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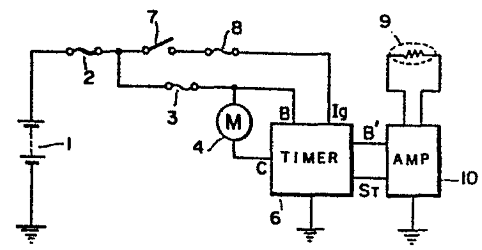
(54) Apparatus for preventing thermal seizure of a turbo-supercharger drive shaft.

(57) In a first embodiment, a thermal sensor senses the temperature of exhaust from an internal combustion engine. When the sensed temperature of exhaust exceeds a predetermined value, the sensor produces a drive signal which drives a fan motor (4) to cool the engine compartment and therefore the shaft and bearings of an exhaust turbine of a turbo-super-charger for use with the engine, thereby preventing thermal seizure of the shaft and bearings. In a second embodiment, the fan motor (4) is responsive to the opening of an ignition switch (7) and to the presence of a value (ST) indicative of the drive signal immediately before the opening of the ignition switch (7) to be driven to cool the turbo-supercharger shaft and bearings subjected to high heat produced in the engine compartment after the engine has been stopped.

FIG.2



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DESCRIPTION

The present invention relates to an engine cooling fan control apparatus, and more particularly to apparatus for preventing thermal seizure of the drive shaft of a turbo-supercharger installed in the engine.

In an internal combustion engine with a turbo-supercharger which discharges compressed air to the engine to improve engine output, the drive shaft common to the exhaust turbine and the compressor of the turbo-supercharger is subjected to hot exhaust gas so that the shaft has a tendency to be seized by its bearings.

The present invention provides an apparatus which senses the temperature of exhaust to drive a turbo-supercharger shaft cooling means when the sensed temperature exceeds a predetermined value, thereby preventing seizure of the shaft by its bearings.

In the drawings:

Fig. 1 is a diagramatic illustration of a preferred embodiment of a turbo-supercharger shaft cooling apparatus according to the present invention;

Fig. 2 is a view, similar to Fig. 1, of a second embodiment of the present invention; and

Fig. 3 is a schematic diagram of the timer of Fig. 2.

The same reference numerals are used to designate similar elements of the embodiments shown in the figures.

Referring to Fig. 1, there is shown a preferred embodiment of a turbo-supercharger shaft cooling apparatus according to the present invention. In the particular embodiment, a battery 1 is adapted to supply electrical power to a fan motor 4, installed to cool the engine compartment, via a fusible link 2 and a fuse 3 when the circuit is closed, thereby driving fan motor 4 to cool the engine compartment and therefore the exhaust turbine shaft and its bearings which are subjected to hot exhaust. Switch 5, acting as a thermal sensor, is closed when the exhaust temperature exceeds a predetermined value, and is open when the exhaust temperature falls below the predetermined value. Fusible link 2 and fuse 3 are for protection of battery 1 and the whole circuit from short-circuiting and/or malfunction of motor 4.

Referring to Fig. 2, there is shown a second embodiment of a turbine shaft cooling apparatus according to the present invention. In addition to the previously described cooling function while the engine is running, this embodiment ensures that the turbine shaft and bearing will be cooled for a predetermined interval after the ignition key is turned off when the exhaust temperature exceeds the predetermined value because the temperature of the engine compartment tends to rise greatly after the engine is turned off. In this embodiment, battery 1 has one electrode grounded and the other electrode connected via fusible link 2 and fuse 3 to one terminal of fan motor 4, the other terminal of which is connected to a control terminal C of a timer 6 which serves to control the operating interval of motor 6. The power supply for timer 6 is provided by connection of a power supply terminal B thereof to the output of fuse 3. Timer 6 has an ignition detection terminal Ig to detect the off state of an ignition switch 7. Terminal Ig is connected via a fuse 8 to a terminal of ignition switch 7, the input of which is connected to the output of fusible link 2. Fuse 8 has the same function as fuse 3. In Fig. 3, power supply terminal B is connected via a stabilizing power source SB and an analog switch AS to a power supply line B' for an amplifier 10. When ignition switch 7 is closed analog switch AS is actuated via input terminal Ig and a resistor r_1 to supply the stabilized supply voltage via B' to amplifier 10. Returning to Fig. 2, an exhaust temperature sensor 9, provided in the exhaust manifold, not shown, senses the temperature of exhaust and outputs a signal to amplifier 10 when the sensed temperature is above a predetermined value, for example 700°C. Sensor 9 may be a conventional semiconductor thermal sensor. Amplifier 10 amplifies the signal from sensor 9 and supplies the amplified signal S_T to timer 6. Amplifier 10 is supplied with electrical power from terminal B' only while ignition switch is on. Timer 6 may have a structure such as shown in Fig. 3. In this particular structure, an AND gate receives a drive input via resistor r_1 and an inverter INV from terminal Ig while ignition switch 7 is open. A level adjust circuit including a Zener diode Z_D, a resistor r_2 and a capacitor C_1 adjusts the voltage at the control input terminal of analog switch AS and at inverter INV to a desired value. Another drive input S_T is supplied from amplifier 10 to the AND gate. A hold circuit comprising a resistor r_3 and a capacitor C_2 holds the value of S_T for a short time, for example 1 second. The time constant determined by r_3 and C_2 is selected to be greater than that determined by C_1 and r_2 of the level adjust circuit. When the AND gate outputs a high level signal, a monostable multivibrator M/M produces a high level signal continuing for a short predetermined time of from 1 to 3 minutes, thereby turning on a transistor Tr via an OR gate for that interval to operate fan motor 4. For as long as the signal S_T persists, transistor Tr is also turned on via the OR gate, thereby operating fan motor 4 for that interval during which the exhaust temperature exceeds the predetermined value.

In operation, during engine operation, exhaust temperature sensor 9 continuously checks the temperature of exhaust. When sensor 9 detects that the temperature of exhaust exceeds the predetermined value (700°C in this particular embodiment), sensor 9 outputs a signal and therefore amplifier 10 outputs a constant-level d.c. voltage signal as signal S_T to timer 6 which drives motor 4 via the OR gate and transistor Tr for as long as signal S_T persists. When ignition switch 7 is opened, the Ig control input to analog switch AS disappears, and analog switch AS is turned off, thereby interrupting the supply of electrical power to amplifier 10. At this time, the output signal S_T from amplifier 10 disappears, but the value of S_T immediately before S_T disappears is held by the hold circuit. Thus, both inputs to AND gate are high so that monostable multivibrator M/M produces an output continuously for 1 to 3 minutes. Thus the engine compartment, turbo-supercharger shaft and bearings are cooled whereby seizure of the drive shaft is prevented.

The temperature of exhust corresponds accurately to the temperature of turbine shaft. After engine stops, the temperature of the exhaust system can rise to a value higher than any other system in the engine compartment. Thus, it is most recommendable to sense the temperature of exhaust itself in order to prevent seizure of the turbo-supercharger shaft by its bearings.

While the present invention has been described in terms of a preferred embodiment thereof, it should be noted that the present invention is not limited thereto. Various modifications and changes could be made by those skilled in the art without departing from the scope of the present invention, as set forth in the attached claims.

CLAIMS

1. Apparatus for preventing thermal seizure of the shaft and bearings of exhaust turbine and compressor of a turbo-supercharger for use with an internal combustion engine, comprising:

- means (5;9) for sensing the temperature of exhaust gas from the engine to output a drive signal when the sensed temperature exceeds a predetermined value;
- means (4) for cooling the shaft and bearings, and
- control means (5;6) responsive to the drive signal for driving the cooling means to cool the shaft and bearings.

2. Apparatus according to claim 1, c h a r a c t e r i z e d in that said control means includes a timer (6) responsive to the opening of an ignition switch (7) and the presence of a value indicative of the drive signal from said sensing means (9) immediately before the opening of the ignition switch to drive the cooling means (4) for a particular time interval after the ignition switch has opened.

3. Apparatus according to claim 2, c h a r a c t e r i z e d in that said timer (6) includes means (AS) responsive to the closing of said ignition switch (7)

for supplying power therethrough to said sensing means (9) and responsive to the opening of said ignition switch (7) for interrupting the supply of said power to said sensing means (9), and means (C_2,r_3) for holding the value indicative of the drive signal for a short time.

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FIG.1

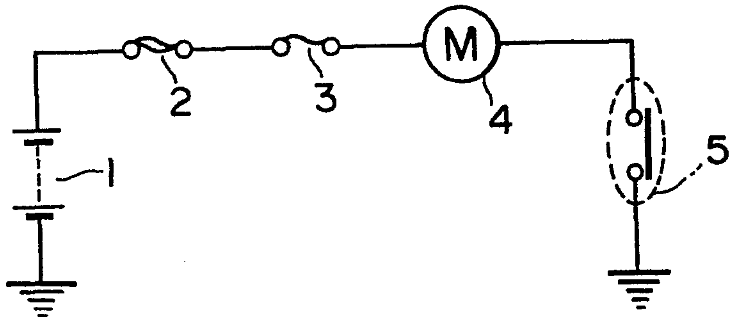

FIG.2

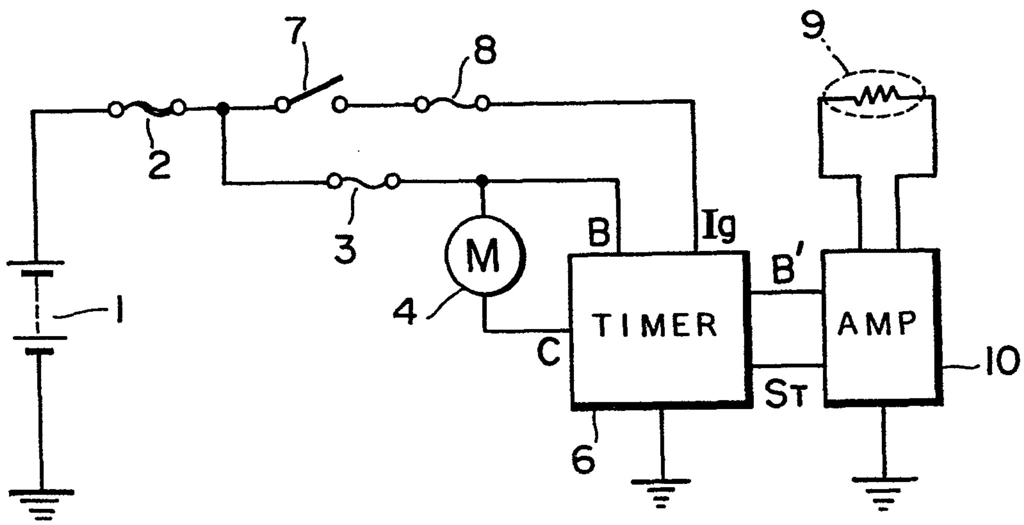

FIG.3