(57) Vehicle control systems are provided for improving the fuel economy of vehicles by operating their systems in a more efficient manner. Configurations comprise arrangements for controlling compressed air supply, an alternator, a throttle, a pneumatic compressor duty cycle and a cooling fan. The air supply system comprises an air compressor 2, an air dryer 4, an air tank 6, a pressure governor 12, and a controller 16 which is coupled to an economizer valve 8 and to other electrical systems. Controllers of the various systems include an engine ECU (20 fig 4 & 42 fig 8), transmission ECU (22 see fig 4), brake system ECU (24 see fig 4), fuel save ECU (16 see fig 4), gearbox ECU (see fig 8), throttle control ECU (48 see figs 8,9), and fan control ECU (88 see fig 11). The air supply system for example is aimed at improving fuel economy by air storage in response to vehicle braking and/or during an efficient range of engine operation.

![Diagram](image-url)
Is air pressure < min?

Yes: Close solenoid valve (8)

No: Open solenoid valve (8)

Is engine fuel cut active?

Yes: Close solenoid valve (8)

No: Is air pressure < low air limit?

Yes: Is engine in efficient operating area?

No: No

FIG. 5
FIG. 10

FIG. 11
Title: Energy Saving in Vehicles

Field of the Inventions

The present inventions relate to reducing the energy consumption of vehicles. More particularly, they concern improving the fuel economy of vehicles by operating their systems in a more efficient manner.

Background to the Inventions

There is an ever increasing need to reduce the fuel consumption of vehicles in order to lower the associated carbon emissions into the atmosphere and reduce running costs. Commercial vehicles account for a large proportion of the fuel consumed by vehicles and efficiency improvements which are applicable to these vehicles are particularly beneficial.

Summary of the Inventions

The first invention provides a compressed air supply system for a vehicle, comprising:

an air compressor for compressing air drawn from the surrounding atmosphere;

a compressed air storage tank coupled to the air compressor to receive compressed air and store it for use by other systems of the vehicle;

a pressure governor which is responsive to the air pressure within the storage tank;

a control arrangement which is responsive to the operation of the vehicle; and an economiser valve which is controllable by the control arrangement, wherein the pressure governor is arranged to divert the air flow from the air compressor to the economiser valve, instead of the storage tank, when the air pressure within the storage tank exceeds a predetermined upper threshold, until a predetermined lower threshold is reached,

and wherein the control arrangement is arranged to close the economiser valve in response to vehicle braking and/or in response to the vehicle engine operating in a
predetermined efficient operating range, which causes the air from the air compressor to flow to the storage tank.

Commercial vehicles, and in particular buses, usually have engine-driven air compressors. The compressors tend to be mechanically controlled using a “bang bang” controlled system, which will deliver the compressor output to a storage tank when the tank pressure reaches a minimum level, and then divert the flow to atmosphere when the tank pressure reaches a maximum level. The air is used to power the braking system and, in a bus for example, may open doors or raise and lower the suspension.

A commercial vehicle compressor may take 3 to 4 kW of power from the engine when it is operating to pump compressed air into the storage tank (rather than its output being diverted to atmosphere). When it is pumping into the tank, its power consumption is much higher. Depending on the use of the vehicle, the compressor may be pumping air into the tank for between 10% and 50% of the time, which represents a significant cost in fuel to drive the compressor.

According to the invention, the compressed air supply system is controlled to charge up the storage tank during braking events and/or when the engine is in its most efficient operating area. During braking, the fuel supply to the engine is normally cut off. Accordingly, under either set of circumstances, power is drawn from the engine to drive the compressor when it is especially fuel efficient to do so.

Preferably, the predetermined efficient operating range of the vehicle engine is defined with reference to at least one measure dependent on a parameter selected from: the engine speed, the torque generated by the engine, and the fuel efficiency of the engine.

The first invention also provides a method of operating a compressed air supply system of a vehicle including an air compressor for compressing air drawn from the surrounding atmosphere, and a compressed air storage tank coupled to the air
compressor to receive compressed air and store it for use by other systems of the vehicle, comprising the steps of:

diverting air flow from the air compressor to an economiser valve, instead of the storage tank, when the air pressure within the storage tank exceeds a predetermined upper threshold, until a predetermined lower threshold is reached; and

closing the economiser valve in response to vehicle braking and/or in response to the vehicle engine operating in a predetermined efficient operating range, causing the air from the air compressor to flow to the storage tank.

According to a second invention, a vehicle alternator control arrangement is provided which comprises a controller having:

a braking input for receiving a braking signal responsive to application of the brakes of the vehicle;

a battery input for receiving a battery status signal responsive to the vehicle battery voltage; and

an alternator control output for outputting an alternator signal to indicate when power is to be generated by the alternator,

wherein the controller is arranged to output an alternator signal to indicate that power is to be generated by the alternator in response to a braking signal which indicates that the vehicle is braking and/or in response to a battery status signal which indicates that the battery voltage is below a predetermined threshold.

Accordingly, the controller may output an alternator signal to instigate energising of the field winding of the alternator when it is particularly fuel efficient to do so and/or when the battery voltage is below a pre-determined threshold. A commercial vehicle will usually be fitted with an alternator which has a separately excited field winding. This winding is supplied with voltage (typically 24V) from the vehicle battery.

The controller may include an engine load input for receiving an engine load signal responsive to the load on the engine or another parameter indicative thereof, such as the engine speed or power output. The controller may then be arranged to output an alternator signal to indicate that power is not to be generated by the alternator in
response to an engine load signal which indicates that the engine load is below a predetermined threshold.

The alternator output current may be controlled directly by fitting a switch in the power output of the alternator, between the alternator and battery. The switch may be responsive to the alternator signal outputted by the controller so as to be closed when power is to be supplied by the alternator. This switch may be either an electro-mechanical contactor, or a solid state switch, for example.

The second invention also provides a method of controlling a vehicle alternator comprising the steps of:

receiving a braking signal responsive to application of the brakes of the vehicle and/or receiving a battery status signal responsive to the vehicle battery voltage; and

outputting an alternator signal to indicate when power is to be generated by the alternator in response to a braking signal which indicates that the vehicle is braking and/or in response to a battery status signal which indicates that the battery voltage is below a predetermined threshold.

According to a third invention, a vehicle engine control system is provided which comprises a throttle control arrangement having a torque demand input arranged to receive a torque demand input signal responsive to torque demands from a driver, an acceleration input arranged to receive an acceleration signal responsive to the actual acceleration of the vehicle, and a torque reduction output for outputting a torque reduction signal,

wherein the control arrangement is configured to compare the acceleration signal with a predetermined threshold value, and when the threshold value is exceeded, calculate the value of a torque reduction parameter with reference to the torque demand input signal, and output a torque reduction signal at its torque reduction output which is responsive to the torque reduction parameter.
Existing vehicle engine control systems tend to be “drive-by-wire”. That is, the vehicle accelerator pedal includes a potentiometer or other electrical position sensing device, which is electrically connected to the engine control system. The engine control system then decides how much torque the engine will produce as a response to the pedal position.

Additionally, the engine control system is able to reduce the torque demanded by the driver. A bus will have an engine and gearbox system sized so as to allow acceptable vehicle performance when the vehicle is fully laden. This means that the driver may drive the vehicle using excessive torque when unladen.

According to the third invention, a throttle control arrangement is provided which monitors the acceleration of the vehicle and the torque demands from the driver. If the driver demands excessive torque resulting in excessive acceleration, the control arrangement will reduce the torque of the vehicle, to allow an acceptable level of acceleration only. This will save fuel and result in more consistent vehicle operation.

According to a fourth invention, a vehicle pneumatic compressor monitoring arrangement is provided which comprises:

a duty cycle signal input for receiving a duty cycle signal which is indicative of the on-time of the compressor;

a controller for monitoring the duty cycle signal and calculating an on-time parameter dependent on the duty cycle signal; and

an alert signal output for outputting an alert signal when the controller determines that the on-time parameter exceeds a predetermined threshold.

The pneumatic compressor system on a vehicle tends to consume a considerable amount of fuel. Many commercial vehicles will tend to repeat the same routes and have a very well-defined duty cycle. Therefore, during normal routine operation, the consumption of air via the use of brakes and door openings and the like will be constant, within a reasonable tolerance. In the event that an air leak develops, the vehicle will consume considerably more fuel, but will otherwise be operating normally.
According to the fourth invention, a controller monitors the duty cycle of the pneumatic compressor either directly or indirectly. If the compressor on-time increases significantly, this may be sensed and indicated by outputting an alert signal. This may be sent by the communication network of the vehicle. It may trigger a visual indication on a fuel save ECU for example, or on an existing display or monitoring system on the vehicle.

The duty cycle signal may be responsive to the on-time of the compressor. It may be generated with reference to the actual operation of the compressor. Alternatively, it may be dependent on the air pressure within the pneumatic system that includes the compressor. The duty cycle signal may be dependent on an air pressure signal that is responsive to this system pressure.

A method of monitoring a vehicle pneumatic compressor is also provided, comprising:

- receiving a duty cycle signal indicative of the on-time of the compressor;
- calculating an on-time parameter dependent on the duty cycle signal; and
- outputting an alert signal when the on-time parameter exceeds a predetermined threshold.

According to a fifth invention, a cooling fan control arrangement is provided for use in a vehicle to control the operation of a cooling fan, the control arrangement comprising a fan controller having an input for receiving a signal responsive to application of the brakes of the vehicle, and an output for outputting a control signal, wherein the controller is arranged to output a control signal in response to application of the brakes to cause the cooling fan to be driven.

A vehicle fan is usually sized for vehicle operation at extremes of climate and loading. It therefore tends to be oversized for operation under normal conditions. Also, an engine has a considerable thermal inertia. Therefore, it is possible to run the vehicle with the fan operating intermittently.
If the engine is under load, and the fan is turned off, the thermal inertia means that it will take minutes for the engine to coolant temperature to increase significantly. Therefore, the fan can be turned off under acceleration. Under braking, the fan will be turned on, possibly at a higher level than that needed for continuous operation, providing the cooling mass flow required.

The fan will primarily be driven under fuel cut conditions, when the vehicle is braking. The kinetic energy of the engine is therefore used to drive the fan. When the fuel cut finishes, the fan will be deactivated. If the braking fuel cut events are not frequent enough to cool the engine sufficiently, then the controller may operate to activate the fan during periods of optimal engine efficiency.

A predetermined efficient operating range of the engine may be defined with reference to at least one measure dependent on a parameter selected from: the engine speed, the torque generated by the engine, and the fuel efficiency of the engine.

A method of controlling the operation of a cooling fan is also provided, the method comprising:

- receiving a signal responsive to the application of the brakes of the vehicle;
- and
- outputting a control signal to cause the cooling fan to be driven in response to application of the brakes.

**Brief description of the drawings**

Prior art configurations and embodiments of the inventions will now be described by way of example with reference to the accompanying schematic drawings, wherein:

- Figure 1 is a block diagram of a known commercial vehicle air system;
- Figure 2 is a block diagram of a commercial vehicle air system which has been modified according to an embodiment of the first invention;
- Figure 3 is a block diagram of a known vehicle control system;
- Figure 4 is a block diagram of a vehicle control system modified according to an embodiment of the first invention;
Figure 5 is a flow diagram relating to control of a vehicle air supply system according to an embodiment of the first invention;

Figure 6 illustrates a vehicle alternator control arrangement according to an embodiment of the second invention;

Figure 7 is a block diagram of a known vehicle engine control system;

Figure 8 is a block diagram of a vehicle engine control system modified according to an embodiment of the third invention;

Figure 9 illustrates a throttle control arrangement according to an embodiment of the third invention;

Figure 10 is a block diagram representing a control algorithm for a throttle control arrangement according to an embodiment of the third invention;

Figure 11 is a diagram representing a known vehicle fan drive arrangement;

Figures 12 and 13 are cross-sectional side views of part of a known variable swash plate hydraulic pump;

Figure 14 is a diagram representing a known cooling fan control arrangement;

Figure 15 is a cooling fan control arrangement according to an embodiment of the fourth invention; and

Figure 16 is a flow diagram relating to the operation of a cooling fan control arrangement according to an embodiment of the fifth invention.

Detailed description of the drawings

Figure 1 shows a representation of a known commercial vehicle air system. An air compressor 2 is mechanically driven and directly connected to the vehicle engine. It feeds compressed air via an air dryer 4 to a compressed air storage tank 6 (often referred to as a "wet tank"). The air pressure in the tank 6 is maintained by a non-return valve 10 located in the fluid path between it and the air dryer 4. The pressure in the tank is monitored by a pressure governor 12 (via a coupling not shown in the Figure). The pressure governor is a mechanical valve system which holds a valve shut using spring pressure. When this valve is open, air is allowed to flow from the compressor 2 to an unloading valve 14.
When the system is charging, air from the compressor is driven through the air dryer system 4 and then stored in the tank 6.

When the pressure in the tank overcomes the sprung valve of the pressure governor, the valve opens and allows the air to flow to the unloading valve 14. This allows air to flow from the compressor to the atmosphere. The pressure governor has in-built hysteresis, and allows its valve to close when the pressure in the tank 6 drops below a preset level. This will cause air from the compressor to recharge the tank.

A compressed air system which has been modified according to an embodiment of the first invention is shown in Figure 2. An “economiser valve” 8 is inserted in the air flow path between the pressure governor 12 and the unloading valve 14. The operation of the economiser valve is controlled using a controller 16 which is electrically coupled to other electrical systems on the vehicle.

In the embodiment illustrated, valve 8 is a normally-open electrically operated valve, and in particular a 2/2 way pneumatic solenoid valve, which is electrically operated by the controller 16. It may be a 24V solenoid for example.

When de-energised, the valve adopts its open position, allowing air to flow from the pressure governor 12 to the unloading valve 14. When the valve is energised, flow from the pressure governor is blocked by the valve.

In this embodiment, the controller 16 is an electronic control unit (“ECU”) comprising a microprocessor. The controller is preferably connected to other bus systems via an industry standard controller area network (“CAN”) bus. In this way, the controller is able to receive information relating to the state of other vehicle systems.

The controller is arranged to close the economiser valve 8 in response to receipt of a signal indicating that the vehicle is braking. This signal may be generated in response to the engine operating in a fuel cut mode.
Alternatively or additionally, the control arrangement is arranged to close the economiser valve when the vehicle engine is operating in a pre-defined efficient operating range. This may be determined by the controller 16 with reference to stored information regarding the engine efficiency. This may be in the form of a three-dimensional map of engine speed, torque and specific fuel efficiency, for example.

The controller therefore operates to close the economiser valve so that the storage tank 6 is charged when it is particularly fuel efficient to do so.

A flow diagram representing a control algorithm for implementation in the controller 16 to operate the economiser valve as discussed above is shown in Figure 5.

Part of a known vehicle control system is shown in Figure 3. It has a number of microprocessor control units controlling different functions on the vehicle. Figure 3 shows an engine ECU 20, a transmission ECU 22 and a brake system ECU 24 by way of example. These units are inter-connected via a data bus 26. One industry standard for such a communication system is CAN, but others may be used.

Systems connected to the communication network will measure various vehicle parameters, such as vehicle speed, brake pressure, activation of an engine fuel cut mode, and the like.

According to the first invention, as illustrated in the embodiment shown in Figure 4, another ECU is added to the system, namely controller 16, which may be denoted as a “fuel save ECU”. Controller 16 is coupled to the vehicle communication system and/or other data buses on the vehicle. It is also electrically coupled to the economiser valve 8 in order to control its operation as described above.

**Alternator Control**

Figure 6 shows a diagram representing a controller for a vehicle alternator according to an embodiment of the second invention. The controller 30 may be embodied within the “fuel save ECU” described above. Alternatively, it may be provided as a separate electronic control unit dedicated to the alternator. The controller is arranged
to receive a number of signals relating to the operation of the vehicle. They may be provided over a shared communication network of the vehicle.

In the embodiment of Figure 6, the controller is arranged to receive a braking input signal 32 responsive to application of the brakes of the vehicle and a battery input signal 34 which is responsive to the vehicle battery voltage. An output signal 36 indicates that the alternator should be energised.

The controller is arranged to output an alternator signal to indicate that the alternator should be energised when the vehicle is braking with the engine fuel cut active, or when the measured battery voltage is below a value which indicates that the battery is in a low state of charge, this value being preset in software.

When the vehicle is idling or under low load, the alternator will be disabled. During these periods, the vehicle electrical system will be discharging the vehicle battery.

**Throttle Control**

A known vehicle engine 40 control system is illustrated in Figure 7. The vehicle engine, typically a diesel-fuelled engine in a commercial vehicle, will be controlled via a microprocessor operated engine control unit, “engine ECU” 42. Unit 42 takes its primary demand from a fly-by-wire coupled throttle pedal 44. The engine ECU 42 will also receive input signals via the vehicle’s communication network regarding the operation of the engine, from a crankshaft position sensor, a fuel pressure sensor, and the like. In response, the engine ECU controls the timing of the fuel delivery to the engine. Other signals may be received from a gearbox ECU 46. The engine ECU converts the driver’s demanded throttle input into a required torque and calculates the amount and timing of the delivery of fuel to achieve the required torque.

The engine ECU 42 may have the ability to interface with other control systems such as a gearbox controller 46. This control may use an industry standard CAN protocol, such as a J1939, which will specify specific CAN addresses and scalings for specific functions, such as a torque reduction. A torque reduction parameter may therefore be defined which reduces the driver demanded torque. This may be used to reduce the
torque demanded by the driver during a gear change, to enable a smooth gear change to take place.

An engine control system modified according to an embodiment of the third invention is shown in Figure 8. A throttle control arrangement in the form of “throttle control ECU” 48 is added and coupled to the vehicle communication network (which may be in the form of a CAN system for example).

An embodiment of the throttle control arrangement is shown in Figure 9. It is arranged to receive a torque demand input signal 52 responsive to torque demands from the driver and an acceleration input signal 50 responsive to the actual acceleration of the vehicle. In response, a torque reduction signal 54 is outputted by the control arrangement to the engine ECU via the vehicle communication network. The control arrangement 48 stores an algorithm which calculates the required torque reduction when appropriate and outputs this onto the CAN bus to be inputted to and processed by the engine ECU 42. An embodiment of such an algorithm is illustrated in Figure 10. The algorithm has an acceleration limiting branch and a torque filtering branch.

Figure 10 includes the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Accel</td>
<td>the maximum allowable acceleration for the vehicle;</td>
</tr>
<tr>
<td>Ki</td>
<td>the gain on the integral part of the acceleration limiting branch of the algorithm;</td>
</tr>
<tr>
<td>Kp1</td>
<td>the gain on the proportional part of the acceleration limiting branch;</td>
</tr>
<tr>
<td>Kp2</td>
<td>the gain on the proportional part of the torque filtering branch of the algorithm;</td>
</tr>
<tr>
<td>T</td>
<td>a filter time constant;</td>
</tr>
<tr>
<td>Limit function</td>
<td>a fixed parameter which limits the amount by which the algorithm can reduce the torque; and</td>
</tr>
<tr>
<td>s</td>
<td>represents a parameter in accordance with the use of this symbol in Laplace transform technology.</td>
</tr>
</tbody>
</table>
The parameter “Max Accel” can be set by the user to specify the absolute maximum vehicle acceleration that will be permitted. This is compared with the actual acceleration of the vehicle by a comparator 60. The actual acceleration may be transmitted over a communication network of the vehicle to the throttle control arrangement. It forms the feedback element in a closed loop control system.

If the actual acceleration is less than Max Accel, the comparator 60 will generate a positive error output. This output is reduced to 0 by an operator 62. If the actual acceleration is greater than Max Accel, the comparator 60 will generate a negative error output which is unmodified by operator 62. A gain is applied to this error by the proportional part 64 of the acceleration limiting branch. This branch also has an integral function 66, to reduce steady state errors to 0. The outputs of the proportional part and the integral part are combined in an adding operator 68.

The algorithm also includes a torque filtering branch to filter the torque requested from the driver. It receives a signal 70 indicative of the torque demanded by the driver from the vehicle communication system. This signal is fed to a comparator 72 and also via a proportional part 74. This operates to limit the frequency response of the torque applied to the engine with reference to filter time constant T. This serves to inhibit aggressive throttle input from the driver which may otherwise result in excessive fuel consumption. The output of the proportional part 74 is combined with the demanded torque 70 at the comparator 72 and the result fed into the adding operator 68. The output of the operator 68 is fed via a limit function 76 to cap the amount by which the algorithm can reduce the torque demanded from the engine.

**Fan Control**

A schematic diagram of a known fan drive arrangement is shown in Figure 11. A pump 80 is driven directly from the engine by means of a belt and pulley (not shown). The pump is connected via hydraulic hoses 82 to a hydraulic fixed displacement motor 84. The motor is then directly connected to a fan 86. Pump 80 is a variable swash plate hydraulic pump. The angle of the swash plate on the pump is controlled by a fan control ECU 88. This is in turn coupled to the vehicle communication network. It may be integrated into the vehicle engine ECU.
The hydraulically driven fan 86 directs air through a heat exchanger to control the
temperature of the engine and gearbox water or oil coolant.

The operation of a known swash plate pump is illustrated in Figures 12 and 13.
Pistons 90 and 92 are able to slide in and out of their respective bores 94 and 96.
Their outer ends are pivotally coupled to a swash plate 98. The swash plate is
rotatable together with a drive shaft 100.

When the swash plate is vertical as in Figure 12, the pistons do not reciprocate in their
bores as they rotate around drive shaft 100. No fluid is therefore pumped into and out
of the bores. Tilting the swash plate as shown in Figure 13 causes the pistons to
reciprocate in their bores as the rotating group turns. Depending on the tilt angle, the
amount of oil displaced can be varied. The greater the angle of tilt, the greater the
displacement. Fluid is thereby drawn into one bore and subsequent ejected at a
different location, to provide a pumping action.

A block diagram representing a known cooling fan control arrangement is shown in
Figure 14. A fan control ECU 88 determines a required fan speed with reference to
input signals 104 and 106 representing the engine speed and coolant temperature
respectively. The required fan speed signal is fed to a PWM generator 108 which in
turn outputs a control signal to the swash pump 80. This governs the swash plate
angle of the pump which in turn determines the fan speed. A feedback loop 110
adjusts the input signal to the PWM generator with respect to the actual fan speed.
Alternatively the system may be driven “open loop”, whereby the fan speed is not
included in a feedback loop. The fan control ECU aims to control the swash plate
angle so as to maintain a constant fan speed with variable engine speed (for a given
coolant temperature).

A block diagram of a cooling fan control arrangement according to an embodiment of
the fifth invention is shown in Figure 15. It includes a modified fan control ECU 102.
It has a further input 112 for receiving a signal responsive to application of the brakes
of the vehicle, when the fuel supply to the engine is cut. The controller 102 may also
have a signal input 114 which is response to one or more current operating parameters of the engine. Controller 102 will drive the fan primarily under fuel cut conditions when the vehicle is braking. If the braking fuel cut events are not frequent enough to cool the engine sufficiently (as determined with reference to temperature input 106), then the controller will also operate to activate the fan during periods when the engine is operating in a predetermined efficient operating range.

The predetermined efficient operating range of the vehicle engine may be defined with reference to at least one parameter such as the engine speed, the torque generated by the engine, the fuel efficiency of the engine, and the like. The efficient operating range may be a space mapped with reference to selected parameters within the controller 102.

An algorithm to govern operation of the controller 102 in accordance with an embodiment of the fifth invention is shown in Figure 16.

Embodiments described above relate to a cooling fan driven by a pump via a hydraulic fixed displacement motor, but in other embodiments, the fan may be driven directly by an electric motor. In that case, the electric motor is controlled by the modified fan control ECU 102 is response to the control parameters discussed above.

Also, whilst the hydraulic implementations described above include a hydraulic swash plate pump, other types of pump may be employed. If a pump is used which is hydraulic, but without the variable capacity of a swash plate pump, the present concept may be implemented by including a bypass valve fitted in parallel with the motor 84, between the pressure and return sides of the system. The fan control ECU would then control the bypass valve (instead of the swash plate angle). Energising the valve would cause the hydraulic pump to circulate the fluid flow via the valve, stopping the motor 84.
Claims

1. A compressed air supply system for a vehicle, comprising:
   an air compressor for compressing air drawn from the surrounding atmosphere;
   a compressed air storage tank coupled to the air compressor to receive compressed air
   and store it for use by other systems of the vehicle;
   a pressure governor which is responsive to the air pressure within the storage tank;
   a control arrangement which is responsive to the operation of the vehicle; and
   an economiser valve, which is controllable by the control arrangement,

   wherein the pressure governor is arranged to divert the air flow from the air compressor
   to the economiser valve, instead of the storage tank, when the air pressure within the storage
   tank exceeds a predetermined upper threshold, until a predetermined lower threshold is
   reached,

   and wherein the control arrangement is arranged to close the economiser valve in
   response to vehicle braking and/or in response to the vehicle engine operating in a
   predetermined efficient operating range, which causes the air from the air compressor to flow
   to the storage tank.

2. A system of claim 1, wherein the economiser valve is a normally open solenoid valve.

3. A system of claim 1 or claim 2, wherein the predetermined efficient operating range of
   the vehicle engine is defined with reference to at least one measure dependent on a parameter
   selected from: the engine speed, the torque generated by the engine, and the fuel efficiency of
   the engine.

4. A vehicle including a compressed air supply system of any preceding claim.

5. A method of operating a compressed air supply system of a vehicle including an air
   compressor for compressing air drawn from the surrounding atmosphere, and a compressed air
   storage tank coupled to the air compressor to receive compressed air and store it for use by
   other systems of the vehicle, comprising the steps of:
diverting air flow from the air compressor to an economiser valve, instead of the storage tank, when the air pressure within the storage tank exceeds a predetermined upper threshold, until a predetermined lower threshold is reached; and

closing the economiser valve in response to vehicle braking and/or in response to the vehicle engine operating in a predetermined efficient operating range, causing the air from the air compressor to flow to the storage tank.

6. A method of claim 5, wherein the predetermined efficient operating range of the vehicle engine is defined with reference to at least one measure dependent on a parameter selected from: the engine speed, the torque generated by the engine, and the fuel efficiency of the engine.

7. A vehicle alternator control arrangement comprising a controller having:
a braking input for receiving a braking signal responsive to application of the brakes of the vehicle;
a battery input for receiving a battery status signal responsive to the vehicle battery voltage; and
an alternator control output for outputting an alternator signal to indicate when power is to be generated by the alternator,

wherein the controller is arranged to output an alternator signal to indicate that power is to be generated by the alternator in response to a braking signal which indicates that the vehicle is braking and/or in response to a battery status signal which indicates that the battery voltage is below a predetermined threshold.

8. A control arrangement of claim 7, wherein the controller includes an engine load input for receiving an engine load signal responsive to the load on the engine;

wherein the controller is arranged to output an alternator signal to indicate that power is not to be generated by the alternator in response to an engine load signal which indicates that the engine load is below a predetermined threshold.

9. A control arrangement of claim 7 or claim 8, wherein the controller is arranged to be coupled to a switch in the power output of the alternator, wherein the switch is responsive to the alternator signal.
10. A vehicle including a vehicle alternator control arrangement of any of claims 7 or 9.

11. A method of controlling a vehicle alternator comprising the steps of:
receiving a braking signal responsive to application of the brakes of the vehicle and/or
receiving a battery status signal responsive to the vehicle battery voltage; and
outputting an alternator signal to indicate when power is to be generated by the
alternator in response to a braking signal which indicates that the vehicle is braking and/or in
response to a battery status signal which indicates that the battery voltage is below a
predetermined threshold.

12. A vehicle engine control system comprising:
a throttle control arrangement having a torque demand input arranged to receive a
torque demand input signal responsive to torque demands from a driver, an acceleration input
arranged to receive an acceleration signal responsive to the actual acceleration of the vehicle,
and a torque reduction output for outputting a torque reduction signal,
wherein the control arrangement is configured to compare the acceleration signal with a
predetermined threshold value, and when the threshold value is exceeded, calculate the value of
a torque reduction parameter with reference to the torque demand input signal, and output a
torque reduction signal at its torque reduction output which is responsive to the torque
reduction parameter.

13. A control system of claim 12, wherein the torque reduction parameter is dependent on
the difference between the acceleration signal and the predetermined threshold value.

14. A control system of claim 13, wherein the calculation of the value of the torque
reduction parameter comprises applying a gain to the difference between the acceleration signal
and the predetermined threshold value.

15. A control system of claim 14, wherein the gain comprises an integral part and a
proportional part.
16. A control system of any of claims 12 to 15, wherein the calculation of the value of the torque reduction parameter includes reducing the value if it exceeds a predetermined threshold.

17. A control system of any of claims 12 to 16, wherein the frequency response of the torque demand input signal is reduced when it exceeds a threshold value.

18. A control system of any of claims 12 to 17, wherein the throttle control arrangement has a gear change input arranged to receive a signal responsive to the execution of an engine gear change, with the control arrangement configured to increase the value of the torque reduction parameter during a gear change.

19. A vehicle including a vehicle engine control system of any of claims 12 to 18.

20. A method of operating a vehicle throttle control arrangement, comprising the steps of:
   receiving a torque demand input signal responsive to torque demands from a driver at a torque demand input of the control arrangement;
   receiving an acceleration signal responsive to the actual acceleration of the vehicle at an acceleration input of the control arrangement;
   comparing the acceleration signal with a predetermined threshold value, and when the threshold value is exceeded, calculating the value of a torque reduction parameter with reference to the torque demand input signal; and
   outputting a torque reduction signal at a torque reduction output of the control arrangement, which signal is responsive to the torque reduction parameter.

21. A vehicle pneumatic compressor monitoring arrangement, comprising:
   a duty cycle signal input for receiving a duty cycle signal which is indicative of the on-time of the compressor;
   a controller for monitoring the duty cycle signal and calculating an on-time parameter dependent on the duty cycle signal; and
   an alert signal output for outputting an alert signal when the controller determines that the on-time parameter exceeds a predetermined threshold.
22. An arrangement of claim 21, wherein the duty cycle signal is responsive to the air pressure within a pneumatic system coupled to the compressor.

23. An arrangement of claim 21 or claim 22, wherein the predetermined threshold is calculated by the controller by monitoring past operation of the compressor with reference to the duty cycle signal.

24. A vehicle including a vehicle pneumatic compressor monitoring arrangement of any of claims 21 to 23.

25. A method of monitoring a vehicle pneumatic compressor, comprising:
   receiving a duty cycle signal which is indicative of the on-time of the compressor;
   calculating an on-time parameter dependent on the duty cycle signal; and
   outputting an alert signal when the on-time parameter exceeds a predetermined threshold.

26. A cooling fan control arrangement for use in a vehicle to control the operation of a cooling fan, the control arrangement comprising a fan controller having an input for receiving a signal responsive to application of the brakes of the vehicle, and an output for outputting a control signal,
   wherein the controller is arranged to output a control signal in response to application of the brakes to cause the cooling fan to be driven.

27. A control arrangement of claim 26, wherein the controller is arranged to receive a temperature signal responsive to a temperature associated with the vehicle engine, and to output a control signal to cause the cooling fan to be driven when the temperature signal exceeds a predetermined threshold and the vehicle engine is operating in a predetermined efficient operating range.

28. A control arrangement of claim 27, wherein the predetermined efficient operating range of the vehicle engine is defined with reference to at least one measure dependent on a parameter selected from: the engine speed, the torque generated by the engine, and the fuel efficiency of the engine.
29. A control arrangement of any of claims 26 to 28, wherein the control arrangement controls the operation of a pump which drives the cooling fan and the fan controller output is arranged to output a control signal to cause the pump to drive the cooling fan.

30. A control arrangement of claim 29, wherein the control signal is intended to be used to control a hydraulic swash pump which is arranged to selectively drive the cooling fan.

31. A control arrangement of claim 29, wherein the control signal is intended to be used to control a bypass valve which is arranged to control the flow of fluid along a fluid path including the pump, which path bypasses a drive for the cooling fan.

32. A control arrangement of any of claims 26 to 28, wherein the control arrangement controls the operation of an electric motor which drives the cooling fan and the fan controller output is arranged to output a control signal to cause the motor to drive the cooling fan.

33. A vehicle including a cooling fan control arrangement of any of claims 26 to 32.

34. A method of controlling the operation of a cooling fan in a vehicle, the method comprising:

   receiving a signal responsive to the application of the brakes of the vehicle; and

   outputting a control signal to cause the cooling fan to be driven in response to application of the brakes.
Application No: GB1313354.1
Examiner: Mike McKinney
Claims searched: 1 to 6
Date of search: 14 November 2013

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

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Field of Search:
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Worldwide search of patent documents classified in the following areas of the IPC:
B60K; B60T; B60W

The following online and other databases have been used in the preparation of this search report:
EPODOC, WPI

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Application No: GB1313354.1
Claims searched: 7 to 11

Examiner: Mike McKinney
Date of search: 15 January 2014

**Patents Act 1977**
**Further Search Report under Section 17**

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**Field of Search:**
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Worldwide search of patent documents classified in the following areas of the IPC:

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Application No: GB1313354.1
Claims searched: 12 to 20

Examiner: Mike McKinney
Date of search: 17 January 2014

**Patents Act 1977
Further Search Report under Section 17**

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