Bimetals heat and cool in a way which corresponds to the heating and cooling of a motor, i.e. according to the thermal energy associated with a current through the motor. The thermal energy of a current can be defined as I_{RMS}^2t where I_{RMS} is the root mean squared current and t is the duration of current flow. By choosing an electromechanical overload relay having a bimetal which approximates the thermal characteristics of a particular motor, the electromechanical overload relay is able to prevent the motor from becoming overloaded. In practice, this is achieved by selecting an electromechanical overload relay having an FLA value that corresponds to the FLA of the motor.

Electronic overload relays use a current transformer to measure the current flowing through each supply line of a power supply. The measured current is then used to determine whether the continuity of the power supply should be interrupted.

Most electronic overload relays work by charging a capacitor at a rate proportional to the current measured by the current transformer. The charge on the capacitor is then compared to a first threshold. If charge exceeds the first threshold, then a bi-stable relay is tripped in order to interrupt the continuity of the power supply. Once the bi-stable relay is tripped, the capacitor discharges until it drops below a second threshold level at which time the bi-stable relay returns to its original position.

At its most general, embodiments of the present invention provides an overload relay for protecting a motor or other device

from an overload condition, the overload relay having one or more shunt resistors which are locatable in the supply line(s) of a power supply for the motor or other device, and a control means for measuring current in the supply line(s) of the power supply by measuring the voltage across the shunt resistor(s). The power supply may have a single supply line or plural supply lines. The supply line(s) may carry AC or DC current.

Previous electronic overload relays measured current in the supply lines of a power supply using current transformers, not shunt resistors. Previous electromechanical devices did not measure currents using shunt resistors but instead used thermal bi-metals which bend according to the current passing through it. The inventors have found that shunt resistors provide various advantages which are described below.

In a first aspect of the present invention, there is provided an overload relay for protecting a motor or other device from an overload condition, the overload relay having: a plurality of shunt resistors, each shunt resistor being locatable in the current path of a respective supply line of a power supply for the motor or other device; and a control means connected to each of the shunt resistors and arranged to receive signals representative of current through each of the shunt resistors; wherein the control means is arranged to produce a trip signal to interrupt the continuity of the power supply if it determines that an overload condition exists based on one or more of the signals representative of current through the shunt resistors, and wherein the control means includes: a plurality of measuring units,

each measuring unit being connected to a respective one of the shunt resistors and arranged to receive a signal representative of current through the shunt resistor to which it is connected; and a processing means arranged to determine whether an overload condition exists based on one or more of the signals representative of current through the shunt resistors, the processing means including a plurality of processing units, each processing unit being located in a respective measuring unit.~~according to claim 1~~.

The control means may be connected across each of the shunt resistors, so it can receive a signal representative of the voltage across each shunt resistor. Since, according to the equation V=IR, the voltage across the shunt resistor is proportional to the current though the shunt resistor, a signal representative of the voltage across the shunt resistor is also representative of the current through the shunt resistor.

When the overload relay is in use, each shunt resistor is located in the current path of a respective supply line of the power supply and therefore the current through each shunt resistor is the same as the current

using current transformers to measure current. This is because current transformers cannot usually measure currents over a wide range because they tend to saturate at high currents. The possible FLA values of electromechanical overload relays are even more restricted due to the need to use a different bimetal for each FLA value.

With the overload relay according to the first aspect of the present invention, current is measured by shunt resistors which can typically measure currents over a wider range than an equivalent current transformer. Therefore, the overload relay of the present invention may have a wider FLA value range than previous overload relays which include current transformers. An overload relay according to the invention may, for example, have a maximum FLA value which is five or more times, or ten or more times larger than a minimum FLA value. This may allow, for example, a current range of 0.1A to 100A to be covered by three or four different overload relays according to the invention, e.g. using FLA value ranges of 0.1A to 1A, 1A to 10A, 3.7A to 37A and 6.3A to 100A. Typically, seven current transformer-based overload relays or nineteen bi-metal-based overload relays would be needed to cover a range of 0.1A to 100A.

The tripping characteristics of the overload relay may be arranged to correspond to the FLA value and/or trip class of the overload relay in any suitable manner. For example, the tripping characteristics of the overload relay may be arranged to correspond to the FLA value of the overload relay by changing the gain of the amplification means in the measuring units. As another example, the tripping characteristics of the overload

The overload relay may include a power supply unit for supplying power to the overload relay. The power supply unit may be arranged to be powered from one or more supply lines of the power supply which powers the device it is protecting. The power supply unit may be as described in connection with the third aspect of the invention.

In a second aspect of the present invention, there is provided an apparatus having a motor or other device; a power supply having a plurality of supply lines for supplying power to the motor or other device; and an overload relay as described above, each shunt resistor of the overload relay being located in the current path of a respective supply line of the power supply.

In a third aspect of the present invention, there is provided a power supply unit for supplying power to an overload relay, the power supply unit having:

a rectifier for producing a direct current from one or more supply lines of an AC power supply connected to a motor or other device protected by the overload relay; and

at least one transformer for coupling the power supply unit to the overload relay.

Accordingly, the overload relay can be powered from the power supply which powers the device it is protecting, such as a motor. This avoids the use of an external power supply for the overload relay.

The supply lines may have large voltages between them, which could therefore damage the overload relay. The transformer may therefore be useful because it can

The overload relay may include a rectifier, and optionally a regulator, for converting alternating current from the oscillator into direct current for use by the overload relay. The properties of the alternating current supplied to the overload relay can be chosen by selecting an appropriate oscillator, so as to match the requirements of the overload relay (e.g. rather than using alternating current directly from the supply lines of the power supply).

If the overload relay includes a plurality of measuring units, the oscillator may be coupled to each measuring unit by a respective transformer, since this can provide electrical isolation between the measuring. Each measuring unit may include a rectifier, and optionally a regulator, for converting alternating current from the oscillator into direct current for use by the measuring unit.

In a fourth aspect of the present invention there is provided an overload relay for protecting a motor or other device from an overload condition, the overload relay having:

a shunt resistor locatable in the current path of a supply line of a power supply for the motor or other device; and

a control means connected to the shunt resistor and arranged to receive or produce a signal representative of current through the shunt resistor;

wherein the control means is arranged to produce a trip signal to interrupt the continuity of the power supply if it determines that an overload condition exists

based on the signal representative of current through the shunt resistor.

Therefore, there may be provided an overload relay having only one shunt resistor, e.g. for protecting a motor or other device powered by a power supply having a single supply line, e.g. a single phase AC power supply. The overload relay may accordingly have any feature associated with the overload relay described above. In particular, the overload relay may have a measuring unit connected to the shunt resistor and arranged to receive a signal representative of current through the shunt resistor.

Optional and/or preferred features of any one aspect of the present invention may be applied to any one of the other aspects. In addition, any one or more aspects of the present invention may be combined with any other aspect.

Embodiments of our proposals are discussed below, with reference to the accompanying drawings in which:

Fig. 1 is a symbolic diagram of a first overload relay.

Fig. 2 is a schematic diagram of the first overload relay.

Fig. 3 is a schematic diagram of a measuring unit of the first overload relay.

Fig. 4 is a schematic diagram of a power supply unit of the first overload relay.

Fig. 5 is a schematic diagram of a second overload relay.

Fig. 6 is a schematic diagram of a power supply unit of the second overload relay.