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(54) **Title**: IMPROVEMENTS IN OR RELATING TO REDUCING ENERGY CONSUMPTION OF AN ENERGISABLE DEVICE

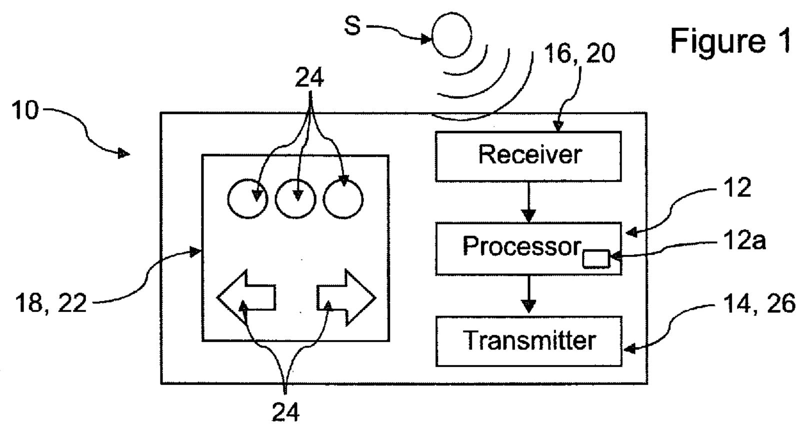

Figure 1

(57) **Abstract**: A controller (10) is provided which is capable of time-dependently periodically deactivating and reactivating an energisable device to reduce an energy consumption of the energisable device. The controller (10) includes a processor which can accept a global performance profile (GPP) which is comprised at least in part from an adaptive performance profile (APP) which utilises data external to the controller (10) in order to modify the period and/or frequency of the periodic deactivation and reactivation of the energisable device during its activation period. The adaptive performance profile (APP) being formed at least in part from a predetermined data set, map or profile.

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Improvements In Or Relating To Reducing Energy Consumption Of An Energisable Device

The present invention relates to a method of reducing the energy consumption of an energisable device, and more particularly but not necessarily exclusively to wherein the energisable device is a temperature and/or climate control device or a motorised vehicle. The invention further relates to a system for reducing the energy consumption of such an energisable device, preferably utilising such a method.

One of the major challenges facing modern society is the need to reduce its energy consumption, both from an economic and an environmental perspective. Many energisable devices have energy-saving modes, in order to reduce their energy consumption. There are multiple ways of achieving energy savings, but these can primarily be separated into two categories: improving the efficiency of energy conversion of a device; or reducing the period for which the device must be active, or otherwise reducing the intensity of operation of the device.

Of these solutions, the former is applicable to a majority of devices, energy-saving light bulbs being one such example. In the latter case, however, energy savings are only achievable if the energisable device can feasibly be deactivated, or where a reduced intensity of operation could achieve the same output result.

Examples of such energy-saving devices could be a thermostat, wherein a signal is sent to a boiler to prevent further energy expenditure once a room has reached a or substantially a desired temperature, or cruise control on a car, wherein the driver of the car need not engage the accelerator further once the car has reached a cruising velocity.

Critically, these means of reducing energy consumption are all reactive, requiring some means of feedback from an output variable of the energisable device, in this case being either temperature or velocity, in order to reduce the energy consumption. There are many scenarios, however, in which it is known that a reduced energy consumption may be needed, and therefore an anticipation of the demand which cannot be achieved solely through feedback means may be preferable.

It is an object of the present invention to provide a method of reducing the energy consumption of an energisable device to substantially mitigate or reduce the aforementioned problems.

According to a first aspect of the invention there is provided a method of reducing energy consumption of an energisable device having an output for effecting a change in an associated system, the method comprising the step of time-based periodically deactivating and reactivating at least part of the device during an activation period, such that the output ceases to effect or diminishes the change in the said associated system, a deactivation period or deactivation frequency being set by a global performance profile formed by a predetermined default performance profile and at least an adaptive performance profile based on data external to the device.

Preferably, the said global performance profile is automatically dynamically modified by at least the said at least one adaptive performance profile.

It is possible to provide a controller which is capable of time-based periodic deactivation and reactivation of an energisable device, so as to reduce the energy consumption of said device. Many energisable devices are designed to maintain a steady state of a particular condition, such as temperature or velocity. In the absence of competing factors, deviation from the steady-state condition will be slow, and therefore the energisable device does not necessarily need to be continuously operational in order to maintain or maintain a semblance of said steady-state.

As such, it may be advantageous to temporarily deactivate the energisable device, so as to reduce an energy consumption of the device, since there will be little to no noticeable effect on the overall steady-state condition. By way of example, a boiler for a central heating system does not necessary need to be continuously operational in order to maintain the internal temperature of a building; heat loss is low from well-insulated buildings, and therefore the boiler can be readily deactivated within a predetermined activation period, thereby relying on a residual heating effect within the system, with periodic reactivations used to provide a reconditioning effect to bring the overall temperature back or substantially back to the steady- , nominal- or predetermined-state, if the temperature deviates substantially from that desired.

An overall preferred or global performance profile can therefore be constructed so as to achieve the optimum settings with regards to deactivation and reactivation periods and/or frequency during a standard activation period or duty cycle. This is formed using a baseline profile, which may be a default internal to the controller, and an external profile, which can adapt and/or react to relevant characteristics relating to the energisable device. This can advantageously be performed as and when said characteristics are measured, this dynamic behaviour allowing the selection of a more appropriate predetermined external profile, and thus updating of the global profile as necessary.

Optionally, the energisable device may be a climate control device, typically being for the ambient environment of a user, and more preferably being a temperature control device wherein the ambient temperature of an enclosed space is controlled.

To form the overall global performance profile, the adaptive performance profile may include a predetermined temporal performance profile, which may be based on any or all of: the predefined seasons of a year; the predefined months within the said predefined seasons; the predefined weeks within the said predefined months; the predefined days within the said predefined weeks; and/or the predefined times during the said predefined days.

Additionally or alternatively, the adaptive performance profile may include an environmental performance profile, which may include a long range weather forecast and/or a short range weather forecast. The terms ‘long range’ and ‘short range’ may apply to time-based predictions, but equally to distance related determinations from the device’s current location.

A plurality of factors can advantageously be accounted for when creating the final global performance profile. When utilising the controller in conjunction with a climate control device, the important factors will clearly be those relating to temperature, and these may be dependent primarily upon temporal and environmental parameters. These can therefore beneficially be transmitted to the controller in order to allow for processing of the adaptive performance profile, which is thus capable of modifying the global performance profile.

As a preferred alternative, the energisable device may be a motorised vehicle, or is an engine of a motorised vehicle.

Vehicles which are travelling at a cruising speed do not necessarily need to provide a constant power in order to maintain or substantially maintain said cruising velocity. The present invention therefore advantageously provides a means of reducing the fuel consumption of a vehicle in such circumstances, leading to a greater fuel efficiency and therefore mileage of the vehicle.

In the vehicular case, the adaptive performance profile may include a vehicle stability performance profile, which may be based on any or all of: an inclination of the vehicle; an attitude of the vehicle; a lateral g-force of the vehicle; and/or a traction of one or a combination of wheels of the vehicle.

Additionally or alternatively, the adaptive performance profile may include a vehicle velocity performance profile, which may be based on linear acceleration and/or deceleration of the vehicle.

Optionally, the adaptive performance profile may include an environmental performance profile, which may be based on any or all of: a long range weather forecast; a short range weather forecast; an altitude of the vehicle; and/or traffic data.

As in the temperature control example, the factors relevant to the vehicle are reflected in the various constituent profiles which make up the adaptive, and therefore global, performance profile. In the vehicular scenario, these factors are those which may affect the overall control of the vehicle, and therefore the relative safety of deactivating or disengaging the drive means of the vehicle. By monitoring as many of these factors as possible, the fuel consumption of the vehicle can advantageously be reduced without compromising the safety of the driver, passengers or third party road users.

Preferably, the global performance profile may be manually modifiable to alter and/or override the deactivation period, and said unmodified global performance profile may be stored as a default global user profile. The modified global performance profile formed by an altered and/or overridden said deactivation period may revert to the default global user profile after a predetermined period and said default global user profile may be indefinitely modified when the deactivation period is persistently manually modified.

The controller may be operational automatically, requiring no user input in order to reduce the energy consumption of the energisable device, but it is beneficial to provide a means by which the user can input their own preferences in respect of the device, so as to alter the periodic deactivation and reactivation of the device.

The or each performance profile may be preferably applied to the global performance profile immediately on receipt of data, and said performance profiles may be excised from the global performance profile immediately when no data specific to the said performance profile is available.

Evidently, there is no point in introducing irrelevant or missing data into the global performance profile, and therefore it is beneficial from the view of processing speed to filter out such data.

Preferably, the deactivation period of the energisable device resulting from the global performance profile may be recorded and quantified to calculate an energy saving when compared to use of the energisable device without the deactivation period, the energy saving being outputted to a user display.

Given that the controller is capable of reducing an energisable device's energy consumption, there will clearly be associated cost savings which are achievable. As such, it is beneficial to display cost savings or potential cost savings to the user such that they may make a judgment with regards to alteration of the deactivation period or frequency from an economic perspective.

According to a second aspect of the invention, there is provided an energy consumption reduction system comprising: an energisable device having an output for effecting a change in an associated system; and a controller for periodic deactivation and reactivation of at least part of the device during an activation period, such that the output ceases to effect or diminishes the change in the said associated system, the controller including a processor for generating a global performance profile from a predetermined default performance profile and at least an adaptive performance profile based on data external to the energisable device and a device communication means for enabling communication between the controller and the energisable device; wherein the in use controller outputs a control signal to the energisable device via the device communication means based on the global performance profile.

Preferably, the energisable device may be a climate control device, and in particular the climate control device may be a temperature control device, for example, a boiler for a central heating system. During an activation period, the controller may thus periodically deactivate and reactivate the boiler, a thermostat associated with the boiler, or a system pump associated with the boiler, for example.

Alternatively, the energisable device may be a vehicle having a chassis including a plurality of wheels, a drive unit for the generation of a motive force, and a transmission means for imparting the generated motive force from the drive unit to the wheels of the vehicle. The energisable device may also be considered to be a drive unit for the generation of motive force of a vehicle, the drive unit providing said motive force to said vehicle, and/or a drive train of a vehicle. The energisable device may further be or include a transmission means for transmitting the said motive force to the said vehicle.

Furthermore, the controller may be capable of disengaging and reengaging the transmission means in order to effect periodic deactivation and reactivation of positive drive means to wheels of the vehicle, whilst the vehicle is in use.

The energisable device may preferably be a climate control device or a motorised vehicle; these are two such examples of devices which can operate under steady-state or substantially steady-state conditions, and are thus appropriate energisable devices for use with the method of the first aspect of the invention. However, other forms of energisable device can also be envisaged which would benefit from the energisation method herein described, and more particularly the residual energy inherent in the system which can be made use of during brief deactivation periods.

The invention will now be more particularly described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a diagrammatic representation of a controller for reducing the energy consumption of an associated energisable device, for use with a method in accordance with the first aspect of the invention;

Figures 2a to 2g show a number of possible different deactivation and reactivation control signals which may be transmitted to an energisable device by the controller of Figure 1;

Figure 3 shows a flow diagram of the method according to the first aspect of the invention;

Figure 4 shows a flow diagram of the method shown in Figure 2, used in conjunction with a first embodiment of an energy-consumption reduction system according to the second aspect of the invention; and

Figure 5 shows a flow diagram of the method shown in Figure 2, used in conjunction with a second embodiment of an energy-consumption reduction system according to the second aspect of the invention.

Referring firstly to Figure 1, a first embodiment of a control device 10 for use with an energisable device is shown. The control device 10 includes a processor 12 and a device communication means 14, and is able to control an activation status of the energisable device based upon a signal from the processor 12. The controller 10 further comprises at least one external input means 16 through which external data may be relayed to the controller 10, and may also include a user interface 18, via which a user may input manual commands to the controller 10.

The processor 12 is a microprocessor unit including a data storage means. The processor is capable of receiving data from the or each external input means 16 and the user interface 18, if present, to form a global performance profile GPP. This global performance profile GPP relates to likely usage of the energisable device, based on associated data. Based on this global performance profile GPP, the processor 12 is able to output a signal to the controller at set periods, such signals being shown by way of examples only in Figures 2a to 2g.

The global performance profile GPP is essentially a data set, matrix, map or profile ((hereinafter referred to as 'profiles' for simplicity) of numerical multipliers which may draw in different multipliers from various constituent performance profiles or maps. After compilation, the final output of the global performance profile GPP can be as simple as a straightforward modifier to change the frequency or period of the time-dependent periodic deactivations and reactivations of the energisable device during a standard activation period or duty cycle. Alternatively, the global performance profile GPP can be used to construct a full temporal profile for deactivation and reactivation, over the course of an hour, day, week, or any desired period.

The device communication means 14 will typically be a wireless transmitter 20 which is capable of communicating with, and sending signals to, an appropriate receiving unit of the energisable device which can effect the deactivation and reactivation of the device. It will be appreciated however, that an equivalent wired connection means could be provided, should the energisable device have no wireless signal receiving capability.

The user interface 18, if present, may typically be a touch-screen display 22 through which the user can enter commands to the controller 10 to set their preferences in respect of the energisable device. There may be a plurality of interface options 24 on the touch-screen display 22, each performing a distinct function in respect of the device. It will be apparent that such a touch-screen display could easily be replaced with a tactile control panel or similar, if desired, so as to allow user input.

The controller 10 operates by sending a time-based periodic series of activation and deactivation signals to the in use energisable device. A variety of different signal profiles are shown in Figures 2a to 2g. During a period of deactivation, the energisable device is not or only partially operational, and therefore does not consume or consumes considerably less energy than under normal operating conditions.

It is possible to vary both the period and frequency of the deactivation and reactivation signal pulses which are sent from the controller 10. Figure 2a shows the case for which the period and frequency of the pulses remains constant, referenced as signal DRSP1. Figure 2b shows the case for which the frequency of the pulses increases whilst the period for which each pulse is active increases, referenced as signal DRSP2, with Figure

2c showing the reverse, referenced as signal DRSP3, and Figure 2d showing a more extreme example of that of Figure 2c, referenced as signal DRSP4.

Figure 2e shows the reverse of Figure 2d, that is, a more extreme version of the increasing period whilst reducing frequency profile of Figure 2b, referenced as signal DRSP5. Figures 2f and 2g respectively show a pulse where the energisable device is constantly on or constantly off, referenced respectively as signals DRSP6 and DRSP7.

These pulse profiles demonstrate that there is huge scope for varying the periodicity and frequency of the time-dependent periodic deactivation and reactivation of the energisable device.

Where the energisable device is a device which controls a steady-state condition, that is, where it maintains at least one output variable at a particular and/or predetermined level or rate, then short deactivation periods will be unlikely to grossly affect the overall state of the target of the energisable device, and therefore the periods of deactivation do not substantially alter the state.

The periodicity of deactivation and reactivation is set by the global performance profile GPP associated with characteristics of the target of the energisable device. This global performance profile GPP comprises a number of sub-profiles, each of which can be relatively weighted and combined into the global performance profile. The result of the global performance profile GPP is a modifier which alters the frequency or period of the deactivations and reactivations.

These sub-profiles can be taken from innumerable sources, but will primarily be associated with the key characteristics of the target of the energisable device. The formation of the global performance profile GPP can be most readily understood with reference to a few exemplary embodiments, as described below.

A generalised schematic of a system incorporating the controller is shown in Figure 3. The controller 10 is connected to an energisable device ED, which can be time-dependently periodically deactivated and reactivated by sending a control signal, such as that indicated as DRSP1, from the controller 10.

The energisable device ED is capable of effecting change in an associated system. Input conditions I are altered into output conditions O in response to a disturbance D, which is normal for any energisable device ED capable of effecting change in a system. However, the controller 10 provides the control signal DRSP1 to interrupt the activation of the energisable device ED.

The controller 10 can produce the output signal DRSP1 based on a global performance profile GPP, which is comprised of a default performance profile DPP and an adaptive performance profile APP. The adaptive performance profile APP may take in data from external data sources EDS, whereby predetermined profiles are selected within the controller which best-match the received external data, the selected predetermined profile thus being used to alter or adapt the global performance profile GPP dynamically. A user may also be able to input their own preferences via a global user profile GUP, and stored historical user settings may be stored as a default global user profiles DGUP. Each of these features may contribute to a change in or adaptation of the global performance profile GPP.

One of the primary scenarios in which such a controller 10 is intended to be used is with a climate control device. Temperature is generally maintained at a constant level for a given purpose, and unless conductive heat exchangers are present in the object to be heated, then radiative thermal emissions will be the primary mechanism by which heat losses occur. Therefore, temperature changes slowly in most scenarios and therefore any heating or cooling element can afford to be periodically deactivated without substantially altering the overall temperature of the object.

Such climate control devices could be one of any number of types of device. Examples of such devices are: refrigerators; freezers; ovens; heating, ventilation and air conditioning (HVAC) devices; air conditioners; tumble driers; clothes driers; and/or furnaces. Whilst the controller 10 could be used in conjunction with any such device, the invention shall be now described in more detail for the case where the energisable device is a boiler 100 of a central heating system 110, as shown in Figure 4. In this scenario, the input conditions I might be the initial rate of fuel flow to the boiler 100, the output conditions O being the modified rate of fuel flow to the boiler 100 in response to a disturbance D, such as a temperature being achieved and recognised by a thermostat. The controller 10 is able to send a signal to the boiler 100 to change the output conditions O, based on the global performance profile GPP.

The controller 10 is connected to the boiler via the device communication means 14, which in this embodiment is a wireless transmitter 26 (see Figure 1) which is in communication with a control unit 128 of the boiler 100. A control signal, which may be a supplementary control signal in relation to the control signal for the normal or standard activation period during the duty cycle, passed from the controller 10 to the control unit 128 will either be a deactivation trigger, thereby overriding the normal functionality of the boiler 100 to effect a temporary shutdown condition, or a reactivation trigger to restart the normal functionality. Such a control signal is temperature independent.

As stated, the frequency and/or period of these triggers is controlled by a said global performance profile GPP compiled by the processor 12 of the controller. A predetermined default performance profile DPP will be provided as standard, programmed into the processor.

Such a default performance profile DPP may, for instance, be set to be such that the boiler 100 is inactive for thirty minutes per activation hour. This may be set to be one period of thirty minutes of deactivation, thirty periods of one minute of deactivation, or any combination of frequency and period so as to form a total period of thirty deactivated minutes in one hour.

In the absence of any competing factors, the global performance profile GPP will therefore solely comprise the default performance profile DPP, the rate of time-dependent periodic deactivation and reactivation being set by the pre-programmed information available to the controller 10.

However, the control offered by the controller 10 in such a situation is clearly limited, since the boiler 100 can neither pre-empt expected requirements of the central heating system 110, nor can it react to changes in ambient temperature, other than by standard thermostat control. In certain iterations of the present invention, it is envisaged that a thermostat or thermostatic control of the central heating system can be dispensed with.

It is therefore possible to provide at least one adaptive performance profile APP which can combine with and/or alter the default performance profile DPP in order to generate the global performance profile GPP. This adaptive performance profile APP may dynamically and automatically update the global performance profile GPP, or may be configured so as to only make updates at predetermined intervals, for example, once per hour.

Adaptive performance profiles APP can utilise any number of variables in an attempt to modify the global performance profile GPP at any given time by use of one or more predetermined data sets, matrices, maps or profiles (hereinafter referred to as 'profiles' for simplicity). For a controller 10 which is periodically deactivating and reactivating a boiler 100 during its normal activation period, the adaptive performance profiles APP will primarily relate to the temperature of the building or room which is being heated by the underlying central heating system.

The variables which comprise the or each adaptive performance profile APP can be grouped by their type. The primary factors will be temporal, resulting in adaptive performance profiles APP which may be deemed temporal performance profiles TPP. On a macroscopic level, the temporal performance profiles TPP may adjust the global performance profile GPP on a seasonal basis, with the expectation being that central heating is largely unnecessary during summer, and required to a much greater extent during the winter period.

As such, a predetermined first, seasonal temporal performance profile TPP1 (see Figure 4) can be used to increase the frequency and/or period of the deactivation and reactivation periods during the summer, resulting in a greatly reduced energy consumption during this period. On the other hand, the first seasonal temporal performance profile TPP1 will decrease the said frequency and/or period during the winter, resulting in a reduced energy consumption whilst still maintaining an acceptable level of heating during the coldest season.

The temporal changes in temperature and needs can be further broken down. A predetermined second, monthly temporal performance profile TPP2 could also be created to build up a more nuanced global performance profile GPP, utilising the historic average outdoor temperatures of a particular month to better alter the deactivation and reactivation periods. Further still, a predetermined third, weekly temporal performance profile TPP3 could be constructed, again utilising historic data in respect of likely weekly average temperature variations.

Delving down further, a predetermined fourth, daily temporal performance profile TPP4 may also be constructed, which may take into account a historic likely daily temperature requirement across the days of the week. For example, weekend days may require a greater level of heating, and therefore a reduced frequency or period of deactivation and reactivation of the boiler 100. A predetermined fifth, hourly temporal profile TPP5 could also be utilised, which may relate to the times of day in which the building to be heated is historically most likely to be occupied, such as during the evenings.

It will be apparent that, in order for the controller 10 to be able to determine when to deactivate and reactivate the boiler 100 in response to any of the temporal performance profiles TPP, it must have some means of determining the passage of time. This may be by the use of an internal clock 12a of the processor 12, with the time and date being set via a time input on the user interface 18 of the controller 10. Additionally or alternatively, an external input means 16 of the controller 10 may be a receiving unit, capable of receiving a signal from an external source S in respect of the time and date. This would typically be the wireless receiver 20, configured to access the worldwide web.

Temporal changes aside, there are other significant variables which may have an effect on the temperature of the building or room to be heated or cooled. For example, there are a number of environmental factors which may affect the ambient temperature, primary among these being the weather.

It is therefore possible for the adaptive performance profile APP to include an environmental performance profile EPP, wherein the variations in the climate or weather may be taken into account. This environmental performance profile EPP may include a short-term weather forecast STWF and/or a long-term weather forecast LTWF in order to determine an adjustment to apply to the adaptive performance profile APP.

By way of example, the controller 10 could determine the day's weather forecast, receiving data through the wireless receiver 20. If the weather forecast showed that it would likely be sunny in the morning and overcast later in the day, the controller 10 could ensure that the total period for which the boiler 100 were deactivated was increased during the morning, and reduced for the afternoon. In this manner, the controller 10 is acting proactively to meet the needs of the user.

Again, suitable predetermined environmental performance profiles EPP relating to determined short-term and long-term weather forecasts can be generated for selection and combining with one or more of the temporal performance profiles TPP, thus generating the adaptive performance profile APP. For example, if the short-term weather forecast indicates cloud in the morning and sunshine in the afternoon and evening, this can be anticipated in a predetermined environmental performance profile EPP. A range of selectable different short-term weather forecast profiles STWF and/or long-term weather forecast profiles LTWF can thus be formed. As mentioned previously, the short-range and long-range forecasts can be time based, but equally can be distance based from the controller 10.

The controller 10 could, via its wireless receiver 20, accommodate any relevant information transmitted to it in order to modify the adaptive performance profile APP and thereby the global performance profile GPP which sets the overall period and/or frequency of boiler 100 deactivation and reactivation.

Whilst the external data most useful to a climate control device such as a boiler 100 would likely be the temporal and environmental data, any relevant external information could be incorporated. This is indicated in Figure 3 as another performance profile OPP, which is further capable of modifying the adaptive performance profile APP.

However, each of these aspects are independent of a particular user of the controller 10, and therefore it is preferable to provide on the user interface 16 a user input device 24 to allow a user to manually modify the periodicity, or indeed force an override, of the deactivation and/or reactivation, either to allow for greater energy savings or greater temperature control.

This user preference data may be stored as a global user profile GUP within the processor 18 memory, which can be applied to the global performance profile GPP to modify the period or frequency of the deactivation and/or reactivation of the boiler 100. After a predetermined period, the global user profile GUP may revert to a default global user profile DGUP, allowing the controller 10 to function as if no user modification had occurred. For example, the default reversion period might be daily.

If the user makes persistent manual modifications, however, the processor 18 may recognise this, and permanently modify the default global user profile DGUP such that this is the profile which is reverted to after the predetermined reversion period. In this manner, the controller 10 may learn more about the user's particular desired heating requirements, and as such modify its behaviour accordingly.

It will be appreciated that the controller can be applied to any climate control device, or indeed any device which controls a steady-state condition. By way of example, a device which generates pressure or a vacuum may find that the energy consumption reductions are available following use of the controller, without substantially adversely affecting the maintenance of the steady-state pressurisation or vacuum condition.

It is thus possible to provide a controller which is capable of time-dependently periodically deactivating and reactivating a climate control device based on predetermined parameters external to the controller, and which may be further capable of learning behaviour so as to adapt to a user's needs.

The requirements for the user of a controller as described above, that is, one which can time-dependently periodically deactivate and reactivate an energisable device based on a combination of two or more predetermined performance profiles, is that the state altered by the energisable device can be maintained at a consistent level in the absence of a continuous output of the energisable device. Temperature modification is therefore a primary candidate for such a controller, but there are other such conditions to which this above could apply.

Newtonian mechanics dictate that, in the absence of an external force, a moving object will continue to move at a constant velocity. Therefore, where the external force on a moving object is minimal, only a small force will be required to maintain said constant velocity, or else will only decelerate slowly.

This principle can therefore be applied to driven objects, such as motors. If the motor is time-dependently periodically deactivated and reactivated during an activation- or, in this case driving- period, the minimal friction of the bearings of the motor will only minimally slow the rotor of the motor during the periods of deactivation, and therefore a steady or substantially steady rotational velocity can be achieved whilst reducing the overall energy consumption of the motor.

An exemplary embodiment of such a system is shown in Figure 5. Identical or similar references are used to refer to identical or similar components as described in the first embodiment of the invention, and therefore further detailed description is omitted for brevity.

A motorised vehicle 200 is shown, in this instance, a car, the vehicle 200 having a chassis 202 including a plurality of wheels 204, a motor 206 for the generation of motive force, and a transmission means 208 for transmitting the motive force from the motor 206 to the wheels 204. The motor 206 is typically an internal combustion engine, either being spark-ignition or compression-ignition, but equally could be an electric motor or any other suitable motor.

In such an arrangement, there are multiple interpretations of what constitutes the energisable device; the vehicle 200 itself is an energisable device, but the motor 206 is also separately an energisable device. A drive train incorporating the motor and the transmission may be considered the energisable device.

The controller 10 is therefore provided such that the device communication means 14 is in communication with the transmission means 208 of the vehicle 200, such that the vehicle 200 can be deactivated and reactivated at will. In practice, this may in particular mean disengagement and re-engagement of the transmission means 208, thus reducing the workload on the motor 206 and thereby creating an associated reduction in energy consumption, without the necessity of halting the motor 206.

In the scenario described above, if the vehicle 200 were to be considered the energisable device, then, as the transmission means 208 is disengaged, the drive functionality of the vehicle 200 will not be active, and as such, the energisable device is deactivated. If the motor 206 were considered the energisable device, then the disengagement of the transmission means 208 does not technically deactivate the motor 206 itself, but rather puts it into a disengaged state, unable to perform its function or performing a reduced function on the surrounding system, that is, providing drive or energisation functionality to the vehicle 200.

The terms deactivated and reactivated should therefore be interpreted in terms of whether the energisable device is in a state to perform its function, not necessarily being limited to whether it is physically operational and on. The terms 'deactivated and reactivated' may also in certain situations be understood to mean disengaged and reengaged, for example, in the instance when a transmission is controlled to disengage and reengage an engine, thereby deactivating and reactivating drive to associated wheels.

It will be apparent that deactivation and reactivation of a transmission means 208 may be an inherently dangerous operation, since this may lessen the control that the driver can wield over the vehicle 200. It is therefore critical that disengagement of the transmission means 208 only occurs in certain circumstances and this can be achieved through, or through modification of, the global performance profile GPP.

Evidently, the construction of the global performance profile GPP in this situation is largely different to that of the climate control device described above, since there are different parameters to consider. However, the overall construction of the global performance profile GPP is the or substantially the same; a predetermined default performance profile DPP can be combined with an adaptive performance profile APP which is dependent upon parameters external to the controller 10 in order to generate the global performance profile GPP.

For a vehicle 200, the safest option may be that the disengagement of the transmission means 208 is not effected, or that disengagement only occurs when the vehicle 200 is stationary, and the default performance profile DPP may reflect this.

The adaptive performance profile APP may then build up scenarios in which it is acceptable to periodically disengage the transmission means 208 in order to ensure the continued reduction in the energy consumption of the vehicle 200.

One should only perform any such deactivation of the drive functionality of the vehicle 200 under controlled conditions; motorway driving under cruising conditions might be one such scenario. It is therefore critical that the vehicle 200 be entirely under the user's control, or at least able to be controlled immediately as required.

The stability of the vehicle 200 could therefore be monitored, with relevant data being subsequently transmitted to the controller 10. A predetermined vehicle stability performance profile VSPP could therefore be compiled, which can modify the adaptive performance profile APP and thus the global performance profile GPP of the controller. Rather than necessarily changing the period or frequency of the deactivation and reactivation periods of the drive functionality, such a profile may enforce automatic engagement of the transmission means 208 should the vehicle be determined to be unstable, out of control or beyond predetermined parameters.

Features which could be monitored to determine a vehicle stability performance profile VSPP could be: the inclination of the vehicle 200 to form a predetermined first vehicle stability performance profile VSPP1; the attitude of the vehicle 200 to form a predetermined second vehicle stability performance profile VSPP2; a lateral g-force on the vehicle 200 to form a predetermined third vehicle stability performance profile VSPP3; or a traction on one or a combination of the wheels 204 of the vehicle 200 to form a predetermined fourth vehicle stability performance profile VSPP4.

Any or all of these individual predetermined vehicle stability performance profiles could feasibly be created and incorporated into the adaptive performance profile APP. To monitor each feature, one could use any of a variety of sensors, for example gyroscopic sensors in the chassis 202 of the vehicle 200 to monitor the inclination, attitude or lateral g-force, or a velocity sensor to measure rotational velocity of the wheels 204 of the vehicle 200 to monitor the traction.

Furthermore, it may be advantageous to incorporate a vehicle velocity performance profile VVPP into the adaptive performance profile APP, since rapid changes in the velocity of the vehicle 200 are indicative of imminent loss of control or avoiding action by the driver. As such, it is advisable to ensure engagement of the transmission means 208 in such a scenario.

A predetermined vehicle velocity performance profile VVPP1 may be created which relates to a linear acceleration of the vehicle 200, and a separate predetermined vehicle velocity performance profile VVPP2 may be created relating to the linear deceleration of the vehicle. These are naturally separable, since it is likely that the transmission means 208 must be engaged in order to effect acceleration of the vehicle 200, but likely will be able to be disengaged far more often under controlled deceleration conditions.

The control of the vehicle 200 may also be affected by the weather conditions, for example, when driving in icy conditions, and as such, a predetermined environmental performance profile EPP as previously described may also be useful, thereby allowing the controller 10 to set the deactivation and reactivation periods and/or frequency predictively, based on anticipated or expected changes in local weather. Again, both short-term and long-term weather forecasts STWF, LTWF may be used for this purpose, as described above.

In addition to the weather forecasts STWF, LTWF, the predetermined environmental performance profile EPP may further include information relating to the altitude of the vehicle, which may affect the performance of the vehicle, or non-climatic data relating to the urban environment. In particular, the controller 10 could receive traffic data TD via its receiver 20 to thereby further allow for the processor 18 to predictively anticipate upcoming energy consumption needs of the vehicle 10, and refrain from or increase the rate of periodic deactivation and reactivation of the drive functionality based on a further predetermined performance profile or map.

As with the case of the boiler control system, a controller 10 used in conjunction with a vehicle 200 may react to user modifications to the periodic deactivation and reactivation of the drive functionality, should the controller 10 have a user interface 18, and may learn periodicity and/or deactivation frequency behaviour based on the user input, and/or from driving behaviour of a particular user. Similar, the controller 10 may also account for any other significant factors, referenced in Figure 5 as another performance profile OPP.

It will be appreciated that whilst the controller is described above a disengaging and reengaging the transmission means of a vehicle in order to effect periodic deactivation and reactivation of the drive functionality, that the controller could disengage another component of the drive mechanism, such as the flow of fuel to the motor. The above-described mechanism is equally applicable to fossil-fuel driven and electric vehicles.

Furthermore, the controller is not solely applicable to vehicular motion; one could easily imagine the controller being utilised in conjunction with any sort of machine which generates either linear or rotational motion. Any machine where inertia will keep the machine in motion even during periods of drive deactivation are likely to be able to use the present controller.

It will also be noted that the construction of the global performance profile for all above-described embodiments is detailed as being a combination of a default performance profile and an adaptive performance profile, the adaptive performance profile being formed from external data, which may be historic and thus the adaptive performance profile may be at least in part predetermined. It will be appreciated that even if the profiles are inbuilt to the device memory, they may still be reliant on external factors, such as in the case of the temporal performance profiles. The description of default and adaptive performance profiles therefore specifically relates to the concepts, rather than the underlying implementation of the particular performance profiles, and the numerous combinations and means of storing said profiles will be apparent to a person skilled in the art. It will also be understood that one or more predetermined performance profiles may be uploadable to and/or downloadable from a computer-implemented communication network, such as the Internet. In this way, users and/or suppliers can update and/or optimise their predetermine performance profiles or maps as required.

Furthermore, whilst deactivation and reactivation of the energisable device is suggested as being able to fully cease an output effect of the device on an associated system, it will be apparent that the invention could in fact be used to effect partial periodic deactivation of the device, so as to diminish or substantially diminish the output effect, rather than resulting in full cessation of the output, accordingly resulting in lesser, but likely still substantial, reductions in energy consumption of the device.

It is therefore possible to provide a controller which is capable of time-dependently periodically deactivating and reactivating an energisable device during a standard activation period, such as a duty cycle of a climate control system or the drive functionality of a motive device, in particular of a vehicle, by the dynamic forming of a performance profile from two or more at least in part predetermined performance profiles, such that the energy consumption of the device is reduced, with a minimal effect on the power output of the device being noticeable. In particular, it is preferred that the adaptive performance profile has made clear from the description above includes at least in part a predetermined deactivation range, whether time based and/or frequency based, which may be based on the external data inputted typically relating to conditions external of the device.

The words 'comprises/comprising' and the words 'having/including' when used herein with reference to the present invention are used to specify the presence of stated features, integers, steps or components, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

The embodiments described above are provided by way of examples only, and various other modifications will be apparent to persons skilled in the field without departing from the scope of the invention as defined herein.

Claims

1. A method of reducing energy consumption of an energisable device having an output for effecting a change in an associated system, the method comprising the step of time-based periodically deactivating and reactivating at least part of the device during an activation period, such that the output ceases to effect or diminishes the change in the said associated system, at least one of a deactivation period or deactivation frequency being set by a global performance profile formed by a predetermined default performance profile and at least an adaptive performance profile based on data external to the device.

2. A method as claimed in claim 1, wherein the said global performance profile is automatically dynamically modified by at least the said at least one adaptive performance profile.

3. A method as claimed in claim 1 or claim 2, wherein the energisable device may be a climate control device, typically being for the ambient environment of a user, and more preferably being a temperature control device wherein the ambient temperature of an enclosed space is controlled.

4. A method as claimed in claim 3, wherein the climate control device controls an ambient temperature of an enclosed space.

5. A method as claimed in claim 4, wherein the adaptive performance profile includes one or more of: a temporal performance profile; an environmental performance profile.

6. A method as claimed in claim 5, wherein the predetermined temporal performance profile is based on one or more of: predefined seasons of a year; predefined months within the said predefined seasons; predefined weeks within the said predefined months; predefined days within the said predefined weeks; and/or predefined times during the said predefined days.

7. A method as claimed in claim 5 or claim 6, wherein the environmental performance profile includes one or more of: a long range weather forecast; and/or a short range weather forecast.

8. A method as claimed in claim 1, wherein the energisable device is a motorised vehicle, the energisable device being or including an engine of the motorised vehicle.

9. A method as claimed in claim 8, wherein the adaptive performance profile includes one or more of: a predetermined vehicle stability performance profile; a predetermined vehicle velocity performance profile; a predetermined environmental performance profile.

10. A method as claimed in claim 9, wherein the vehicle stability performance profile is based on one or more of: an inclination of the vehicle; an attitude of the vehicle; a lateral g-force of the vehicle; and/or a traction of one or a combination of wheels of the vehicle.

11. A method as claimed in claim 9 or claim 10, wherein the vehicle velocity performance profile is based on one or more of: linear acceleration of the vehicle; and/or linear deceleration of the vehicle.

12. A method as claimed in any one of claims 9 to 11, wherein the environmental performance profile includes one or more of: a long range weather forecast; a short range weather forecast; an altitude of the vehicle; and/or traffic data.

13. A method as claimed in any one of the preceding claims, wherein the global performance profile is manually modifiable to alter and/or override the deactivation period.

14. A method as claimed in claim 13, wherein the unmodified global performance profile is stored as a default global user profile.

15. A method as claimed in claim 14, wherein a modified global performance profile formed by an altered and/or overridden said deactivation period reverts to the default global user profile after a predetermined period.

16. A method as claimed in claim 14 or claim 15, wherein the default global user profile is indefinitely modified when the deactivation period is persistently manually modified.

17. A method as claimed in any one of the preceding claims, wherein said performance profiles are applied to the global performance profile immediately on receipt of data.

18. A method as claimed in any one of the preceding claims, wherein said performance profiles are excised from the global performance profile immediately when no data specific to the said performance profile is available.

19. A method as claimed in any one of the preceding claims, the deactivation period of the energisable device resulting from the global performance profile is recorded and

quantified to calculate an energy saving when compared to use of the energisable device without the deactivation period, the energy saving being outputted to a user display.

20. An energy consumption reduction system comprising: an energisable device having an output for effecting a change in an associated system; and a controller for periodic deactivation and reactivation of at least part of the device during an activation period, such that the output ceases to effect or diminishes the change in the said associated system, the controller including a processor for generating a global performance profile from a predetermined default performance profile and at least an adaptive performance profile based on data external to the energisable device and a device communication means for enabling communication between the controller and the energisable device; wherein the in use controller outputs a control signal to the energisable device via the device communication means based on the global performance profile.

21. An energy consumption reduction system as claimed in claim 20, wherein the energisable device is at least one of: a climate control device; a boiler for a central heating system; or a vehicle having a chassis including a plurality of wheels, a drive unit for the generation of a motive force, and a transmission means for imparting the generated motive force from the drive unit to the wheels of the vehicle.

22. An energy consumption reduction system as claimed in claim 21, wherein the controller periodically deactivates and reactivates the boiler and/or a pump associated with the boiler during an activation period.

23. An energy consumption reduction system as claimed in claim 21, wherein the energisable device includes one or more of: a drive unit for the generation of motive force of a vehicle, the drive unit providing said motive force to said vehicle; and/or a transmission means for transmitting the said motive force to the said vehicle.

24. An energy consumption reduction system as claimed in claim 23, wherein the controller is capable of disengaging and reengaging the transmission means in order to effect periodic deactivation and reactivation of the drive functionality of the vehicle.

Figure 1

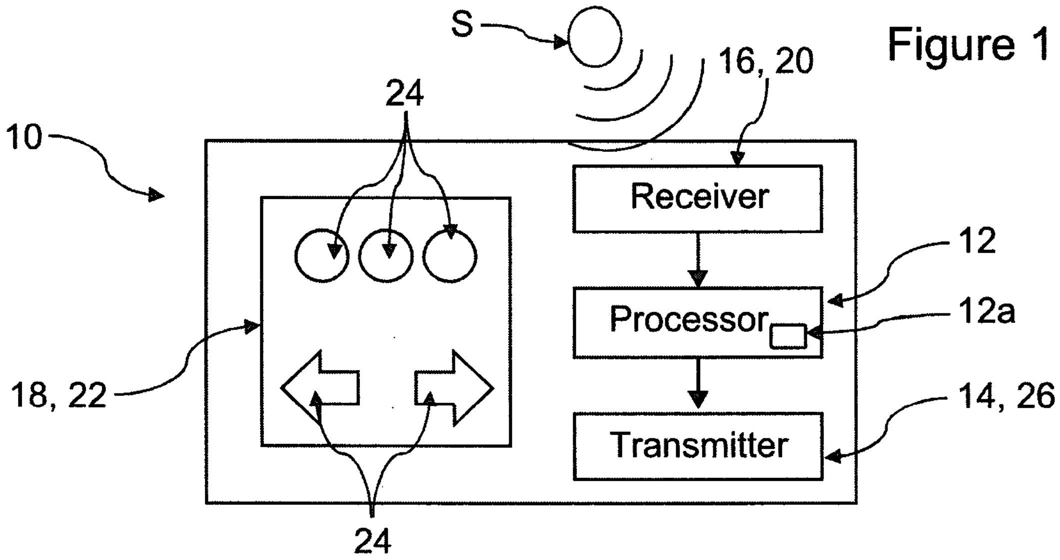


Figure 2a

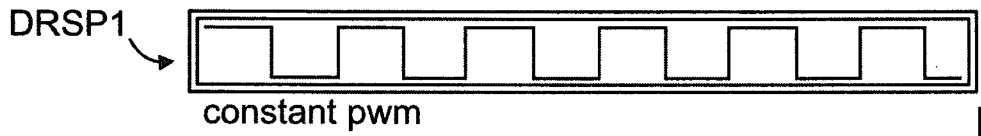


Figure 2b

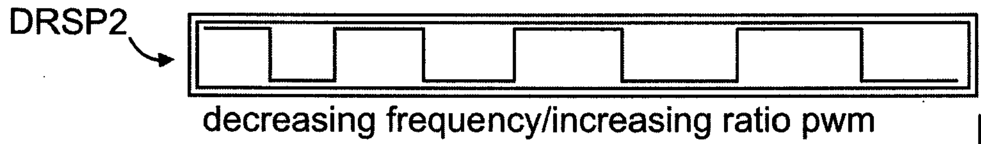


Figure 2c

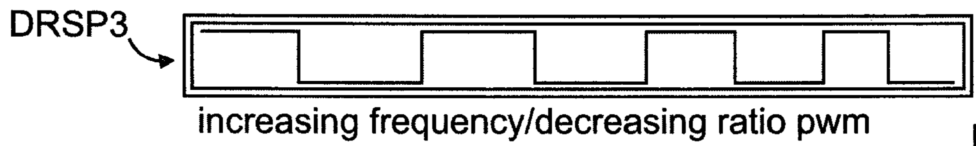


Figure 2d

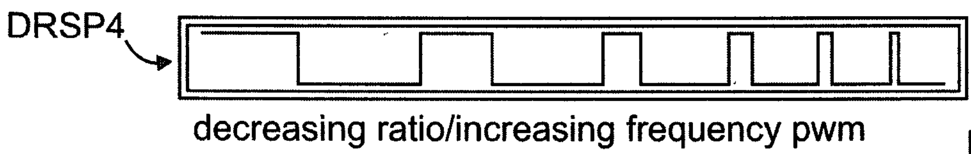


Figure 2e

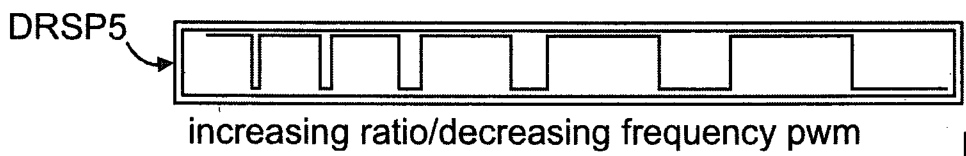


Figure 2f

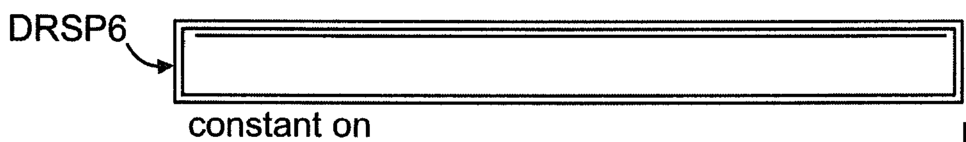
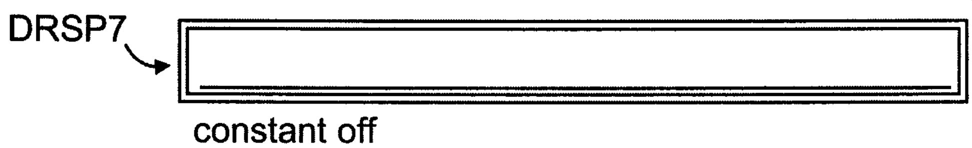


Figure 2g



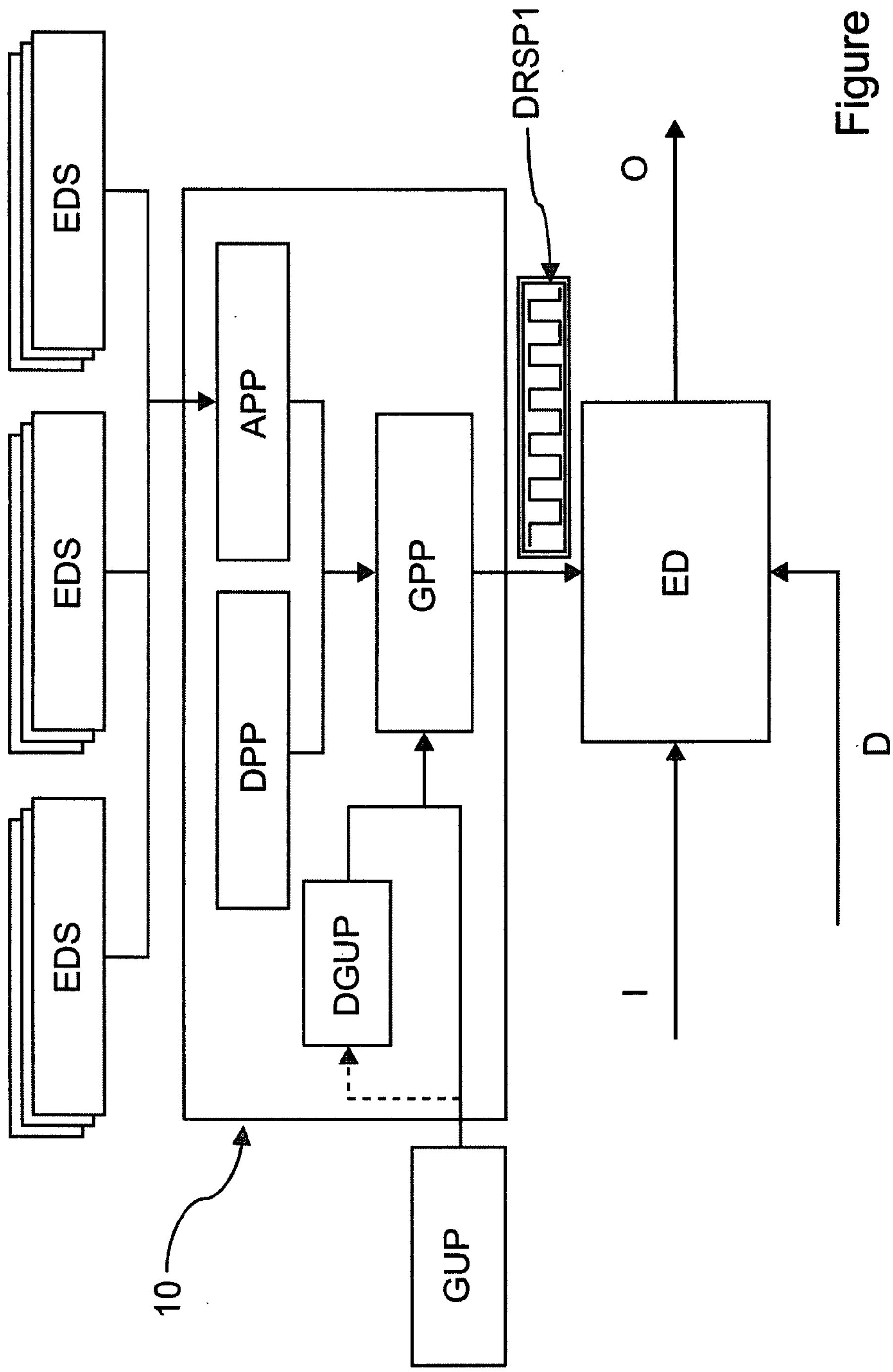
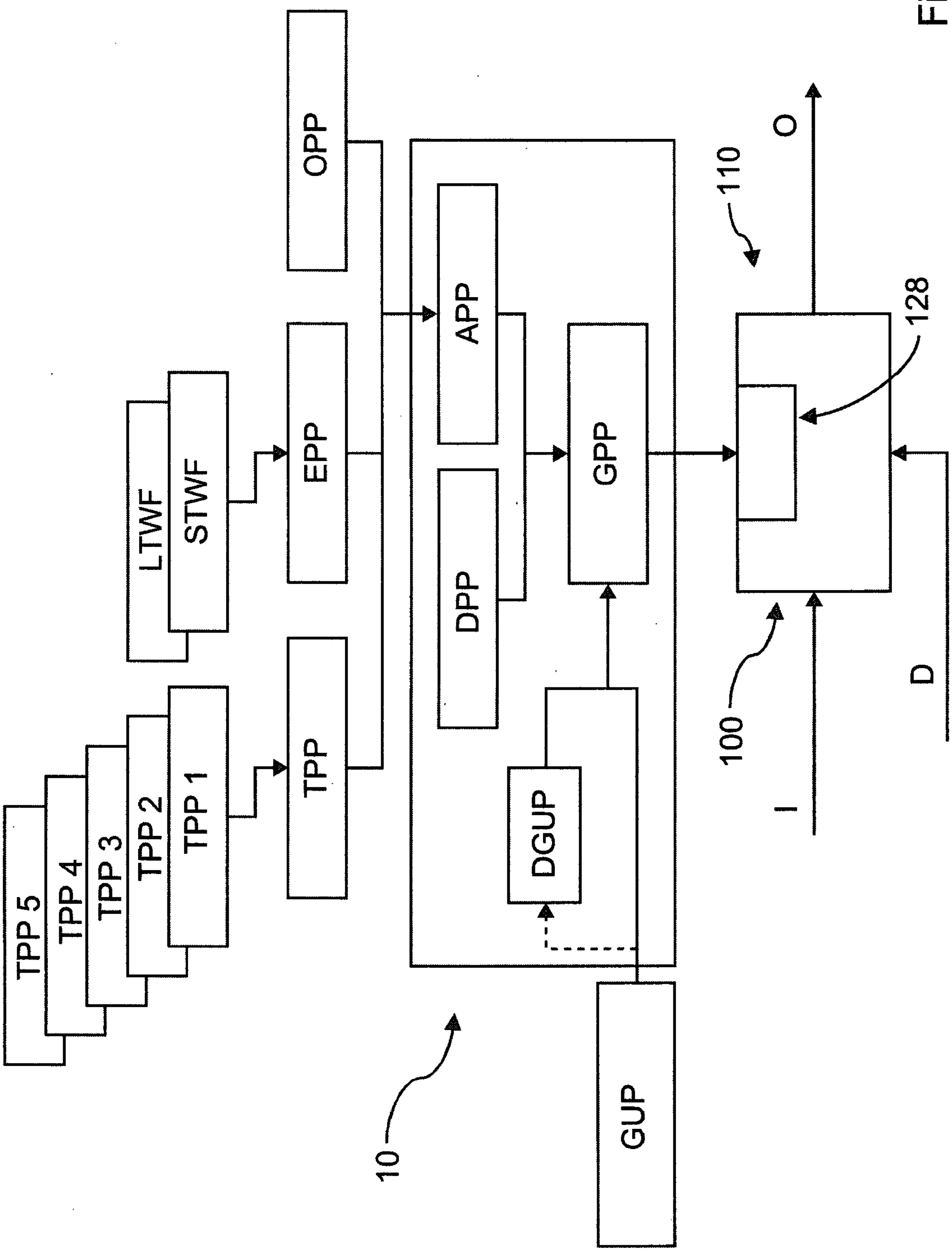


Figure 3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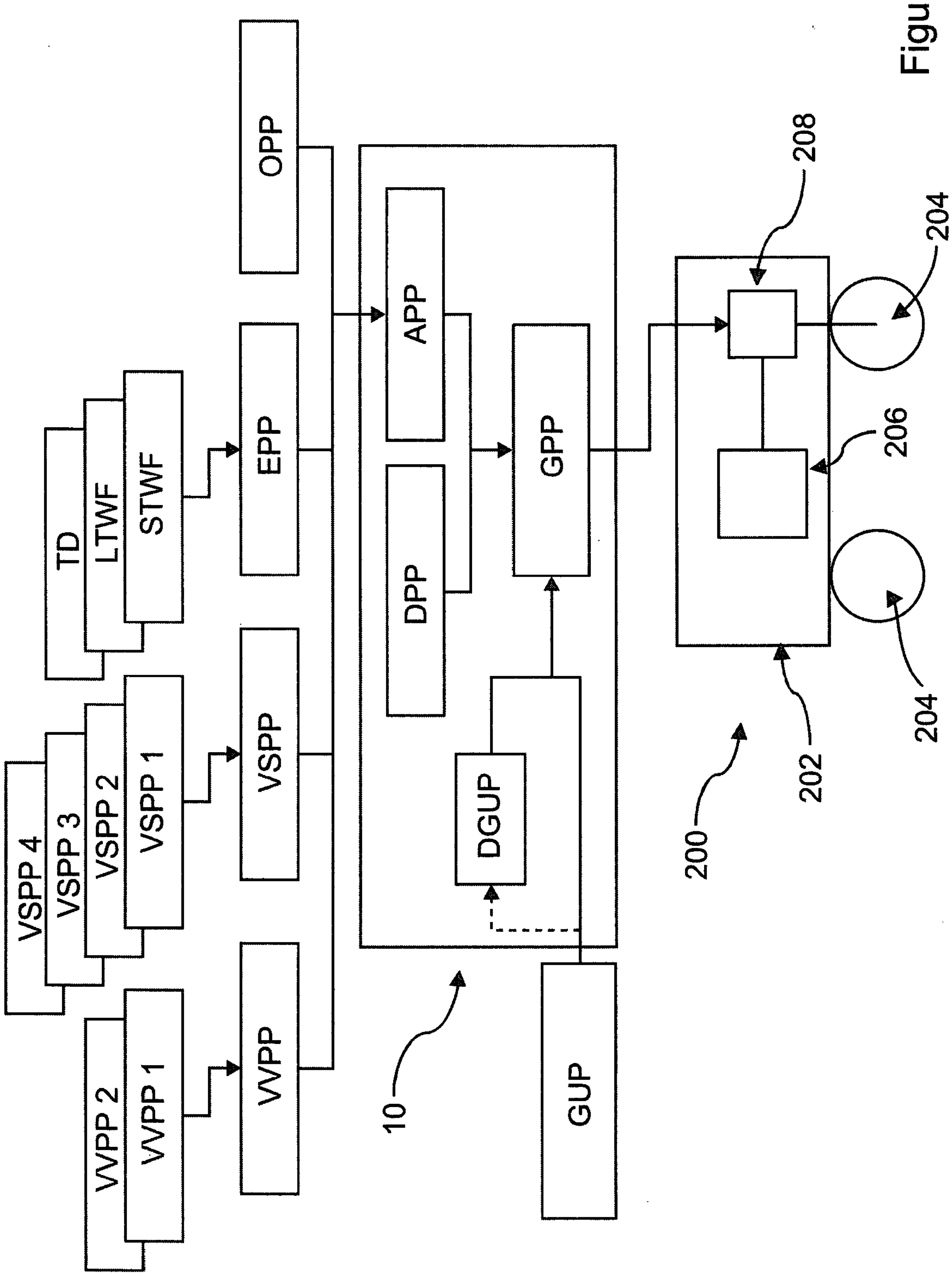
TPP 4
TPP 3
TPP 2
TPP 1
TPP
LTWF
STWF
EPP
OPP
APP
DPP
GPP
DGUP
GUP
10
110
100
128
O
I
D

Figure 4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TD
LTWF
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APP
DPP
GPP
DGUP
GUP
10
200
202
204
206
208
204

Figure 5