engine overload threshold value, the engine 10 is deemed to be experiencing the normal load condition.

25 The engine rotational speed is increasing while the corresponding vehicle speed is increasing at a rate, which is within the predetermined expected rate of increase of the vehicle speed. The engine 10 is able to drive comfortably both the gas compressor 5 and the vehicle wheel.

30

The processor 30 then generates the electromagnetic clutch activating signal, in a step 79. The electromagnetic clutch activating signal serves to direct the output power of the en-

gine 10 for rotating the wheels and for driving the gas compressor 5.

The improved instrument cluster 15 with the control unit has
5 several benefits.

The improved instrument cluster 15 is advantageously simple to implement with low material cost. This is because the implementation acts to mainly send a signal from the instrument
10 cluster to the HVAC control module.

Furthermore, this implementation can be easily applied to many types of vehicles that comprise an instrument cluster and a HVAC control panel.

15

The automatic switching of the gas compressor 5 also enhances driving safety as it allows a driver to concentrate on driving the vehicle 1 and not be burdened with frequent manual switching of the gas compressor 5 during driving.

20

The embodiments can also be described with the following lists of features or elements being organized into an item list. The respective combinations of features, which are disclosed in the item list, are regarded as independent subject matter, respectively, that can also be combined with other features of the application.

25

1. A control module for an engine-driven compressor of a vehicle with an engine, the control module comprising
30 a first port being adapted for receiving at least two engine shaft rotational speed measurements,
a second port being adapted for receiving at least two vehicle wheel rotational speed measurements, and
a processor being adapted for

- determining a first rate of increase according to the engine shaft rotational speed measurements,
- determining a second rate of increase according to the vehicle wheel rotational speed measurements,
- determining a relationship between the first rate of increase and the second rate of increase,
- comparing the relationship with a predetermined engine overload threshold value, and
- when the relationship exceeds the predetermined engine overload threshold value, providing a control signal for disconnecting the compressor from the engine of the vehicle.

2. The control module according to item 1 wherein the processor is further adapted for, when the relationship is within the predetermined engine overload threshold value, providing a control signal for connecting the compressor to the engine of the vehicle.

3. The control module according to item 1 or 2, wherein the processor is further adapted for the determining of the relationship between the first rate of increase and the second rate of increase that comprises determining a difference between the first rate of increase and the second rate of increase.

4. The control module according to item 1 or 2, wherein the processor is further adapted for the determining of the relationship between the first rate of increase and the second rate of increase that comprises determining a

quotient of the first rate of increase and the second rate of increase.

5. An instrument cluster for a vehicle comprising
 - 5 a control module according to one of the above-mentioned items for receiving at least two engine shaft rotational speed measurements and for receiving at least two vehicle wheel rotational speed measurements,
 - 10 a speedometer for displaying a vehicle speed according to the vehicle wheel rotational speed measurements, and
 - a tachometer for displaying the engine shaft rotational speed measurements.
- 15 6. A drive unit for an engine-driven compressor of a vehicle with an engine, the drive unit comprising
 - a control module according to one of the items 1 to 4 for providing a clutch control signal, and
 - 20 a clutch module being adapted for selectively connecting the compressor with the engine according to the clutch control signal.
7. The drive unit according to item 6, wherein the clutch module comprises
 - 25 - a first clutch plate for connecting with the compressor,
 - a second clutch plate for connecting with the engine, and
 - an electromagnetic coil, the electromagnetic coil
 - 30 for actuating one of the first clutch plate and the second clutch plate for connecting the first clutch plate and the second clutch plate to each other.
8. The drive unit according to item 7 further comprising

- a pulley being connected to the second clutch plate,
and
 - a belt being engaged with the pulley and with the
engine for transferring a rotation motion of the en-
5 gine to a rotation motion of the pulley.
9. A vehicle comprising
- a plurality of wheels,
 - an engine,
 - 10 a compressor, and
 - a drive unit according to one of items 6 to 8, the
drive unit being adapted for selectively connecting the
compressor with the engine,
wherein the engine is adapted for driving the wheels and
15 the compressor.
10. A method for operating a control module for an engine-
driven compressor of a vehicle with an engine, the method
comprising
- 20 receiving at least two engine shaft rotational speed
measurements and at least two vehicle wheel rotational
speed measurements,
 - determining a first rate of increase according to
the engine shaft rotational speed measurements,
 - 25 determining a second rate of increase according to
the vehicle wheel rotational speed measurements,
 - determining a relationship between the first rate of
increase and the second rate of increase,
 - comparing the relationship with a predetermined en-
30 gine overload threshold value, and
 - when the relationship exceeds the predetermined en-
gine overload threshold value, disconnecting the compres-
sor from the engine of the vehicle.

11. The method for operating the control module according to item 10, wherein the method further comprising when the relationship is within the predetermined engine overload threshold value, connecting the compressor to the engine of the vehicle.
12. The method for operating the control module according to item 10 or 11, wherein the determining of the relationship comprises determining a difference between the first rate of increase and the second rate of increase.
13. The method for operating the control module according to item 10 or 11, wherein the determining of the relationship comprises determining a quotient of the first rate of increase and the second rate of increase.

Although the above description contains much specificity, this should not be construed as limiting the scope of the embodiments but merely providing illustration of the foreseeable embodiments. The above stated advantages of the embodiments should not be construed especially as limiting the scope of the embodiments but merely to explain possible achievements if the described embodiments are put into practice. Thus, the scope of the embodiments should be determined by the claims and their equivalents, rather than by the examples given.

REFERENCE NUMBERS

	1	vehicle
	2	HVAC unit
	3	engine unit
5	4	measurement unit
	5	gas compressor
	6	gas compressor unit
	7	drive shaft
	8	electromagnetic clutch
10	9	vehicle wheel rotational speed sensing module
	10	combustion engine
	11	crankshaft
	12	engine rotational speed sensing module
	13	belt
15	14	pulley
	15	instrument cluster
	16	electromagnetic coil
	17	clutch plate
	18	HVAC control module
20	19	clutch plate
	21	processor module
	24	speedometer gauge
	27	tachometer gauge
	28	gear position gauge
25	30	computing processor
	33	memory module
	36	input terminal
	39	input terminal
	42	data bus
30	45	solenoid actuated switch device
	48	electromagnetic coil
	49	switch
	50	electrical power source
	51	wire

	54	gear position sensing module
	57	input terminal
	60	flow chart
	63	step
5	65	step
	66	step
	69	step
	70	step
	72	step
10	75	step
	78	step
	79	step

CLAIMS

1. A control module for an engine-driven compressor of a vehicle with an engine, the control module comprising
- 5 a first port being adapted for receiving at least two engine shaft rotational speed measurements,
- a second port being adapted for receiving at least two vehicle wheel rotational speed measurements, and
- a processor being adapted for
- 10 - determining a first rate of increase according to the engine shaft rotational speed measurements,
- determining a second rate of increase according to the vehicle wheel rotational speed measurements,
- 15 - determining a relationship between the first rate of increase and the second rate of increase,
- comparing the relationship with a predetermined engine overload threshold value, and
- 20 - when the relationship exceeds the predetermined engine overload threshold value, providing a control signal for disconnecting the compressor from the engine of the vehicle.
- 25
2. The control module according to claim 1 wherein the processor is further adapted for, when the relationship is within the predetermined engine overload threshold value, providing a control signal for connecting the
- 30 compressor to the engine of the vehicle.
3. The control module according to claim 1, wherein the processor is further adapted for the determining of the relationship between the first rate of increase and

the second rate of increase that comprises determining a difference between the first rate of increase and the second rate of increase.

- 5 4. The control module according to claim 1, wherein
the processor is further adapted for the determining of
the relationship between the first rate of increase and
the second rate of increase that comprises determining a
quotient of the first rate of increase and the second
10 rate of increase.
5. An instrument cluster for a vehicle comprising
a control module according to claim 1 for receiving
at least two engine shaft rotational speed measurements
15 and for receiving at least two vehicle wheel rotational
speed measurements,
a speedometer for displaying a vehicle speed accord-
ing to the vehicle wheel rotational speed measurements,
and
20 a tachometer for displaying the engine shaft rota-
tional speed measurements.
6. A drive unit for an engine-driven compressor of a vehicle
with an engine, the drive unit comprising
25 a control module according to claim 1 for providing
a clutch control signal, and
a clutch module being adapted for selectively con-
necting the compressor with the engine according to the
clutch control signal.
- 30 7. The drive unit according to claim 6, wherein
the clutch module comprises
- a first clutch plate for connecting with the com-
pressor,

- a second clutch plate for connecting with the engine, and
 - an electromagnetic coil, the electromagnetic coil for actuating one of the first clutch plate and the second clutch plate for connecting the first clutch plate and the second clutch plate to each other.
- 5
8. The drive unit according to claim 7 further comprising
- a pulley being connected to the second clutch plate, and
 - a belt being engaged with the pulley and with the engine for transferring a rotation motion of the engine to a rotation motion of the pulley.
- 10
9. A vehicle comprising
- a plurality of wheels,
 - an engine,
 - a compressor, and
 - a drive unit according to claim 6, the drive unit
- 15
- being adapted for selectively connecting the compressor with the engine,
- 20
- wherein the engine is adapted for driving the wheels and the compressor.
- 25
10. A method for operating a control module for an engine-driven compressor of a vehicle with an engine, the method comprising
- receiving at least two engine shaft rotational speed measurements and at least two vehicle wheel rotational
- 30
- speed measurements,
 - determining a first rate of increase according to the engine shaft rotational speed measurements,
 - determining a second rate of increase according to the vehicle wheel rotational speed measurements,

determining a relationship between the first rate of increase and the second rate of increase,

comparing the relationship with a predetermined engine overload threshold value, and

5 when the relationship exceeds the predetermined engine overload threshold value, disconnecting the compressor from the engine of the vehicle.

11. The method for operating the control module according to
10 claim 10, wherein the method further comprising
 when the relationship is within the predetermined engine overload threshold value, connecting the compressor to the engine of the vehicle.

15 12. The method for operating the control module according to
 claim 10, wherein
 the determining of the relationship comprises determining a difference between the first rate of increase and the second rate of increase.

20 13. The method for operating the control module according to
 claim 10, wherein
 the determining of the relationship comprises determining a quotient of the first rate of increase and the second
25 rate of increase.

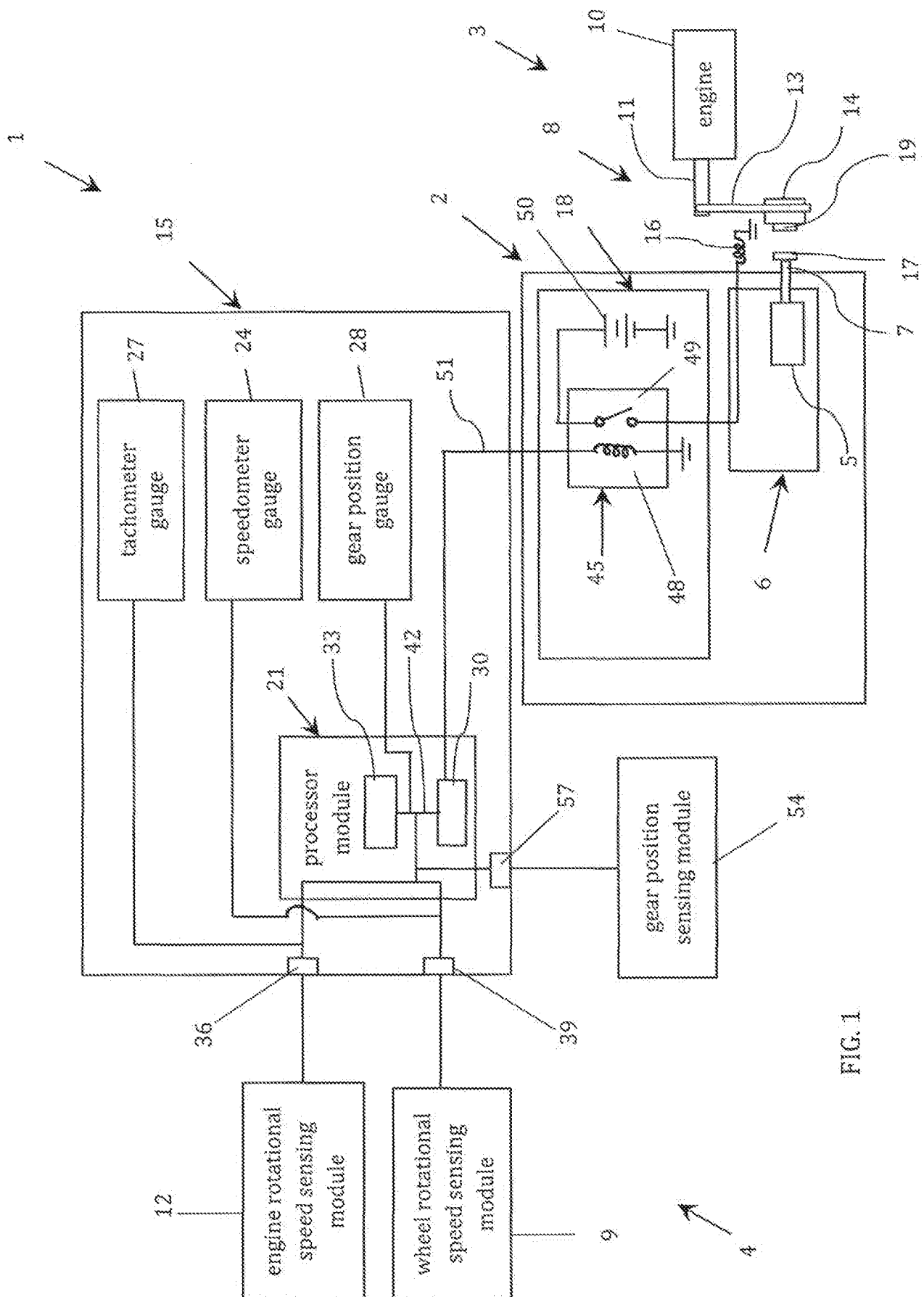


FIG. 1

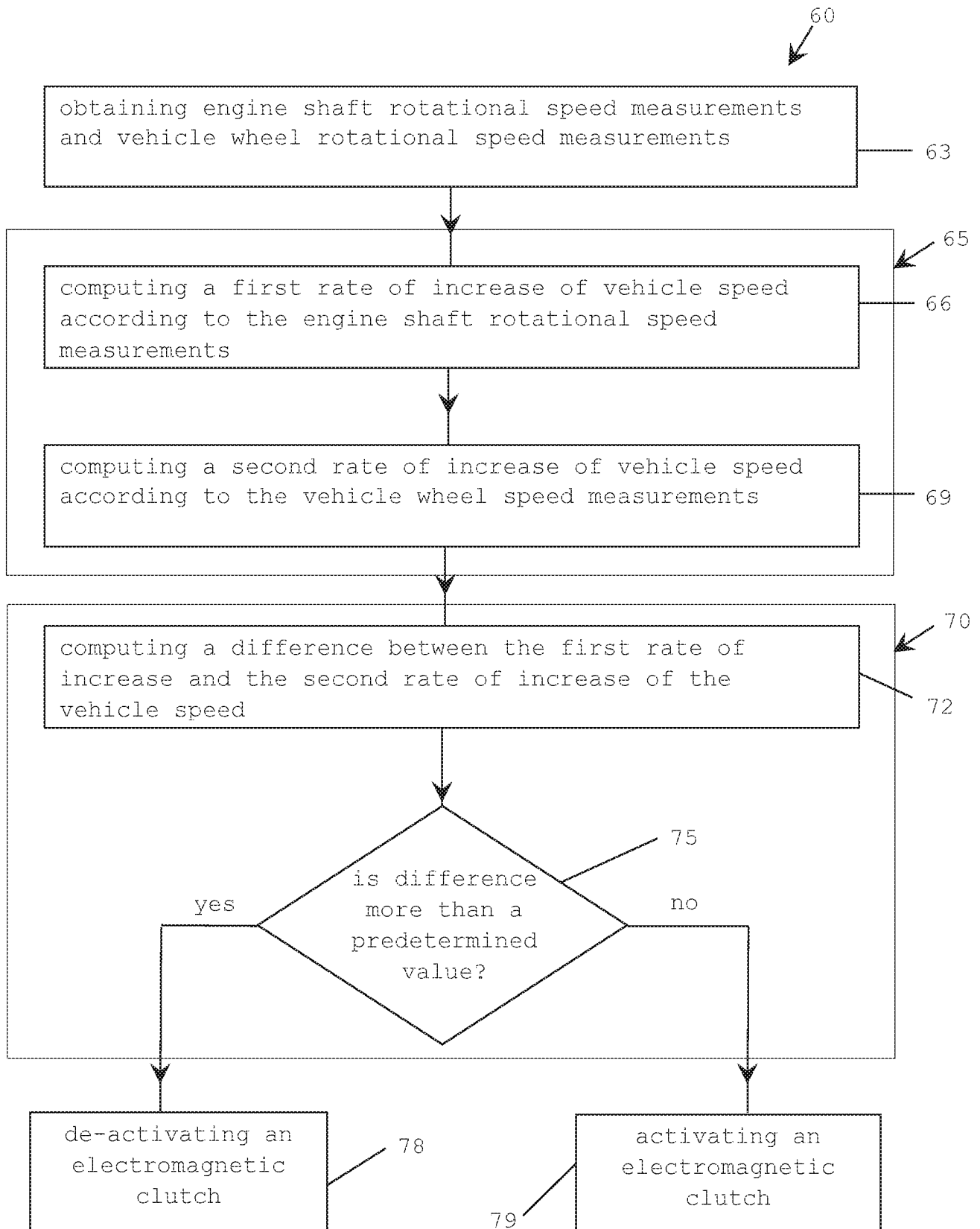


FIG. 2

A. CLASSIFICATION OF SUBJECT MATTER**B60K 35/00(2006.01)i, B60K 37/02(2006.01)i, B60H 1/32(2006.01)i, F16H 9/12(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B60K 35/00; F16D 37/02; F02B 67/06; B60H 3/04; B60H 1/00; F25B 1/00; B60K 37/02; B60H 1/32; F16H 9/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: vehicle, engine-driven compressor, engine speed, vehicle speed, clutch, and disconnecting

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-0210608 B1 (KIA MOTORS CORPORATION) 15 July 1999 See page 2, line 13 - page 3, line 12 and figures 1-3.	1-6,9-13
Y		7-8
Y	EP 0066874 A2 (HITACHI, LTD. et al.) 15 December 1982 See page 4, line 24 - page 5, line 22 and figure 2.	7-8
A	US 6626001 B2 (HAMACHI et al.) 30 September 2003 See column 5, line 38 - column 6, line 42, column 10, line 26 - column 12, line 64, claims 6-9, and figures 1, 4.	1-13
A	US 2007-0080037 A1 (LARRY et al.) 12 April 2007 See paragraphs [0020], [0023], [0038], claims 1-2, 7-8, and figures 1, 4.	1-13
A	US 5056326 A (OHKUMO et al.) 15 October 1991 See column 3, line 10 - column 3, line 44, claim 1, and figures 1-2.	1-13

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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