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A LOAD OVERCURRENT ALARM DEVICE AND A CONNECTOR OVERHEAT ALARM DEVICE

Field of the Invention

The present invention generally relates to electronic circuits, particularly to an overcurrent and overheat alarm device mounted in a connector, such as a receptacle, a plug, or a patchboard etc..

Background of the Invention

Today, electrical appliances have been found more widespread use. Usually, many electrical appliances are connected to one single receptacle. However since there is no load overcurrent or overheat alarm device for the electrical appliance in the receptacle, a fire caused by overheat as a result of electrical overload often occurs.

It is difficult, for a common person, to know when an electrical appliance would become overloaded and consequently shorted or overheated. Especially for the elder and the blind, they even could not know how many electrical appliances connected to the receptacle would cause a overload at all.

Therefore, there is a need for electrical appliance overload alarm devices mounted in connectors, such as receptacles, plugs, or patchboards etc..

Summary of the Invention

The object of the present invention is to provide a device mounted in a connector, such as a receptacle, a plug, or a patchboard etc., which capable of alarming for load overcurrent and/or connector overheat caused by overload.



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According to the technical problem to be solved, the invention provides a load overcurrent alarm device comprising a current detecting circuit composed of a mutual inductor L1 for detecting current changes of a load and outputting in voltage form to an circuit for amplifying-rectifying and sampling-filtering, the primary coil of said detecting circuit being a single turn coil formed together with a power line "N" in series with the load; a circuit for signal amplifying-rectifying and sampling-filtering, which sending the voltage signal from the current detecting circuit to a circuit for comparing and outputting after amplifying-rectifying and sampling-filtering process; a circuit for comparing and outputting, which detecting the voltage from the circuit for amplifying-rectifying and sampling-filtering to trigger the LED1 of a flash alarm circuit to flash when the output is high level and an audio alarm circuit to sound the alarm at the same time; a flash alarm circuit; an audio alarm circuit; a manual testing circuit.

Based on the technical problem to be solved, the present invention also provides a connector overheat alarm device comprising a temperature detecting circuit for detecting temperature variation of a connector and outputting to a circuit for comparing and outputting in the form of voltage variation; a circuit for comparing and outputting, which comparing the voltage which comes from the temperature detecting circuit with a predetermined voltage so as to control a flash alarm circuit and an audio alarm circuit; a flash alarm circuit; an audio alarm circuit; a manual testing circuit.

Because the alarm device of the invention has a function of alarming (making flash and audio alarm) when it detects overcurrent and overheat in a connector as a result of overload of a electrical appliance, it is possible to make the user (especially for the elder and the blind) alert and take corrective action to avoid a fire caused by it.

The present invention also provides: (1) a purification and protection

circuit for network voltage to prevent lightning strike and absorb surge pulses and high frequency signals in a limited range of the network to provide the electrical appliances an high quality operating power source; (2) a manual test circuit, the test switch of which can be turned to sense whether the device of the invention is at normal working conditions.

Brief Description of the Drawings

Figure 1 shows a block diagram of the load overcurrent alarm device according to the invention;

Figure 2 shows a block diagram of the connector overheat alarm device according to the invention;

Figure 3 shows the composition of the overcurrent and overheat alarm circuit according to a preferred embodiment of the invention.

Detailed Description of the Preferred Embodiments

The preferred embodiments will be described in great detail with reference to the drawings as following:

Firstly the load overcurrent alarm device of the invention will be introduced, wherein a block diagram of the load overcurrent alarm circuit according to the invention is shown in Figure 1, and the overcurrent alarm circuit according to a preferred embodiment of the invention is shown in Figure 3. The load overcurrent alarm device includes a current detecting circuit 11, a circuit for signal amplifying-rectifying and sampling-filtering 12, a circuit for comparing and outputting 13, a flash alarm circuit 14, and an audio alarm circuit 15, wherein the L1 of the current detecting circuit 11 is a mutual inductor, through which the source input line "N" is coupled to the line "N" of a connector, i.e. the "N_{out}" terminal. The mutual inductor can detect the state of the load current, and output it to a circuit for comparing and outputting 13 in voltage form after it is processed by an

circuit for amplifying-rectifying and sampling-filtering 12. The heavier the load is, the larger the current becomes. Then the voltage across two ends of the mutual inductor $L1$ becomes larger. The $C3$ coupled with two ends of the mutual inductor $L1$ can attenuate high frequency component and other inductor certainly can be used to substitute the mutual inductor $L1$ as a current detecting circuit. The output voltage of the circuit for signal amplifying-rectifying and sampling-filtering 12 is regulated to a voltage corresponding to a predetermined alarm current, then sent to the circuit for comparing and outputting 13 for on-line detecting comparison. When the load current reaches a predetermined current level (for example $14A \pm 1A$), the output voltage of sampling circuit 12 will reach the high level of the circuit for comparing and outputting at which the circuit for comparing and outputting will invert, then the operational amplifier IC1A outputs a high level. The transistor VT1 of the flash alarm circuit 14 becomes conductive and the overcurrent indicator LED1 is energized and emits flash. At the same time, the negative trigger type audio alarm circuit 15 is connected to the collector of the VT1 after being separated by the D5, then becomes low electrical level and is triggered to work. The buzzer BZ1 sounds the alarm loudly, then people can immediately know the load of the appliances is too heavy(i.e. overcurrent) at that time and they should make adjustment action on time. The concrete structure of the circuit for signal amplifying-rectifying and sampling-filtering in Figure 1 is indicated by the dotted line frame 12 in Figure 3. The circuit 12 in Figure 3 includes: the operational amplifier IC1B, capacitor $C3$, resistor $R2$, $R3$, diode $D2$, rheostat $RP1$, capacitor $C5$, in which the positive terminal of the operational amplifier IC1B is coupled with the mutual inductor $L1$, and its negative terminal is coupled with circuit ground "N" through the resistor $R2$ as well as with the output terminal through the resistor $R3$. So by selecting the proportion of the resistor $R2$ with $R3$ properly, the voltage which comes from the terminal 5 can be linear

amplified appropriately. After rectified by the diode D2, sampled by the rheostat RP1, and filtered by the capacitor C5, it reaches the positive terminal 3 of the operational amplifier IC1A. For the circuit 13 in Figure 1, the high voltage output comparing circuit is composed of the operational amplifier IC1A, resistor R5, diodes D3, D4, in which the resistor R5, diode D3, D4 form a stable standard voltage circuit. Then, when the voltage of the positive terminal 3 reaches the predetermined value, i.e. larger than standard voltage of the negative terminal 2, the operational amplifier IC1A outputs high electrical level, so that the flash and audio alarm circuits are triggered for alarming.

The circuit for comparing and outputting 13 and the flash alarm circuit 14 and the audio alarm circuit 15 shown in Figure 3 can have a variety of modifications, for example, in stead of the circuit 13, a time based circuit 555 can be used as the trigger control circuit. A predetermined voltage in the circuit 555 is used to set a valve value. When the output voltage of the circuit for signal amplifying-rectifying and sampling-filtering 12 is beyond the valve value, the 555 circuit outputs low electrical level, but at that time the transistor VT1 is abolished. The luminescent diode and the D5 of the audio alarm circuit 15 are directly coupled with the output terminal of the 555 circuit, so the luminescent diode becomes luminous and the buzzer sounds alarm signal. Of course, the Schmidt circuit also can be used as the comparing control circuit, and after corresponding modification used for controlling various alarms. It should be noticed that any variance of frame 13,14,15 in Figure 3 based on the novel teaching of the present invention would be within the scope of the present invention.

In present invention, the rheostat RP1 has a function of making the voltage in the positive terminal 3 of the IC1A correspond to a predetermined alarm current through changing of resistance. For example, when the current is at a predetermined value $14A \pm 1A$, the circuit for comparing and

outputting outputs high electrical level as a result of trimming the rheostat RP1 so that the alarm circuit is triggered for alarming.

Below referring Figure 2 and 3 the function of the overheated alarm circuit of the present invention will be described, in which the connector overheated alarm device comprises: a temperature detecting circuit 21 coupling with the +terminal of the source and N_{out} for detecting the variance of connector temperature and outputting in voltage form to a circuit for comparing and outputting 22; a circuit for comparing and outputting 22, which comparing the voltage which comes from the temperature detecting circuit with a predetermined voltage, when the output voltage of a sampling circuit 21 reaches the low electrical level making the comparator IC1C invert, the comparator IC1C outputs high electrical level and the transistor VT1 of a flash alarm circuit 23 becomes conductive so that an overheated indicator LED2 is energized and starts to emit flash and at the same time a negative trigger type audio alarm circuit 15 which coupled with the collector of transistor VT2 after separated by the diode D6, becomes low electrical level and is triggered to work. Then the buzzer sounds alarm loudly to make people alert. Therefore they would immediately take rectifying action on time and a fire caused by it could be avoided.

In Figure 3 the temperature detecting circuit 21 includes the resistor R8, R9 and the rheostat RP2 and the thermistor RT1 in Figure 1, the thermistor is a negative temperature coefficient thermistor.

In Figure 3 the comparator of the comparing control circuit 22 is a operational amplifier IC1C, the voltage reference terminal 10 of which is coupled with two terminals of the source through the resistors R10, R11 respectively; the signal input terminal 9 of the comparator is coupled with the +terminal of the source through the resistor R8, and coupled with the resistor R9, as well as coupled with the negative terminal of the source through the rheostat RP2, thermistor RT1.

When the temperature of the connector, such as a receptacle, is raised, the resistance of the negative temperature coefficient thermistor RT1 reduces, at that time the voltage of the signal input terminal 9 of the comparator IC1C decreases. When the temperature of the connector is raised to the predetermined temperature, the resistance of the thermistor RT1 reduces to a low resistance value and the voltage of the signal input terminal 9 of the comparator decreases to a low electrical level. At that time, the comparison result of the comparator is that the voltage of the signal input terminal 9 is lower than the voltage of the reference terminal 10. Then the output terminal 8 of the comparator outputs high electrical level. Such high electrical level makes the transistor VT2 become conductive after limitation of current by the resistor R12 and the luminescent diode LED2 flashes. At the same time separated by the D6, the audio alarm circuit 15 becomes low electrical level and is triggered for alarming to take user's attention, so they would immediately make rectifying action on time and avoid a fire caused by it.

In the temperature detecting circuit of the present invention, an rheostat RP2 is coupled between the resistor R9 and the thermistor RT1, which is used for trimming voltage at the signal input terminal of the comparator by changing the resistance. For example, when temperature is at a predetermined temperature $70\pm5^{\circ}\text{C}$, the output terminal of the comparator outputs high electrical level as a result of trimming the rheostat RP2, and the LED2 emits flash, at the same time the audio alarm circuit 15 is triggered for alarming. The C6 coupled with terminal 8, 9 of the comparator IC1C can accelerate reversing of the comparator when the temperature is at a critical alarm point, and make the output stable.

It should be apparent to those skilled in the art that the comparing circuit 22 shown in Figure 3 can have various variances and modifications. For example a Schmidt circuit can be used to substitute the comparator. Of

course it is also possible that the comparator is substituted by the time base circuit 555 and it only needs the peripheral circuits to be made the corresponding adjustment. In addition, if the positive temperature coefficient thermistor was used, the connection of between the positive and the negative terminals of the comparator IC1C would be in reverse as shown in Figure 3. It should be noticed that any change of frame 21, 22, 23 in Figure 3 based on the teaching of the present invention will be within the scope of the present invention.

In Figure 3, the switch K1 is a single-pole triple-throw switch for manual testing, one end of which is coupled with the high electrical level terminal of the RT1 through a terminal J1; the common terminal of which is coupled with the negative terminal of the source through a terminal J2; and another end of which is coupled with the terminal 2 of the operational amplifier IC1A through a terminal J3. A resistor R4 is located between the terminal 3 of the operational amplifier IC1A and +terminal of the source, so that the manual testing circuit of the overcurrent alarm circuit and the overheated alarm circuit is formed. When the switch K1 is switched to the terminal J1, the thermistor RT1 is equivalent to be shorted. If the temperature is very high, then the comparator IC1C outputs high electrical level. The overheat alarm circuit is triggered, the buzzer BZ1 sounds, and the LED2 flashes. These demonstrate the overheated alarm circuit 21, 22, 23, 15 circuit all work well. Because of the function of the resistor R4, when the mutual inductor L1 has no current induction and the operational amplifier IC1B has no output, a positive voltage which is a little higher than the negative source is provided to the terminal 3 of the operational IC1B. When the switch K1 turns to the terminal J3, the terminal 2 of the operational amplifier IC1B is set lower to a negative electrical level and the operational amplifier IC1B outputs high electrical level. Then the overcurrent alarm circuit is triggered, the buzzer BZ1 sounds, and the LED1

flashes. These demonstrate the overcurrent alarm circuit 13, 14, 15 circuits also work normally. When the switch K1 locates at the middle position, the device is in the normal working conditions.

The overcurrent and/or overheat alarm devices of the present invention also includes a purification and protecting circuit 31 of the network voltage comprising varister RV1, RV2, RV3 which are connected in parallel between the source input terminals L, N, E, for protection from surge and lightning strike, and a capacitor C1 connected in parallel between the source input terminals L, N, for restraining high frequency pulse of a certain range.

The overcurrent and/or overheat alarm devices further comprises a circuit 32 which capable of stepping down the voltage by capacitors, rectifying-filtering and voltage-stabilizing formed by capacitors C2, C4, and the diode D1, resistor R1, as well as the voltage-stabilizing diode ZD1 for providing a power source to the circuits of the present invention. The device of the present further includes a fuse disposed between the source terminals. If the receptacle was used in overload but rectifying action is not taken in time, when the current reaches the melt point of the fuse, then the fuse would be broken to carry out the protection.

In Figure 3,

notes:

1. The mutual inductor L1 is formed by winding Φ 0.6mm enamel insulated wire 20 turns on T13*7.5*5 toroidal magnetic core to construct a toroidal magnetic coil of 24uH as an inductance coil.
2. The LED1, LED2 are Φ 3 mm red emitting, superbright, self-glister type light emitting diodes.
3. The thermistor RT1 is a glass packaged negative temperature coefficient thermistor: NTC 10K $\pm$ 5 %.
4. The D.C. resistance of the L2 is 350 $\Omega \pm$ 20%.

What is claimed is:

1. A load overcurrent alarm device , characterized by comprising:

a current detecting circuit, constructed by a mutual inductor L1 for detecting current changes in the load and outputting in voltage form to an circuit for amplifying-rectifying and sampling-filtering, its primary coil being a single turn coil formed by a power line “N” in series with the load;

a circuit for signal amplifying-rectifying and sampling-filtering sending the voltage signal which comes from the current detecting circuit to a circuit for comparing and outputting after amplifying-rectifying and sampling-filtering;

a circuit for comparing and outputting, detecting voltage which comes from the circuit for amplifying-rectifying and sampling-filtering, when the output is high electrical level, the LED1 of a flash alarm circuit being triggered to flash and at the same time an audio alarm circuit being triggered to give the alarm;

a flash alarm circuit;

an audio alarm circuit;

a manual testing circuit.

2. The device according to claim 1, wherein said current detecting circuit is a mutual inductor.

3. The device according to claim 1, wherein the circuit for signal amplifying-rectifying and sampling-filtering comprises: an operational amplifier IC1B, capacitors C3, C5, resistors R2, R3, a diode D2, and an rheostat RP1.

4. The device according to claim 1, wherein the circuit for comparing and outputting includes: an operational amplifier IC1A, a resistor R5, diodes D3, D4, when the voltage which comes from said circuit for signal amplifying-rectifying and sampling-filtering reaches reversing high

electrical level, the comparator inverts, the operational amplifier IC1A outputs a high electrical level, said flash alarm circuit and audio alarm circuit are triggered to give an alarm.

5. The device according to claim 1 or 4, wherein said flash alarm circuit comprises: a resistor R6, a resistor R7, a transistor VT1 of NPN type and a luminescent diode LED1.

6. The device according to claim 1-4, wherein said audio alarm circuit is jointly used by the overcurrent alarm circuit and the overheated alarm circuit.

7. The device according to any of claim 1-4, wherein said audio alarm circuit comprises: a police vehicle alarm IC2, resistors R14, R15, diodes D5, D6, a transistor VT3, an inductor L2, and a buzzer BZ1.

8. The device according to claim 6, wherein said police vehicle alarm IC2 is a negative triggering integrated circuit.

9. The device according to claim 7, wherein said police vehicle alarm IC2 is a negative triggering integrated circuit.

10. The device according to claim 7, wherein said diode D5, D6 are isolating diodes, and are coupled to the collector of said transistor VT1 and the collector of said transistor VT2 respectively so as to make the overcurrent alarm and the overheat alarm do not interfere with each other.

11. The device according to any of claim 1-4, wherein said operational amplifiers IC1A, IC1B, IC1C are three units of the integrated circuit IC1; LM324.

12. The device according to claim 1, wherein the manual testing circuit includes: a single-pole triple-throw switch K1, one end of which is coupled with the high electrical level terminal of the thermistor RT1 through a terminal J1; the common terminal of which is coupled with the negative terminal of the power source through a terminal J2; another end of which is coupled with the terminal 2 of the operational amplifier IC1A through a

terminal J3, and a resistor R4 coupled between the terminal 3 of the operational amplifier IC1A and + terminal of the power source to form the testing circuit of the overcurrent alarm circuit and the overheat alarm circuit.

13. The device according to any of claim 1-4, wherein it also includes a circuit capable of stepping down the voltage by capacitors, rectifying, voltage-stabilizing and filtering to provide a power source for said device, said circuit comprising a step-down capacitor C2, a discharging resistor R1, a voltage-stabilizing diode ZD1, a rectifying diode D1 and a filtering capacitor C4, wherein it also includes a fuse disposed between the source terminals, when the receptacle is used in overload but no rectifying action is taken in time and the current had reached the melt point of the fuse, then the fuse would be broken to carry out the protection.

14. The device according to claim 1, wherein it also includes a purification and protection circuit 31 of the network voltage, comprising varistors RV1, RV2, RV3, they are connected in parallel between the source input terminals L, N, E, for protection from surge and lightning strike; the capacitor C1 is connected in parallel between the source input terminals L, N, for restraining high frequency pulse of a certain range.

15. The connector overheat alarm device, characterized by comprising:

a temperature detecting circuit for detecting temperature changes of a connector and outputting in voltage form to a circuit for comparing and outputting ;

a circuit for comparing and outputting, comparing the voltage which comes from the temperature detecting circuit with a predetermined voltage so as to control a flash alarm circuit and an audio alarm circuit ;

a flash alarm circuit;

an audio alarm circuit;

a manual testing circuit.

16. The device according to claim 15, wherein said temperature

detecting circuit comprises a resistor R8, a resistor R9, an rheostat RP2, and a thermistor RT1 for detecting temperature change of the connector and outputting in the form of voltage change to the circuit for comparing and outputting .

17. The device according to claim 16, wherein said circuit for comparing and outputting includes a comparator IC1C, resistors R10, R11 and a capacitor C6 for comparing the voltage which comes from temperature detecting circuit with the predetermined voltage, when temperature is raised to the predetermined value, the output voltage of the temperature detecting circuit reaches the low electrical level that the comparator IC1C inverts, and make the caparator IC1C output high electrical level so that said flash alarm circuit and audio alarm circuit are triggered to give the alarm.

18. The device according to claim 17, wherein said circuit for comparing and outputting also includes the capacitor C6 which is connected in parallel between the terminal 8 and the terminal 9 of the caparator IC1C.

19. The device according to claim 17, wherein the reference terminal 10 of said comparator IC1C is coupled with two terminals of the power source through the resistors R10, R11 respectively, the signal input terminal 9 of said comparator IC1C is coupled with the thermistor through the resistor R9 and the rheostat RP2, the other end of the thermistor is connected to the terminal "N_{out}", the signal input terminal 9 is also coupled with the +terminal of the power source through the resistor R8, the output terminal 8 of said comparator is connected to the transistor VT2 through the resistor R12.

20. The device according to claim 17, wherein said flash alarm circuit comprises a resistor R12, a resistor R13, a transistor VT2 of NPN type and a LED2.

21. The device according to claim 15-17, wherein said audio alarm

circuit is jointly used by the overcurrent alarm circuit and the overheat alarm circuit.

22. The device according to any of claim 15-17, wherein said audio alarm circuit comprises a police vehicle alarm IC2, resistors R14, R15, diodes D5, D6, a transistor VT3, an inductor L2, and a buzzer BZ1.

23. The device according to claim 21, wherein said police vehicle alarm IC2 is an integrated circuit of negative trigger type.

24. The device according to claim 22, wherein said police vehicle alarm IC2 is an integrated circuit of negative trigger type.

25. The device according to claim 22, wherein said diodes D5, D6 are isolating diodes, and coupled with the collector of said transistor VT1 and the collector of said transistor VT2 respectively so that the overcurrent alarm circuit and the overheat alarm circuit do not interfere with each other.

26. The device according to any of claim 15-17, wherein said operational amplifiers IC1A, IC1B, IC1C are three units of the integrated circuit IC1: LM324.

27. The device according to claim 15, wherein the manual testing circuit includes single-pole triple-throw switch K1, one end of which is coupled with the high electrical level terminal of the thermistor RT1 through the terminal J1, the common terminal of which is coupled with the negative terminal of the power source through the terminal J2; another end of which is coupled with the terminal 2 of the operational amplifier IC1A through the terminal J3, and the resistor R4 located between the terminal 3 of the operational amplifier IC1A and +terminal of the source to form the testing circuit of the overcurrent alarm circuit and the overheat alarm circuit,

28. The device according to any of claim 15-17, wherein it is also comprises a circuit for stepping down the voltage by capacitors, rectifying, voltage stabilizing and filtering to provide a source for said device, including the step-down capacitor C2, the discharging resistor R1, the

voltage stabilizing diode ZD1, the rectifying diode D1 and the filtering capacitor C4, wherein said device also comprises a fuse disposed between the source terminals, if the receptacle is used in overload but no rectifying action is taken in time, and the current had reached the melt point of the fuse, the fuse would be broken to carry out the protection.

29. The device according to claim 15, wherein it also includes the purification and protection circuit 31 of the network voltage, comprising the varister RV1, RV2, RV3, they are connected in parallel between the source input terminals L, N, E, for protection from surge and lightning strike; the capacitor C1 is connected in parallel between the source input terminals L, N to restrain high frequency pulse of a certain range.