Electronic regulating device for an electric motor applied to a burner ventilator

An electronic regulating device (1) for an electric motor (2) applied to a fuel burner ventilator. The regulating device has a programmable device (3) and a speed sensor (4) for controlling the speed of the electric motor (2), and a switching device (5) for controlling variations in the speed of the electric motor (2) as a function of a signal from the programmable device (3). The regulating device (1) also has a selector (6) having at least three positions and for selecting the operating mode of the programmable device (3) from at least three alternatives corresponding to a two-stage operating mode, a PWM (Pulse Width Modulation) operating mode, and a three-point modulation operating mode.
The present invention relates to an electronic regulating device for an electric motor applied to a fuel burner ventilator.

As is known, a gas or vapourized liquid fuel burner is supplied with a mixture of fuel and combustion air; and the combustion air supply to the burner is regulated by a ventilator driven by an electric motor, the speed of which is controlled by a flame control device commonly used to control operation of the fuel burner.

The flame control device is normally equipped with an electric control card for processing physical flame combustion parameters to regulate the fuel and combustion air mixture according to the desired calories. The electronic control card therefore has one or more outputs for controlling the speed of the electric motor, so as to regulate combustion air supply by the ventilator on the basis of processing by the electronic control card.

Currently marketed fuel burners are substantially of two types used for two different types of application.

A first type comprises two-stage burners, commonly used in floor-mounted boilers, in which the flame control device directly controls electric power supply to the motor by a motor output (current phase).

A second type comprises modulating burners, commonly used in wall-mounted boilers, in which the flame control device modulates the speed of the ventilator by a PWM (Pulse Width Modulation) signal, i.e. by varying the duty cycle of a square-wave signal.

Currently marketed electric motors for fuel burner ventilators are simply equipped with an electronic switching device, and are designed for use with a specific type of burner.

More specifically, electric motors for two-stage burners simply have an input for receiving electric power supply directly from the motor output of the flame control device; and electric motors for modulating burners simply have a PWM input for connection to the corresponding PWM output of the flame control device.

In other words, being designed for a given type of flame control logic, the same type of electric motor cannot be used with different types of known or newly designed flame control devices.

It is an object of the present invention to provide an electronic regulating device for an electric motor applied to a fuel burner ventilator, designed to eliminate the aforementioned drawback, and which, in particular, is cheap and easy to produce.

According to the present invention, there is provided an electronic regulating device for an electric motor applied to a fuel burner ventilator, as claimed in Claim 1 and, preferably, in any one of the following Claims depending directly or indirectly on Claim 1.

According to the present invention, there is also provided a method of regulating an electric motor applied to a fuel burner ventilator, as claimed in Claim 7 and, preferably, in any one of the following Claims depending directly or indirectly on Claim 7.

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a block diagram of the electronic regulating device for an electric motor applied to a fuel burner ventilator, according to the present invention;

Figure 2 shows a flow chart of the method of regulating an electric motor applied to a fuel burner ventilator, according to the present invention.

Number 1 in Figure 1 indicates as a whole an electronic regulating device for regulating the speed of an electric motor 2 applied to a ventilator (not shown) of a fuel burner (not shown). Regulating device 1 comprises a programmable device (microcontroller) 3; a speed sensor 4 for supplying a signal proportional to the speed of electric motor 2; a switching device 5 for regulating the voltage supplied to electric motor 2; and a selector 6 for selecting the operating mode of programmable device 3. In the Figure 1 embodiment, electric motor 2 is a brushless motor, speed sensor 4 is a Hall sensor, and switching device 5 is based on MOSFET transistors.

Regulating device 1 is controlled by a number of inputs, in particular an electric power supply input 7; a first-stage control input 8; a second-stage control input 9; a PWM (Pulse Width Modulation) input 10; and a three-point modulation input 11.

Electric power supply input 7 is connected to a rectifying block 12 to convert a 230 volt alternating voltage phase to a 230 volt direct voltage required to electrically power electric motor 2 by means of switching device 5; and a DC/DC converter 13 is cascade-connected to rectifying block 12 to convert the 230 volt direct voltage to a 5 volt direct voltage required to electrically power programmable device 3 and speed sensor 4.

First-stage control input 8, second-stage control input 9, PWM input 10, and three-point modulation input 11 supply respective signals directly to programmable device 3, which also receives a signal proportional to the speed of electric motor 2 from speed sensor 4, a feedback signal from switching device 5 and filtered by an integrating circuit 14, and three constant calibration signals from respective potentiometers (trimmers) 15, 16, 17.

Programmable device 3 processes the above signals to control switching device 5, which electrically powers electric motor 2, and to supply an output signal, proportional to the speed of electric motor 2, at an RPM output 18 of regulating device 1.

Electric power supply input 7, first-stage control input 8, second-stage control input 9, PWM input 10, three-point modulation input 11, and RPM output 18 are connected respectively to respective outputs and to a
respective input of a generic external flame control device (not shown) for controlling overall operation of the fuel burner.

More specifically, first-stage control input 8 and second-stage control input 9 interpret two-state ("ON", "OFF") signals from a two-stage burner flame control device; three-point modulation input 11 interprets a three-state ("DOWN", "UP", "ZERO") signal from an external power regulator (not shown) controlled by the flame control device of a more sophisticated two-stage burner; and PWM input 10 interprets a PWM signal from a flame control device of a wall-mounted boiler burner.

RPM output 18 and PWM input 10 are preferably provided with respective optocouplers 20, 19 to protect programmable device 3 from voltage peaks and/or spurious input currents.

Programmable device 3 is programmed (firmware) to process the above signals and accordingly control switching device 5 to regulate the speed of electric motor 2 using a regulating method shown schematically in the Figure 2 flow chart.

The following is a detailed description of the regulating method.

In actual use, programmable device 3 continuously monitors the state of selector 6, which selects the operating mode of regulating device 1 and, therefore, the way in which programmable device 3 processes the signals from inputs 8, 9, 10, 11 of regulating device 1.

In a first (two-stage) operating mode, programmable device 3:
- first turns on electric motor 2 to set electric motor 2 to an intermediate speed determined by the constant signal from a first potentiometer 15;
- enables first-stage control input 8 and second-stage control input 9;
- sets electric motor 2 to a minimum speed, lower than the intermediate speed and determined by the constant signal from a second potentiometer 16, in the event the signal of first-stage control input 8 is "ON" and the signal of second-stage control input 9 is "OFF";
- sets electric motor 2 to a maximum speed, higher than the intermediate speed and determined by the constant signal from a third potentiometer 17, in the event the signals of first- and second-stage control inputs 8, 9 are both "ON"; and
- sets electric motor 2 to the intermediate speed, in the event the signals of first- and second-stage control inputs 8, 9 are both "OFF".

In a second (PWM) operating mode, programmable device 3:
- enables PWM input 10 and RPM output 18;
- sets electric motor 2 to a speed determined by the duty cycle of the square-wave signal of PWM input 10; and
- supplies RPM output 18 with a signal proportional to the speed of electric motor 2.

In a third (three-point modulation) operating mode, programmable device 3:
- first turns on electric motor 2 to set electric motor 2 to an intermediate speed determined by the constant signal from a first potentiometer 15;
- enables first-stage control input 8 and second-stage control input 9;
- sets electric motor 2 to the intermediate speed, in the event the signal of second-stage control input 9 is "OFF";
- enables three-point modulation input 11, in the event the signal of second-stage control input 9 is "ON";
- increases the speed of electric motor 2 according to a given up-ramp, in the event the signal of three-point modulation input 11 is "UP";
- reduces the speed of electric motor 2 according to a given down-ramp, in the event the signal of three-point modulation input 11 is "DOWN"; and
- leaves the speed of electric motor 2 unchanged, in the event the signal of three-point modulation input 11 is "ZERO".

The main advantage of the present invention is that of providing an electronic regulating device 1, for an electric motor 2 applied to a fuel burner ventilator, which can be integrated with the motor and interfaced with any known flame control device to obtain a more versatile motor assembly comprising electric motor 2 and regulating device 1.

Claims

1. An electronic regulating device for an electric motor (2) applied to a ventilator of a fuel burner; the regulating device (1) comprising control means (3, 4) for controlling the speed of said electric motor (2), and a switching device (5) for controlling variations in the speed of said electric motor (2) as a function of a signal from said control means (3, 4); the regulating device (1) being characterized by comprising selecting means (6) for selecting the operating mode of said control means (3, 4).

2. A regulating device as claimed in Claim 1, wherein the selecting means (6) comprise a selector (6) having at least three positions; the three positions corresponding respectively to a two-stage operating mode, a PWM (Pulse Width Modulation) operating mode, and a three-point modulation operating mode.
3. A regulating device as claimed in Claim 1 or 2, wherein said regulating device (1) is characterized by comprising a number of control inputs (7, 8, 9, 10, 11); said control inputs (7, 8, 9, 10, 11) being controlled by a generic external flame control device of said burner.

4. A regulating device as claimed in Claim 3, wherein the number of control inputs (7, 8, 9, 10, 11) comprises an electric power supply input (7), a first-stage control input (8), a second-stage control input (9), a PWM input (10), and a three-point modulation input (11).

5. A regulating device as claimed in Claim 3 or 4, wherein the control means (3, 4) comprise a speed sensor (4) for supplying a signal proportional to the speed of the electric motor (2), and a programmable device (3) for processing the signals from the control inputs (7, 8, 9, 10, 11) and the signal from the speed sensor (4).

6. A regulating device as claimed in one of Claims 1 to 5, wherein the regulating device (1) is characterized by being integrated with the electric motor (2).

7. A regulating method for regulating an electric motor (2) applied to a ventilator of a fuel burner; the regulating method being characterized by providing for at least three alternative operating modes; said operating modes corresponding respectively to a two-stage mode, a PWM (Pulse Width Modulation) mode, and a three-point modulation mode.

8. A regulating method as claimed in Claim 7, wherein the two-stage operating mode depends on a signal of a first-stage control input (8) and a signal of a second-stage control input (9), which signals of the first- and second-stage control inputs (8, 9) may assume two "ON" and "OFF" states, the two-stage operating mode comprising the steps of:

   - first turning on the electric motor (2) to set the electric motor (2) to an intermediate speed, the intermediate speed being between a minimum speed and a maximum speed;
   - setting the electric motor (2) to the minimum speed, in the event the signal of the first-stage control input (8) is "ON" and the signal of the second-stage control input (9) is "OFF";
   - setting the electric motor (2) to the maximum speed, in the event the signals of the first- and second-stage control inputs (8, 9) are both "ON"; and
   - setting the electric motor (2) to the intermediate speed, in the event the signals of the first- and second-stage control inputs (8, 9) are both "OFF".

9. A regulating method as claimed in Claim 7, wherein the PWM (Pulse Width Modulation) operating mode depends on a signal of a PWM input (10); the PWM operating mode comprising the steps of:

   - setting the electric motor (2) to a speed determined by the duty cycle of the square-wave signal of the PWM input (10); and
   - supplying an output (18) with a signal proportional to the speed of the electric motor (2).

10. A regulating method as claimed in Claim 7, wherein the three-point modulation operating mode depends on a signal of a first-stage control input (8) and a signal of a second-stage control input (9), which signals of the first- and second-stage control inputs (8, 9) may assume two "ON" and "OFF" states, and on a signal of a three-point modulation input (11), which signal of the three-point modulation input (11) may assume three "DOWN", "UP" and "ZERO" states; the three-point modulation operating mode comprising the steps of:

   - first turning on the electric motor (2) to set the electric motor (2) to an intermediate speed, the intermediate speed being between a minimum speed and a maximum speed;
   - setting the electric motor (2) to the intermediate speed, in the event the signal of the second-stage control input (9) is "OFF";
   - enabling the three-point modulation input (11), in the event the signal of the second-stage control input (9) is "ON";
   - increasing the speed of the electric motor (2) according to a given up-ramp, in the event the signal of the three-point modulation input (11) is "UP";
   - reducing the speed of the electric motor (2) according to a given down-ramp, in the event the signal of the three-point modulation input (11) is "DOWN"; and
   - leaving the speed of the electric motor (2) unchanged, in the event the signal of the three-point modulation input (11) is "ZERO".
Start

Selector 6 = Two-stage?

YES

1st stage 8 = OFF and 2nd stage 9 = OFF?

YES

Motor 2 at intermediate speed

NO

1st stage 8 = ON and 2nd stage 9 = OFF?

YES

Motor 2 at minimum speed

NO

1st stage 8 = ON and 2nd stage 9 = ON?

NO

YES

Motor 2 at maximum speed

NO

Selector 6 = PWM?

YES

Enable PWM input 10 and RPM output 18

Motor 2 at speed determined by PWM

NO

Selector 6 = Three-point modulation?

YES

2nd stage 9 = OFF?

YES

Motor 2 at intermediate speed

NO

2nd stage 9 = ON?

NO

YES

Motor 2 at speed determined by three-point modulation

NO

Fig. 2
# DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
<th>Category</th>
<th>Citation of document with indication, where appropriate, of relevant passages</th>
<th>Relevant to claim</th>
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