US 20130112367A1

(19) **United States**

(12) **Patent Application Publication**

Kooken et al.

(10) **Pub. No.: US 2013/0112367 A1**

(43) **Pub. Date: May 9, 2013**

(54) SYSTEM AND METHOD FOR REAL-TIME ADJUSTMENT AND OPERATION OF COOLING FAN IN WELDING OR CUTTING SYSTEM

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(21) Appl. No.: **13/291,251**

(22) Filed: **Nov. 8, 2011**

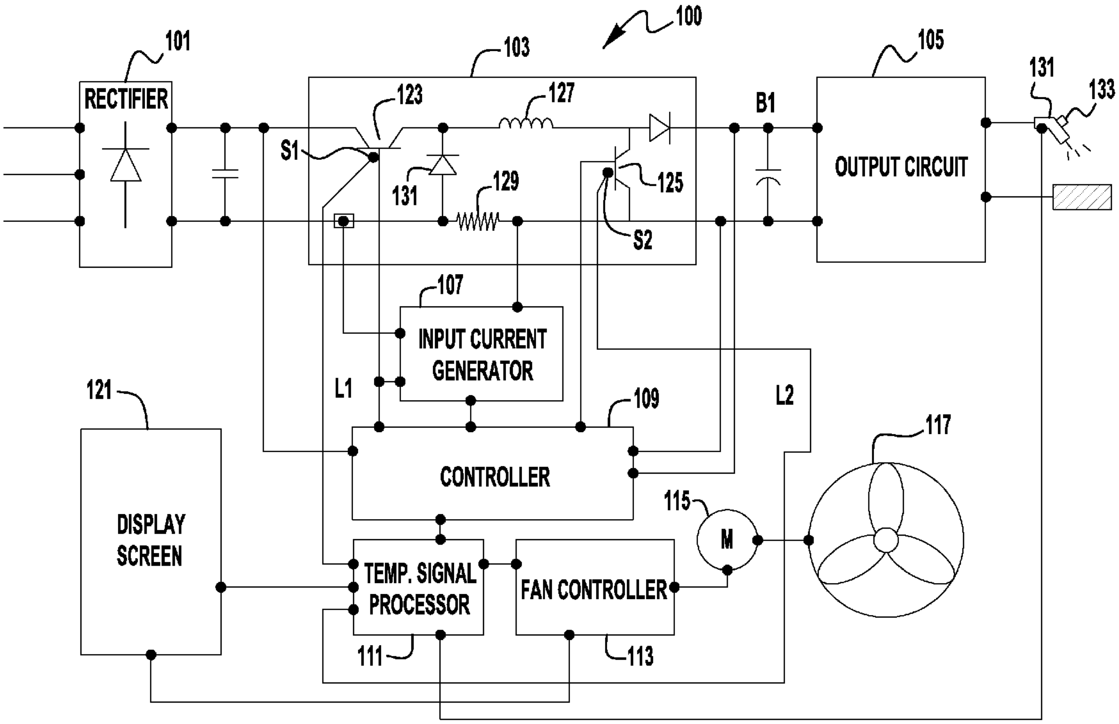
Publication Classification

(51) **Int. Cl.**
F28F 27/00 (2006.01)

(52) **U.S. Cl.**
USPC **165/11.1**

(57) ABSTRACT

A welding or cutting power system having a signal conversion module, which receives an AC input signal and converts the AC input signal to an output signal. The output signal is output to a load. The signal conversion module comprises at least one component which increases in temperature during operation of the signal conversion module, and a cooling fan is used to cool the at least one component of the signal conversion module. A motor is coupled to the fan to operate said cooling fan. The power system also includes a temperature sensor, which senses a temperature of the at least one component and generates a temperature feedback signal. The system further includes a fan controller that controls a rotational speed of the fan based on at least the temperature feedback signal.



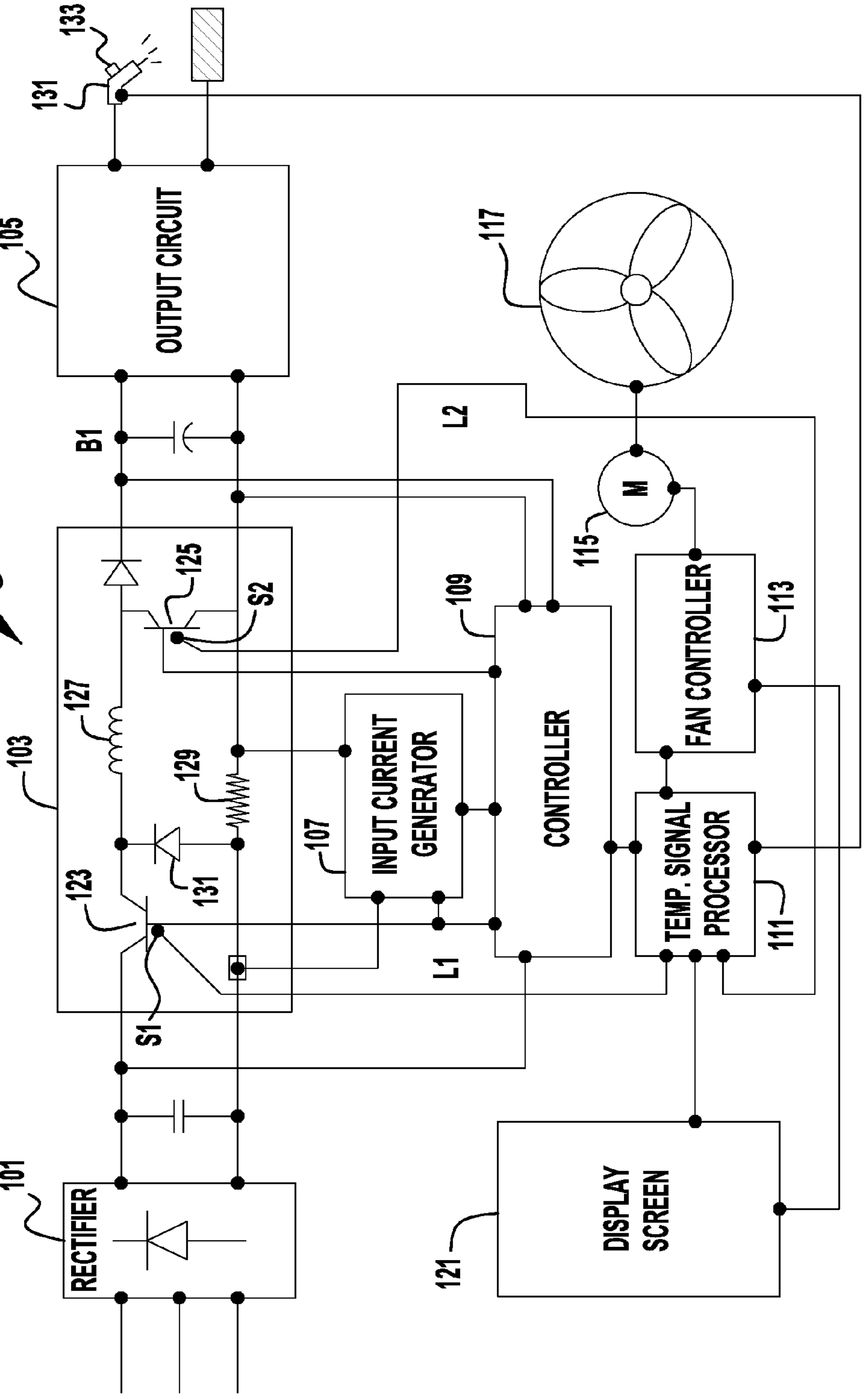

100
101
RECTIFIER
103
123
S1
131
127
129
125
S2
L1
L2
B1
105
OUTPUT CIRCUIT
131
133
107
INPUT CURRENT GENERATOR
109
CONTROLLER
111
TEMP. SIGNAL PROCESSOR
113
FAN CONTROLLER
115
M
117
121
DISPLAY SCREEN

FIG. 1

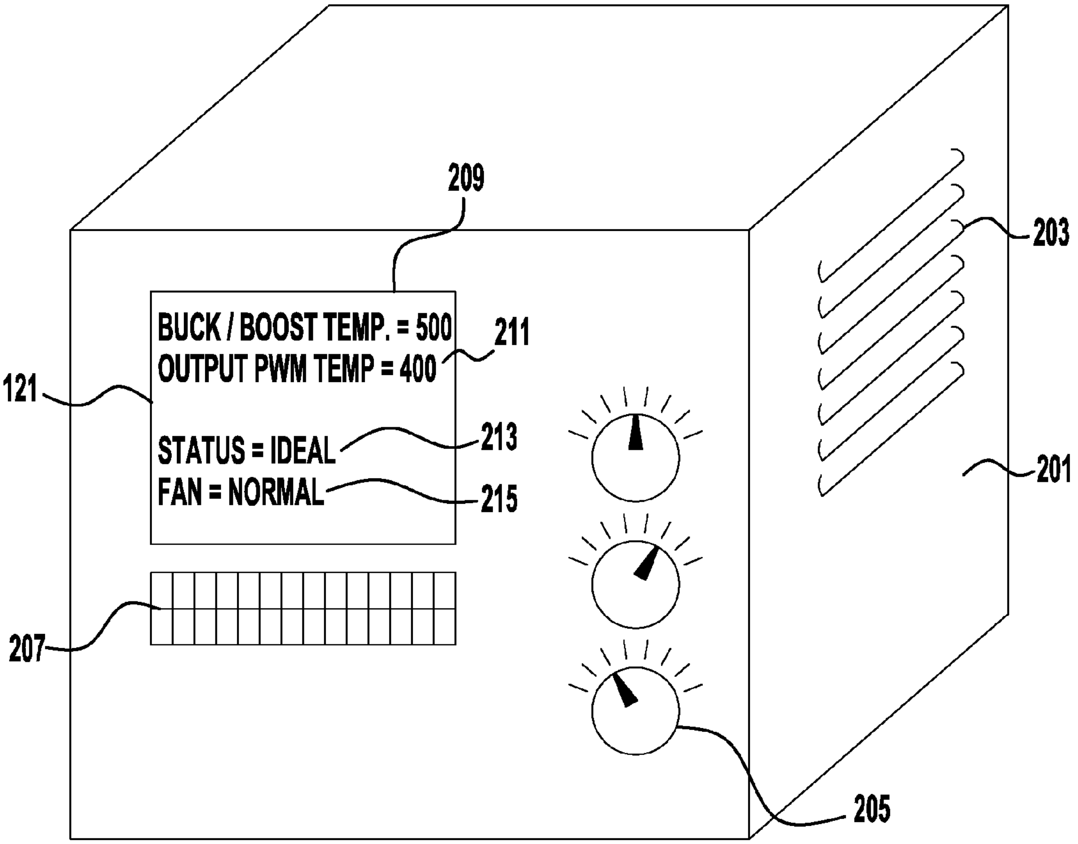

209
BUCK / BOOST TEMP. = 500
OUTPUT PWM TEMP = 400
211
121
STATUS = IDEAL
213
FAN = NORMAL
215
203
201
207
205

FIG. 2

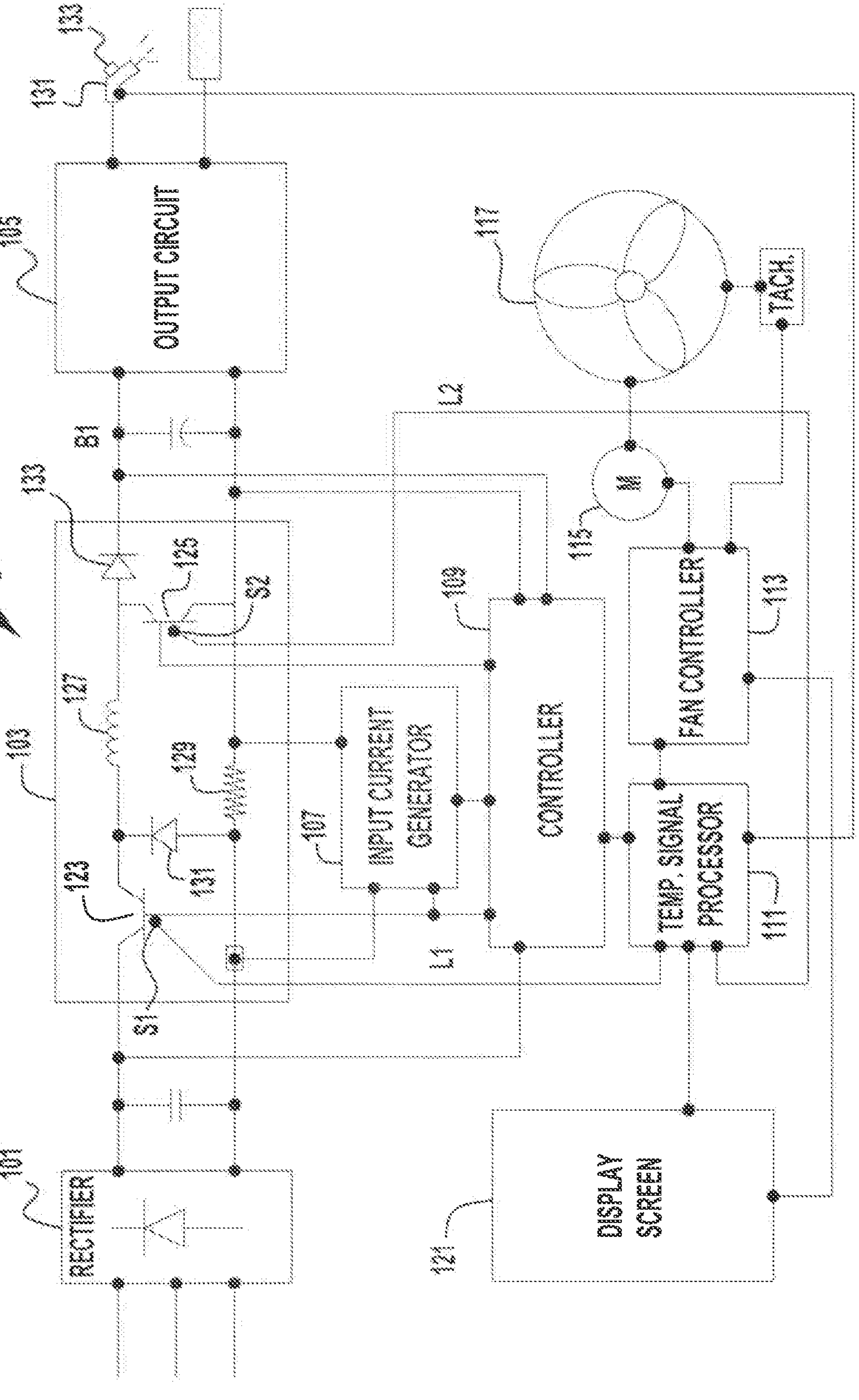

100
101
RECTIFIER
103
105
OUTPUT CIRCUIT
107
INPUT CURRENT GENERATOR
109
CONTROLLER
111
TEMP. SIGNAL PROCESSOR
113
FAN CONTROLLER
115
M
117
TACH.
121
DISPLAY SCREEN
123
125
127
129
131
133
S1
S2
L1
L2
B1

FIG. 3

SYSTEM AND METHOD FOR REAL-TIME ADJUSTMENT AND OPERATION OF COOLING FAN IN WELDING OR CUTTING SYSTEM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] Devices, systems, and methods consistent with the invention relate to welding and cutting, and more specifically related to systems and methods for real-time adjustment and operation of a cooling fan in a welding or cutting system.

[0003] 2. Description of the Related Art

[0004] As welding technology and applications have advanced so have the demands on welding and cutting power supplies. These increased demands require power supplies to provide increased power density and output power capabilities. With these demands come ever increasing demands on the internal components of the power supply. For example, many internal components have a significant temperature rise during operation and thus are required to be cooled. This can be done with a fan, but the use of a fan to cool components has not been optimized.

BRIEF SUMMARY OF THE INVENTION

[0005] An exemplary embodiment of the present invention is a welding or cutting power system having a signal conversion module, which receives an AC input signal and converts the AC input signal to an output signal. The output signal is output to a load. The signal conversion module comprises at least one component which increases in temperature during operation of the signal conversion module, and a cooling fan is used to cool the at least one component of the signal conversion module. A motor is coupled to the fan to operate said cooling fan. There is also a temperature sensor which senses a temperature of the at least one component and generates a temperature feedback signal. A fan controller controls a rotational speed of the fan based on at least the temperature feedback signal. As the temperature of the at least one component incrementally increases the fan controller incrementally increases the rotational speed of the fan and as the temperature of the at least one component incrementally decreases the fan controller incrementally decreases the speed of the fan, such that the rotational speed is directly proportional to the sensed temperature.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The above and/or other aspects of the invention will be more apparent by describing in detail exemplary embodiments of the invention with reference to the accompanying drawings, in which:

[0007] FIG. **1** illustrates a diagrammatical representation of a welding system in accordance with an exemplary embodiment of the present invention;

[0008] FIG. **2** illustrates another diagrammatical representation of an exemplary embodiment of the present invention; and

[0009] FIG. **3** illustrates a diagrammatical representation of another welding system in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0010] Exemplary embodiments of the invention will now be described below by reference to the attached Figures. The described exemplary embodiments are intended to assist the understanding of the invention, and are not intended to limit the scope of the invention in any way. Like reference numerals refer to like elements throughout.

[0011] FIG. **1** depicts an exemplary power supply **100** of the present invention which is capable of welding or cutting. The power supply **100** can have any general topology or structure and the topology shown in FIG. **1** is intended to be exemplary and not limiting as other topologies will also be within spirit or scope of the present invention. In the embodiment show, the system **100** has an inverter-type topology in which an AC input signal is provided to an input rectifier **101** which rectifies the AC signal. The rectified signal is then directed to a regulated circuit **103** which can be any one of a boost circuit, buck circuit or combined buck-boost circuit or an interleaved buck-boost circuit which creates a DC bus having a relatively fixed voltage level. In the embodiment shown the regulated circuit **103** is a buck-boost circuit having both a buck switch **123** and a boost switch **125**. Downstream of the DC bus B**1** is an output circuit **105** which provides an output signal for welding or cutting, as needed. The output circuit **105** can be any type of circuit capable of producing a welding or cutting output, such as a chopper, PWM, etc. In other exemplary embodiments, it is contemplated that another circuit can be in between the regulated circuit **103** and the output circuit **105**, for example an unregulated DC-DC converter can be utilized. Because the operation of such welding or cutting topologies is generally know a detailed discussion of the operation of the welding and cutting system **100** will not be described herein.

[0012] The system **100** also comprises an input current generator **107** which generates an average input current for the controller **109** which controls at least the operation and switching of the switches **123** and **125** of the regulated circuit **103**. The operation and construction of an exemplary controller **109** and the input current generator **107** are discussed in U.S. patent application Ser. Nos. 12/477,511, filed Jun. 3, 2009; and 12/477,550, filed Jun. 3, 2009, the full disclosures of which are incorporated herein by reference in their entirety. As such, their discussion and operation will not be discussed in detail herein.

[0013] The system **100** also contains a cooling fan **117**, a cooling fan motor **115** a fan controller **113**, a temperature signal processor **111** and a display screen **121**. The fan controller **113** is shown in FIG. **1** as a separate controller; however in some exemplary embodiments the fan controller **113** is integral to the controller **109**. In some embodiments, the controller **109** can be constructed in any number of ways and can be implemented in a number of ways without departing from the scope and spirit of the present invention. In an exemplary embodiment of the present invention the controller is a digital controller, and can be, for example, a C2000 series digital signal controller as sold by Texas Instruments. Of course, this example is not intended to be limiting as other types of controllers can be used, so long as they are capable of performing functions similar to those discussed herein.

[0014] In the exemplary embodiment shown, the temperature signal processor **111** has at least two temperature sense leads L**1** and L**2** which are coupled to sensors S**1** and S**2** which sense the temperatures of the IGBT switches **123** and

125, respectively. The sensors S**1** and S**2** can be contact or non-contact type sensors. Of course, if the circuit **103** has more or less of these switches (for example, if the circuit **103** is just a buck or boost stage, or an interleaved buck-boost stage) then there are more or less leads and sensors as needed. The sensors S**1** and S**2** sense the temperature of the switches during the operation of the circuit **103**. The switches **123** and **125** are switched at a very high frequency to maintain a relatively fixed voltage on the DC bus B**1**. Because of this, and because of the current levels passing through these switches, a high amount of heat can be generated in these switches. Furthermore, because of the nature of the operation of the switches **123** and **125**, and the circuit **103**, these switches **123**/**125** can experience the highest amount of heat in the circuit **103**, and perhaps even in the overall system **100**. Further, as these switches heat up their performance can degrade.

[0015] During operation, the sensed heat from the sensors S**1** and S**2** is passed to the temperature signal processor **111** which processes the temperature signal to a format that can be received and utilized by the fan controller **113** (or the controller **109** if the fan control is performed by the controller **109**) to control the speed of the fan. The fan controller **113** uses the temperature signal from the processor **111** to control the speed of the motor **115** (and thus the fan **117**) such that the speed of the fan is directly proportional to the sensed temperature. That is, as the sensed temperature of the switch(s) **123** and/or **125** incrementally increases the fan speed is incrementally increased. This is different than prior systems which either had simply either and "on"/"off" setting or a "low"/"high" setting for the fan **117**, and do not regulate the fan based on any heat sensing.

[0016] Welding and cutting systems **100** of the type described herein are very often used in environments which have a high amount of contaminants in the air. Because of the nature of a fan's operation, a fan will draw these contaminants (along with the air) into the system **100** as it is cooling. Because of this, it is not desirable to have a fan simply operating at a maximum speed just because the system **100** is working. That is, when a system **100** is operating at less than its maximum operational capacity it is not necessary that the fan be drawing excess cooling air (and contaminants) through the welding machine. By unnecessarily drawing in cooling air at maximum speed an unnecessary amount of contaminants can be brought into the system which accelerates the degradation of the system **100**. Furthermore, the excess use of a fan creates excess noise and utilizes power that may not otherwise be needed to be consumed. Thus, embodiments of the present invention regulate the fan speed in such a way that the fan is only used to cool the system components as needed. That is, embodiments of the present invention regulate the fan speed to be directly proportional to heat of the sensed components. In FIG. **1**, the sensed components are the IGBT switches **123** and **125** in the buck-boost circuit **103**. However, in other embodiments of the system **100** other components can be utilized as the temperature drivers of the fan speed.

[0017] Thus, in some embodiments of the present invention the fan speed is controlled in such a way that the fan speed is directly proportional to the sensed temperature such that as the temperature increases (even slightly) the fan speed increases, and conversely as the temperature decreases (even slightly) the fan speed decreases proportionally to maintain a desired cooling of the sensed components. Such embodiments can use an algorithmic control of the fan speed, such that the algorithm is used to control the motor **115** and fan speed **117**. In such an algorithm, each sensed temperature value will result in the creation of a different fan speed value.

[0018] In other exemplary embodiments, the fan speed can be proportional to a predetermined range of sensed temperatures. In such embodiments the anticipated range of operational temperature for the switches **123**/**125** is predetermined and divided into a plurality of equal temperature ranges such that each range will be assigned a different fan speed for operation. For example, if the anticipated operational temperature range of the switches **123**/**125** is 0 to 1,000° F., then the operational range can be divided into 50 equal temperature ranges of 20° F. each, such that each range has a predetermined fan speed setting (there will be 50 different fan speed settings). Thus, during operation as the temperature increases from one range to the next the fan speed will incrementally increase. For example, as the sensed temperature increases above 520° F. the fan speed will increase from the 500 to 520 setting to the 520 to 540 setting. In exemplary embodiments of the present invention, the incremental temperature ranges are in the range of 0 to 100° F. In other exemplary embodiments, the incremental temperature ranges are in the range of 0.001 to 20° F., and while in other embodiments the range is in the range of 0.001 to 5° F. Such control can be implemented using a state table or look-up table control method.

[0019] It should be noted that the above discussion sets forth utilization of the Fahrenheit temperature scale, embodiments of the present invention are not limited in this way as other temperature scales, such as Centigrade, can be utilized.

[0020] In a further exemplary embodiment of the present invention, the above described control of the fan speed occurs after the detected temperature(s) reaches a predetermined threshold value. In such embodiments, it may be desirable to have a constant fan speed when the temperature is below a threshold value (for example, 100° F.) and then when the detected temperature reaches above the threshold the control of the fan speed, using any of the embodiments described above, can be utilized. Typically, the threshold value is predetermined by the system manufacturer. For example, if the threshold temperature is set at 100° F., the fan speed will have a constant value after the system **100** is turned on until the temperature exceeds the threshold value. When the threshold value is exceeded then the fan speed is regulated as described herein.

[0021] In the embodiment shown in FIG. **1**, there are at least two switches **123** and **125** which are sensed. In some embodiments, the highest of the sensed temperatures will be used by the fan controller **113** to determine the fan speed. That is, the temperature signal controller **111** and/or the fan controller **113** will utilize only the highest of the detected temperatures to control the motor **115**. In other exemplary embodiments, the average of the detected of the temperatures can be utilized to control the motor **115**.

[0022] In the embodiment shown in FIG. **1**, only the switches **123** and **125** in the regulated circuit **103** are monitored. However, in other exemplary embodiments, different or alternative switches and other high temperature components can be monitored in any of the other system circuits, such as the output circuit **105** or a DC-DC converter (if present). Typically, the sensed components will be those susceptible to highest temperatures during operation. However, this may not be the case as it may be more important to monitor the temperature of other components that will not achieve the highest temperatures, but their temperature control is important to the operation of the system **100**. The sensed temperatures from these components can also be directed to the signal processor **111** and controller **113** to control the fan speed.

[0023] In other exemplary embodiments, the system **100** utilizes more than one fan **117**, such that each fan is used for cooling its own module **101**, **103** or **105** of the system. In such an embodiment, for example, each of the regulated **103** and output circuits **105** has components which are sensed for their operational temperatures. The sensed temperatures from the regulated circuit **103** are used to control the speed of a first fan **117** directed to the regulated circuit **103** and the sensed temperatures from the output circuit **105** are used to control the speed of a second fan (not shown) directed to the output circuit **105**. The control of the fan speed for each of the respective fans can be similar to that described above.

[0024] In another exemplary embodiment, the system **100** can use multiple fans such that when the temperature is below a threshold only one fan is operating and when the sensed temperature exceeds the threshold at least one additional fan is turned on. For example, it is contemplated that a first fan **117** is operated (as described above) when the sensed temperature is in a first range (e.g., 0 to 450° F.), but when the temperature exceeds the first range (e.g., above 450° F.) a second fan is activated to provide additional cooling.

[0025] Also shown in FIG. **1** is a data connection between the temperature signal processor **111** and the controller **109**. In such embodiments, the detected temperature is sent to the controller **109** so that the controller **109** can also monitor the detected temperature and if the detected temperature exceeds a maximum threshold value the controller **109** can cause the system **100** to be shut off. In such a system, the manufacturer can predetermine a temperature threshold for the switches **123**/**125** (for example) where the system **100** should be shut down when the temperature is exceeded to prevent costly damage to the system **100**.

[0026] In another exemplary embodiment, if the detected temperature(s) of the switches **123**/**125** are low enough (because the system **100** is operating in an extremely cold environment) the fan **117** can be shut off to minimize the intake of debris and contaminants. That is, if the detected temperature is below a minimum threshold the fan can be either slowed to an idle level or shut off.

[0027] FIG. **1** also shows that the temperature signal processor **111** is coupled to a display screen **121**. The display screen **121** can be any type of screen which can visually display information to a user of the system **100**, including but not limited to LCD, LED, etc. FIG. **2**, shows an exemplary embodiment of the system **100** within a housing **201** where the display screen **121** is mounted on a face of the housing **201**. The housing can have louvers **203** to allow for the flow of air to the fan **117** and controls **205**/**207** to control the operation of the system **100**. In FIG. **2**, the display screen **121** is displaying a number of different operational parameters. First the screen **121** is displaying the detected temperature of the regulated circuit **103** at **209**. This allows the user to view the detected temperature of this circuit **103**, or at least the temperature of the IGBTs **123**/**125** in the circuit **103**. Additionally, in embodiments in which the temperature of other circuits (for example the output circuit **105**) is monitored, this temperature is also displayed. As shown in FIG. **2**, the temperature of the output circuit **105** is display at **211**. The display screen **121** can also display a system status based on the operational temperature of at least some of the detected components at **213**. For example, the display screen **121** is capable of displaying a different signal based on the detected temperature. In an exemplary embodiment there can be three different display signals to define the operational status of the system **100** based on temperature. In such embodiments a temperature threshold is defined such that when the detected temperature (or temperatures) is within a first range a first indication is displayed and when the detected temperature is within a second range a second, different, indication is displayed. For example, if the detected temperature is at or below 85% of the maximum operational temperature the display screen **121** will display a first status (for example "IDEAL"), indicating that the temperature is in an acceptable operational range. When the temperature is above this threshold level, the display screen **121** will display a second indication (for example, "WARNING—TEMP."). In another exemplary embodiment, at least three different indications can be utilized. For example, in some embodiments a first indication is displayed when the detected temperature is at or below 85% of a maximum temperature (which can be preset or predetermined by a manufacturer), a second indication is displayed when the detected temperature is above 85% and up to 95% (for example, "CAUTION—TEMP."), and then a third indication (e.g., "WARNING—TEMP.") can be displayed when the detected temperature is above 95% of the maximum or predetermined temperature threshold. Such warning indications can provide a user with real-time feedback regarding the operation of the system **100**.

[0028] In addition to displaying the above warning indications on the display screen **121**, other exemplary embodiments can also send a warning signal to a display indicator on a welding or cutting torch **131**. In many welding or cutting operations the torch **131** will be used at a location remote from the system **100** such that a user will not be able to readily see the display screen **121** during operation. Thus, some embodiments can have a signal device **133** on a torch **131** such that as the temperature exceeds a threshold a warning is provided to the signal device **133**. The signal device **133** can be an LED or other type of light which provides an indication that the operational temperature is reaching a threshold level. For example, the signal device **133** can be a red LED that remains off when the temperature is below a threshold level and as the threshold is exceeded the signal device **133** is activated showing the user that the temperature is getting too high. The signal device **133** can be coupled to the system **100** via any number of different ways, including a wired connection which is shared with the output power of the system **100**. For example, the connection can be coupled to the same lead that provides the welding or cutting power to the torch **131**.

[0029] In a further exemplary embodiment, as shown in FIG. **2**, the display screen can also show a status of the fan **117** and/or fan motor **115**, to display a status of the fan operation. For example, a feedback from the fan controller **113** and/or fan motor **115** can be utilized to test the operation of the fan **117** and fan motor **115** to determine if the operation is within acceptable parameters and if it is not then the display screen **121** can display an indication indicating that the fan operation is not acceptable. In the exemplary embodiment shown in FIG. **3**, a fan tachometer **301** can be utilized to monitor performance of the fan and/or the fan motor. Thus, in such an embodiment if the fan speed is too slow for a specific fan speed control signal it could be an indication that the fan is dirty, some of the fan's bearings are about to fail, or that the motor is not performing optimally. Thus, in this embodiment a tachometer feed back signal is provided (in FIG. **3** it is provided to the fan controller **113**) to monitor the health or performance of the fan and/or the motor. The fan controller **113** and/or controller **109** can utilize the tachometer feedback information to display a maintenance signal on the display screen indicating that the performance of the fan and/or motor is not ideal or that maintenance is required.

[0030] In another exemplary embodiment, the fan controller **113** can have a predetermined fan operational life parameter which is based on an anticipated operational life of the fan **117** and/or motor **115** and as the parameter is approached the display screen **121** can display the appropriate indications. For example, it may be determined that a fan motor **115** and/or fan **117** (for example its bearings) has an operational life of 5,000 hours, such that at or after this operational time the chances of failure become increased. In prior systems, without a warning the fan and/or motor may fail during an operation which can cause harm to the system **100** and or prevent the usage of the system **100** while a replacement is being obtained. In this embodiment, a replacement can be scheduled at a convenient time or at least a replacement can be purchased when an indication is provided in anticipation of a failure. For example, the fan controller **113** and display screen **121** can display a first message when the operational life of the components is below a threshold value (for example, below 90% of the anticipated operational life of the fan and/or motor). In some embodiments, there may be no display on the display screen when the operational life is below such a threshold, indicating that operation is normal. When the operational life of the fan and/or motor is near its anticipated operational life (for example, between 90% and 100% of the determined operational life) then a display is shown which indicates that service may be needed soon. For example, this display can be “SERVICE FAN SOON”. Then, in further embodiments a different display can be shown when the motor and/or fan has exceeded its anticipated operational life. For example, when the fan and/or motor exceed 100% of its determined operational life a different display can be shown such as “WARNING—SERVICE FAN”. This will allow a user to anticipate or schedule maintenance easily, without having to wait for a failure. The service life of the motor and/or fan can be defined in any number of ways including time of operation and/or RPMs. Thus, the fan controller **113** can monitor the RPM’s and/or the overall time of operation of either or both of the motor **115** and/or fan **117** and keep track of the total as it is accumulated during operation. Once the actual operation of these components reaches the set threshold points then the service indications are provided to the display screen. Monitoring RPM’s can be done utilizing the tachometer **301** as shown in FIG. **3**.

[0031] Although not shown in FIG. **1**, the system **100** can also have a data storage device which retains at least the detected temperature and/or maintenance information during the use and operation of the system **100**. This will allow the user to access the stored data (e.g., via the controls **207**) so that the user can display historic temperature information on the display screen **121** related to a specific welding operation or over an operational time period.

[0032] While the invention has been particularly shown and described with reference to exemplary embodiments thereof, the invention is not limited to these embodiments. It will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the following claims.

1. A welding or cutting power system, comprising:

a signal conversion module which receives an AC input signal and converts said AC input signal to a welding or a cutting output signal and outputs said output signal to a load, where said signal conversion module comprises a component which increases in temperature during operation of said signal conversion module;

a cooling fan used to cool said component of said signal conversion module,

a motor coupled to said fan to operate said cooling fan,

a temperature sensor which senses a temperature of said component and generates a temperature feedback signal corresponding to the sensed temperature, and

a fan controller which controls a rotational speed of said fan based on at least said temperature feedback signal,

wherein as said sensed temperature of said at least one component incrementally changes, said fan controller incrementally and directly changes said rotational speed.

2. The system of claim **1**, wherein said signal conversion module comprises a DC bus voltage circuit which creates a fixed voltage DC bus, and said component is a switch internal to said DC bus voltage circuit.

3. The system of claim **1**, wherein said signal conversion module comprises a buck-boost circuit comprising at least a buck switch and a boost switch and said component comprises one of said buck switch and said boost switch.

4. The system of claim **1**, wherein said temperature feedback signal is also directed to a controller which controls an operation of said signal conversion module such that if said sensed temperature exceeds a threshold value the operation of said signal conversion module is turned off.

5. The system of claim **1**, wherein said fan controller utilizes a plurality of temperature ranges to control said rotational speed such that each of said plurality of temperature ranges is associated with a different rotational speed setting, and

wherein as said sensed temperature of said at least one component changes from falling within a first temperature range to falling within a second temperature range of said plurality of temperature ranges, said fan controller incrementally changes said rotational speed from a rotational speed setting corresponding to said first temperature range to a rotational speed setting corresponding to said second temperature range.

6. The system of claim **5**, wherein each temperature range in said plurality of temperature ranges has an incremental temperature range of 0 to 100° F.

7. The system of claim **1**, wherein said fan controller emits a different rotational speed control signal based on each detected difference in said sensed temperature.

8. The system of claim **3**, further comprising;

a second temperature sensor that senses a second temperature of a second component and generates a second temperature feedback signal which is provided to said fan controller,

wherein said fan controller controls said rotational speed of said fan based on at least one of said temperature feedback signal and said second temperature feedback signal, and wherein said component is said buck switch and said second component is said boost switch.

9. The system of claim **8**, wherein said fan controller controls said rotational speed based on a higher temperature of said sensed temperature and said second sensed temperature.

10. The system of claim **1**, further comprising a display screen to display at least one of said sensed temperature of said component, a status of said signal conversion module and a status of said fan.

11. The system of claim **10**, wherein said display screen displays said status of said signal conversion module such that when said sensed temperature is at or below a threshold temperature level, a first status indication is displayed and when said sensed temperature is above said threshold level, a second status indication is displayed.

12. The system of claim **10**, wherein said display screen displays a maintenance status of said fan.

13. The system of claim **12**, wherein said displayed maintenance status is based on at least one of a predetermined maintenance schedule and fan speed feedback signal.

14. The system of claim **10**, wherein said display screen displays a status indication of said signal conversion module based on at least said sensed temperature, and displays a first status indication when said sensed temperature is an a first range, a second status indication when said sensed temperature is in a second range and a third status indication when said sensed temperature is in a third range.

15. The system of claim **12**, wherein a first maintenance status indicator is displayed when the operation of said fan is within a first operational range and a second maintenance status indicator is displayed when the operation of said fan is within a second operational range.

16. The system of claim **12**, further comprising a tachometer coupled to said fan to detect a fan performance, and wherein said displayed maintenance status is based on at least a tachometer feedback signal from said tachometer.

17. A method of cooling a welding or cutting power supply, comprising:

providing an AC input signal to a signal conversion module which receives said and converts said AC input signal to a welding or a cutting output signal, where said signal conversion module comprises a component which increases in temperature during operation of said signal conversion module,

outputting said output signal to a load,

cooling said at least one component of said signal conversion module using a cooling fan,

sensing a temperature of said at least one component,

generating a temperature feedback signal, and

controlling a rotational speed of said fan based on at least said temperature feedback signal,

wherein as said sensed temperature of said at least one component incrementally changes, said rotational speed of said fan is incrementally and directly changed.

18. The method of claim **17**, wherein said signal conversion module comprises a buck-boost circuit comprising at least a buck switch and a boost switch and said component comprises one of said buck switch and said boost switch.

19. The method of claim **17**, wherein said rotational speed is controlled such that a different rotational speed is provided for each different sensed temperature.

20. The method of claim **17**, further comprising displaying at least one of the sensed temperature, a status of said signal conversion module and a status of said cooling fan on a display screen.

21. The system of claim **6**, wherein said incremental temperature range is 0.001 to 20° F.

22. The system of claim **6**, wherein said incremental temperature range is 0.001 to 5° F.

23. The method of claim **17**, wherein said rotational speed of said fan is controlled based on a plurality of temperature ranges such that each of said plurality of temperature ranges is associated with a different rotational speed setting, and

wherein as said sensed temperature of said at least one component changes from falling within a first temperature range to falling within a second temperature range of said plurality of temperature ranges said rotational speed is incrementally changed from a rotational speed setting corresponding to said first temperature range to a rotational speed setting corresponding to said second temperature range.

24. The method of claim **23**, wherein each temperature range in said plurality of temperature ranges has an incremental temperature range of 0 to 100° F.

25. The method of claim **24**, wherein said incremental temperature range is 0.001 to 20° F.

26. The method of claim **24**, wherein said incremental temperature range is 0.001 to 5° F.

27. The system of claim **1**, further comprising:

a second cooling fan used to cool said component of said signal conversion module,

wherein said fan controller controls a rotational speed of said second cooling fan based on at least said temperature feedback signal when said sensed temperature exceeds a threshold temperature.

28. The method of claim **17**, wherein said cooling of said at least one component of said signal conversion module comprises using a second cooling fan, and

said method further comprises controlling a rotational speed of said second fan based on at least said temperature feedback signal when said sensed temperature exceeds a threshold temperature.

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