Thermostatic Control Device

Field of the Invention

The present invention relates to a thermostatic control device for regulating the flow of heating fluid in a conduit, and in particular thermostatic control devices for radiator valves.

Background to the Invention

In homes, commercial premises, hotels, offices, and other locations, it is often desirable for one or more rooms to be maintained at one temperature, and other rooms to be maintained at different temperatures. For example, in a house, the homeowner may wish to maintain the living room at a higher temperature than the kitchen. In homes with piped hot water systems, a boiler supplies hot water to a pipe which feeds the inlets of a number of radiators located in different rooms of the house, and a return pipe connected to the outlet of each radiator returns the water to the boiler for re-heating. A pump is used to pump the water around the system. With conventional central heating systems, unless manually controlled, each radiator will be supplied with hot water from the boiler until a central timer switch turns ~~the~~ off the pump, or a single thermostat located somewhere in the building turns off the boiler, so dictating the temperature of the building based on the temperature of the room where the thermostat is located.

A ~~well established~~well-established method of providing local temperature control in various rooms is to provide each radiator with an individual thermostatically controlled radiator valve. This is a device fitted to the radiator inlet or outlet, which includes a valve that opens or closes to control the hot water flow, and an actuator that controls the opening of the valve in response to the temperature of the room. Electronic thermostatic radiator valves have been designed, which include a temperature sensor and a control circuit wherein when a desired temperature has been attained, the control circuit causes the actuator to temporarily turn off the valve; similarly, when the temperature falls below the desired temperature, the valve will be opened to allow hot water to flow into the radiator.

A problem with existing electronic thermostatic radiator valves is that the temperature sensor is located within the valve housing, which when fitted to the radiator, is in very close proximity to the radiator. The temperature sensor therefore gives a reading of the temperature near to the radiator, rather than an accurate reading of the ambient temperature of the room. When the radiator valve is open and the radiator is on, the temperature sensor will sense a higher temperature than the ambient room temperature. Often users find that they frequently have to adjust the setting of thermostatic radiator valves in order to achieve a desired room temperature. It is not possible to set a desired room temperature using these types of thermostatic radiator valves, therefore the valves usually only include means for adjusting the valve between a discrete range of numbered settings that do not correlate to a desired room temperature.

It is often recommended that thermostatic radiator valves be mounted horizontally rather than vertically, so that the temperature sensor is located adjacent the pipework rather than directly above it, in order that the sensor is not subjected to warm air rising by convection from the pipework. However, even when the valve is mounted horizontally, the sensor will not measure the actual ambient room temperature, since the sensor is still being subjected to some warm air flowing from the pipework by convection.

Other systems have been designed to overcome this problem, wherein each room has a separate, remote temperature sensor or thermostat located in the room, at a distance from the radiator; the remote sensor measures the room temperature and sends a signal to the thermostatic radiator valve, or to a central control unit. The remove sensor may for example be linked to the thermostatic radiator valve via wires, or it may send signals to the thermostatic radiator valve or control unit wirelessly.

It is a general objective of the present invention to provide a thermostatic control device with improved temperature control.

Summary of the Invention

According to a first aspect of the present invention there is provided a thermostatic control device for fitting to a radiator valve and for regulating the flow of heating fluid ~~in a conduit~~through a pipe that is linked to the inlet / outlet of a radiator, the thermostatic control device comprising actuation means operable to alter the flow of heating fluid in the ~~conduit~~pipe, processing means, for controlling the actuation means, a first temperature sensor for sensing the ambient temperature in the vicinity of the device, and a second temperature sensor for sensing the temperature of the ~~conduit~~ pipe by measuring the air temperature influenced by heating fluid in the ~~conduit~~pipe, the processing means being operable to receive temperature inputs from the first and second temperature sensors and produce an output based on the temperature inputs for controlling the actuation means.

The first temperature sensor is adapted to measure the ambient temperature in the vicinity of the device (either the temperature in the immediate vicinity of the device or the temperature of the room in which the device is located). The second temperature sensor is adapted to measure the temperature of the ~~conduit~~pipe. Effectively it measures a temperature influenced by the heating fluid in the ~~conduit~~pipe. Advantageously the actuation means can be controlled based on the ambient temperature in the vicinity of the device and also the temperature of the ~~conduit~~pipe.

Preferably the processing means is operable to calculate a correction to the temperature input measured by the first sensor using the temperature input measured by the second sensor. The temperature reading from the second sensor can be used to calculate an offset to be applied to the temperature reading from the first sensor, so that control of the actuation means can be in accordance with the true room temperature. In this way the thermostatic control device has improved temperature control compared to prior art devices.

The device may be mountable to a radiator valve in a vertical position, wherein in use the first and second sensors are located above the ~~conduit~~pipe, or in a horizontal position wherein in use the first and second sensors are located laterally relative to the ~~conduit~~pipe. Preferably the processing means is operable to apply a first correction to the temperature input measured by the first sensor when the device is mounted in a vertical position, or to apply a second correction to the temperature input measured by the first sensor when the device is mounted in a horizontal position. Therefore the ~~to~~ ambient temperature input, as measured by the first sensor, can be varied depending on whether the device is mounted horizontally or vertically to a radiator valve. Preferably the device includes means for automatically detecting whether the device is mounted in the vertical position or the horizontal position. Therefore the device automatically applies the desired correction to the ambient temperature, as measured by the first sensor.

Preferably, in use, the second temperature sensor is located in close proximity to the ~~conduit~~pipe. In this way, the second temperature sensor can measure a temperature influenced by the heating fluid in the ~~conduit~~pipe.

Preferably the device comprises a housing. The first temperature sensor may be located, in use, remote from the housing, and preferably the first temperature sensor is wirelessly communicable with the device. When the first temperature sensor is located remote from the housing, it can measure the actual ambient room temperature, and advantageously, information regarding the temperature of the ~~conduit~~pipe, as measured by the second temperature sensor, can be used by the processing means to optimise temperature control. Alternatively the first and second temperature sensors are located, in use, within the housing; preferably the first temperature sensor is located at a first end of the housing, remote from the ~~conduit~~pipe; preferably the housing comprises ventilation means located in close proximity to the first temperature sensor. Advantageously, when both the first and second temperature sensors are located within the housing, the device is simple to install. Preferably the housing comprises ventilation means located in close proximity to the second temperature sensor.

Preferably the device is configured to be mounted to valve means of a radiator, wherein the device is adapted to operate the valve means to reduce the flow of heating fluid in the ~~conduit~~ pipe when a desired ambient temperature is exceeded, and to re-actuate the valve means to increase the flow of heating fluid in the ~~conduit~~ pipe if the ambient temperature falls below the desired temperature.

Preferably the device is controllable using a remote control unit, the remote control unit being communicable with the device via wire means or wireless means. Preferably the device is communicable with a remote control unit via infra-red or radio means.

Brief Description of the Drawings

A preferred embodiment of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 shows a cross-sectional view of a thermostatic control valve.

Description of the Preferred Embodiments

Referring to figure 1, a thermostatic control device 10 for a radiator is shown (also known as a thermostatic radiator valve). The device 10 is operable to regulate the flow of heating fluid through a pipe that is linked to the inlet/outlet of a radiator (not shown). The device 10 can be fitted to a standard radiator valve 11, having valve means 12 movable within a valve body 13, to regulate the flow of heating fluid in the valve body

13. The valve 12 is movably adjustable between an open position wherein heating fluid can flow through the valve body 13, and a closed position wherein the valve 12 blocks an opening 14 in the valve body, interrupting the heating fluid from flowing through the valve body 13.

The device comprises a housing 15 which is designed to be fitted onto the radiator valve 11. The housing 15 comprises actuation means which can be coupled to the valve 12 to operate the valve 12. The actuation means comprise an actuator motor 16 and actuator gears 17 for rotatably driving the valve 12 between its open and closed position. The actuation means operates to allow incremental regulation of the flow of heating fluid through the valve body 13, by moving the valve 12 incrementally between the open and closed positions. Preferably the actuator motor 16 is an electric motor.

The actuator gears 17 comprise a reduction gear system, providing a high level of torque, allowing a small electric motor to drive the valve 12. Alternatively the actuation means may comprise a solenoid which is operable to open and close a valve, such as a plunger type valve, in a linear manner.

The device includes a main temperature sensor 18 and an auxiliary temperature sensor 19. Preferably both the main and auxiliary temperature sensors are located within the housing 15.

The main temperature sensor 18 measures the ambient temperature in the vicinity of the device. The main temperature sensor 18 is located at a first end of the housing 15, this first end of the housing being furthest from the valve body 13 when the device is mounted to the radiator valve. Preferably the main temperature sensor 18 is located adjacent to a ventilation hole 20 so that the main sensor 18 can measure the temperature of the air in the vicinity of the device.

The auxiliary temperature sensor 19 measures the temperature of the conduit or pipework of the valve body 13 to which the device is mounted. The auxiliary temperature sensor 19 is located such that heat is convected from the valve body pipework towards the auxiliary sensor 19. The auxiliary sensor 19 is located at a second end of the housing 15, opposite the first end at which the main sensor 18 is located. When the device is mounted to a radiator valve, the auxiliary sensor 19 is located at the end of the housing nearest the valve body 13. Since the auxiliary sensor 19, in use, is located in close proximity to the pipework of the valve body, the auxiliary sensor 19 effectively measures air temperature influenced by the heating fluid present in the pipes. The housing 15 may include ventilation means (not shown in the figures) such as slots in the housing, positioned close to the auxiliary sensor 19, such that the auxiliary sensor can measure the temperature of the air in the close vicinity of the pipework.

Preferably there is a barrier, within the housing 15, preventing flow of air between the region of the housing in which the main temperature sensor 18 is located and the region of the housing in which the auxiliary temperature sensor 19 is located. Referring to figure 1, this barrier comprises the actuator motor 16 and the mount for mounting the motor 16 within the housing. The barrier prevents air within the housing and in the vicinity of the auxiliary temperature sensor 19 from mixing with air from in the vicinity of the main sensor 18.

A control PCB 21 acts as a processing means for controlling the actuation means. The Control PCB 21 receives input signals from the main temperature sensor 18 and auxiliary temperature sensor 19, processes those signals, and produces an output signal based on those inputs, which is sent to the actuator motor 16 to control the valve 12. The control PCB 21 processes the input signals from the main and auxiliary temperature sensors in order to move the valve 12 towards its closed position when a desired ambient temperature is exceeded, and to move the valve 12 towards its open position to increase the flow of heating fluid through the valve body 13 if the ambient temperature falls below a desired temperature. The control PCB 21 uses the temperature input from the auxiliary sensor 19 to calculate a correction or offset which is applied to the temperature input from the main sensor 18, in order that the valve can be controlled in accordance with a corrected room temperature value, rather than the apparent temperature value measured by the main sensor 18. The control PCB 21 incorporates means for executing a suitable algorithm, which based on the inputs from the main and auxiliary temperature sensors, outputs a suitable control signal to the actuation means.

If the valve body is hot, then the main sensor 18 will measure a greater temperature valve than the true room temperature, as the main sensor 18 is being subjected to convected air emanating from the valve body. If the valve body is not hot, then the main sensor 18 will measure a temperature valve that is the same, or very close, to the room temperature. By using an auxiliary sensor, which measures the temperature of the valve body, the thermostatic control device can calculate a temperature offset to apply to the main sensor, so that control of the valve can be in accordance with the actual room temperature.

By means of the auxiliary sensor, control of the actuation means can be in accordance with the actual room temperature, as calculated based on the temperature readings from the main sensor and auxiliary sensor. The device may include temperature setting means by which the user can set a desired room temperature. The device has improved temperature control over prior art thermostatic radiator valves which only allowed the user to adjust between a discrete range of numbered settings and which did not actually correlate to a desired temperature.

The thermostatic control device 10 may be mounted vertically (wherein the main sensor is located above the auxiliary sensor in use) or horizontally (wherein the main and auxiliary sensors is spaced from the auxiliary sensor in use). In figure 1, the device 10 is shown mounted vertically on a radiator valve. The correction required to be applied to the main sensor's temperature reading will vary depending on whether the device is mounted vertically or horizontally (if mounted vertically, the sensors will be subjected to more heat convected from the pipework of the valve body than if the device were mounted horizontally). The control PCB 21 preferably includes means for automatically adjusting the correction that is applied to the reading from main sensor 18, based on whether the device is mounted vertically or horizontally.

It is possible to use the auxiliary sensor 19 to indicate whether the boiler is switched on or not. When the boiler is switched on, the valve body 13 will start to get hot, and this rise in temperature will be detected by the auxiliary sensor 19. The control PCB 21 may be programmed to delay actuation of the valve as a function of the room temperature. On a mild day the time taken to heat the room will be shorter than on a cold day. It is desirable that the room be heated to the required temperature at the required time. For example it may be desired by a user for the kitchen to warm up earlier in the morning than the living room. Temperature readings from the main and auxiliary sensors can be used to calculate how quickly the room will heat up, and therefore can be used to delay operation of the radiator on a mild day, when the warm-up period will be shorter, thus saving energy. From monitoring the temperature readings from the main and auxiliary sensors, the device automatically calculates the optimum time to start operation of the radiator, without the need for a timer or time programme settings. This ensures that the room is heated to the required temperature at the required time, without wasting energy. No time programme setting is required, therefore the device is simple to use.

In calculating the start-up delay it may be assumed, for example, that the heat-up time will be directly proportional to the difference between the desired temperature (as set by the user) and the actual room temperature) as calculated based on the inputs from the main and auxiliary temperature sensors). The processing means may be programmed to use a pre-determined heat-up time figure per degree temperature difference between the desired and actual room temperatures (e.g. 6 minutes heat-up time per degree temperature difference) to determine the required delay before the valve is to be actuated, to ensure that the room is heated to the desired temperature at the desired time. Alternatively the device may record and store information regarding the actual heat-up times and use this data to calculate suitable start-up delays as required.

A further advantage of provision of the auxiliary sensor 19 is that it can be used to detect when the boiler starts up under the control of the boiler’s time program. From this, the device 10 can time its own operations, thus making clock setting and adjustment of individual devices 10 in each room unnecessary. For example, the change in time from GMT to BST can be achieved by re-setting only the main central heating boiler time program; furthermore there would be no requirement to update the device 10 after a battery change.

The actuator motor 16, sensors 18, 19, and control electronics 21 are powered by a battery or batteries 22. Rechargeable batteries may be used. Alternatively the device may be connected to an external power source.

The device 10 may include a timer and/or memory means for storing one or more heating programs, such that the device is programmable to switch on and off at desired times of the day. Optionally the device may include a temperature profiling feature, whereby the device can be set to different temperatures at different times of the day, which is manually or conventionally adjusted. Therefore rather than just setting the device to turn on/off at different times, the device can be set by the user to operate at different temperatures at different times. Existing thermostatic radiator valves only have a single temperature setting or two settings (day and frost). The device may also include a manual override facility to enable the user to temporarily boost or curtail the current setting via a button, giving the user further energy saving options.

The main and auxiliary temperature sensors 18, 19, control PCB 21, actuator motor 16, actuator gears 17 and the battery or batteries 22 are preferably contained within the housing 15.

In an alternative embodiment, not shown in the figure, the main temperature sensor may be located remote from the housing, with the auxiliary temperature sensor located within the housing. In this case, the main temperature sensor will measure the true ambient room temperature and the auxiliary temperature sensor can be used to indicate whether the boiler is switched on or not. The auxiliary sensor 19 can therefore be used to detect when the boiler starts up under the control of the boiler’s time program. When the boiler is switched on, the radiator valve body will start to get hot, and this rise in temperature will be detected by the auxiliary sensor. The control PCB may be programmed to delay actuation of the valve after the boiler is switched on, the calculated delay being a function of the room temperature. By virtue of the auxiliary sensor 19 the device 10 may also be ablet o time its own operations, thus making clock setting and adjustment of individual devices 10 in each room unnecessary. Preferably the main temperature sensor would transmit data relating to the ambient room temperature to the processing means of the device by wire means or wirelessly (via infra-red or radio link).

The device may have a rotatable knob, or the housing 15 may comprise a rotatable cap, to be rotated by the user to thereby adjust the temperature setting of the valve. Alternatively the device may include other means, such as push buttons, by which the user can set the desired temperature setting.

The device may be equipped with remote control means by which the user can set a required time-temperature heating program or override a previously set program. Such remote control means may be achieved by an infra-red or radio signalling link or by other means such as a wire connection.

The device is designed to be fitted onto standard radiator valves, and may include different adaptors and inserts to enable the body to be attached onto different types and sizes of radiator valve fittings.

Optionally, a remote PIR or other occupancy sensing device may be provided, for example so that the heating does not come on if the room is not occupied, or so that the temperature setting is setback by a predetermined amount if the room is not occupied, or so that the heating is turned off if the room is left vacated for a predetermined period of time. The occupancy sensor would preferably be remote from the device and communicable with the device via wires or wireless means.

An LED, or some other display or indicator, may be connected to the PCB controller, in order to visually indicate the status or operation of the device.

In summary, the auxiliary temperature sensor senses the circulation water temperature. Temperature information about the circulation water temperature is used to calculate a correction to the apparent reading arising due to the proximity of the main temperature sensor to the pipework carrying the circulation water. The offset will vary according to the mounting position of the device, as if in a vertical position more heat will be convected from the pipework; the auxiliary sensor will automatically adjust for the required offset irrespective of the valve position.

Furthermore, information about the circulation water temperature (rate of rise) may be used to time the operation of the thermostatic control device by relating the circulation water temperature rise to the operation of the main central heating (boiler) programmer. The device can be programmed to delay switching on on a warm day compared to a cold day when the device may need to switch on immediately without any delay. The idea is that the room will be heated to the required temperature at the required time. Without this optimum start feature, the room may be heated earlier than required and therefore waste energy. The device can use the sensor inputs to work out when best to switch on, i.e. from monitoring the heating pipes getting warm, this will allow set up to be easier as no programming will be necessary (assuming the times on the system are all the same). This feature can also be used to switch on the device automatically where no time programme setting is required and so make the device simple to use. This also means that a remote control unit does not require a costly time-clock to time the system as it will recognize the start of a heating cycle. The change in time from GMT to BST, for example, can be achieved by re-setting only the main central heating (boiler) programmer, and furthermore, there is no requirement to update the thermostatic control device after a battery change.

Although described above with respect to specified embodiments, the present invention may be embodied in numerous different ways as embraced within the claims that follow.

Claims

1. A thermostatic control device for fitting to a radiator valve and for regulating the flow of heating fluid ~~in a conduit~~through a pipe that is linked to the inlet / outlet of a radiator, the thermostatic control device comprising

    actuation means operable to alter the flow of heating fluid in the ~~conduit~~pipe,

    processing means, for controlling the actuation means,

    a first temperature sensor for sensing the ambient temperature in the vicinity of the device, and

    a second temperature sensor for sensing the temperature of the ~~conduit~~ pipe by measuring the air temperature influenced by the heating fluid in the ~~conduit~~pipe,

   the processing means being operable to receive temperature inputs from the first and second temperature sensors and produce an output based on the temperature inputs for controlling the actuation means.

2. A thermostatic control device according to claim 1 wherein the processing means is operable to calculate a correction to the temperature input measured by the first sensor using the temperature input measured by the second sensor.

3. A thermostatic control device according to claim 1 or 2 wherein the device is mountable to a radiator valve in a vertical position, wherein in use the first and second sensors are located above the ~~conduit~~pipe, or in a horizontal position, wherein in use the first and second sensors are located laterally relative to the ~~conduit~~pipe.

4. A thermostatic control device according to claim 3 wherein the processing means is operable to apply a first correction to the temperature input measured by the first sensor when the device is mounted in a vertical position, or to apply a second correction to the

temperature input measured by the first sensor when the device is mounted in a horizontal position.

5. A thermostatic control device according to claims 3 or 4 wherein the device includes means for automatically detecting whether the device is mounted in the vertical position or the horizontal position.

6. A thermostatic control device according to any preceding claim wherein, in use, the second temperature sensor is located in close proximity to the ~~conduit~~pipe.

7. A thermostatic control device according to any preceding claim wherein the device comprises a housing.

8. A thermostatic control device according to claim 7 wherein the first temperature sensor is located, in use, remote from the housing.

9. A thermostatic control device according to claim 8 wherein the first temperature sensor is wirelessly communicable with the device.

10. A thermostatic control device according to claim 7 wherein the first and second temperature sensors are located, in use, within the housing.

11. A thermostatic control device according to claim 10 wherein the first temperature sensor is located at a first end of the housing, remote from the ~~conduit~~pipe.

12. A thermostatic control device according to claims 10 or 11 wherein the housing comprises ventilation means located in close proximity to the first temperature sensor.

13. A thermostatic control device according to any preceding claim wherein the housing comprises ventilation means located in close proximity to the second temperature sensor.

14. A thermostatic control device according to any preceding claim wherein the device is configured to be mounted to valve means of a radiator, wherein the device is adapted to operate the valve means to reduce the flow of heating fluid in the ~~conduit~~ pipe when a desired ambient temperature is exceeded, and to re-actuate the valve means to increase the flow of heating fluid in the conduit if the ambient temperature falls below the desired temperature.

15. A thermostatic control device according to any preceding claim wherein the device is controllable using a remote control unit, the remote control unit being communicable with the device via wire means or wireless means.

16. A thermostatic control device according to claim 15 wherein the device is communicable with a remote control unit via infra-red or radio means.

17. A thermostatic control device substantially as herein described and illustrated.