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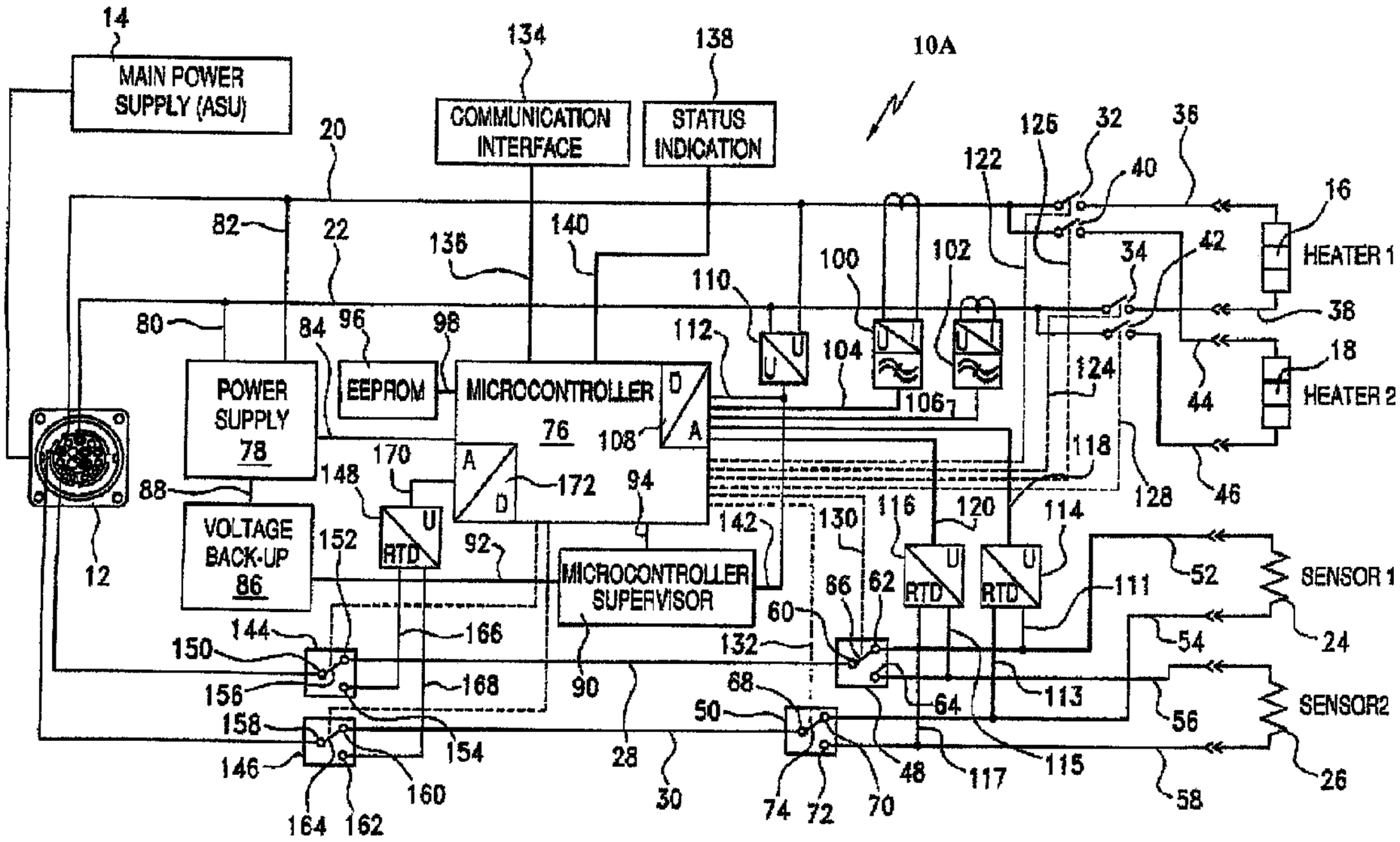
(54) Titre : CIRCUIT DE COMMANDE REDONDANT DESTINE A UN ENSEMBLE TUYAU POUR ADHESIF THERMOFUSIBLE AVEC CIRCUITS DE CHAUFFAGE ET CAPTEURS DE TEMPERATURE

(54) Title: REDUNDANT CONTROL CIRCUIT FOR HOT MELT ADHESIVE HOSE ASSEMBLY HEATER CIRCUITS AND TEMPERATURE SENSORS



(57) Abrégé/Abstract:
A hot melt adhesive hose assembly has a redundant control circuit fixedly mounted thereon which comprises a pair of heater circuits and a pair of temperature sensors. Should a failure occur within the first one of the heater circuits, or within a first one of the temperature sensors, electrical switch mechanisms are activated so as to effectively remove the first, failed heater circuit or the first failed temperature sensor from the hot melt adhesive hose assembly electrical circuitry, and substantially simultaneously therewith, electrically connect the second one of the heater circuits or the second one of the temperature sensors to the hot melt adhesive hose assembly electrical circuitry. The hot melt adhesive hose assembly, with its redundant control circuit comprising the pair of heater circuits and the pair of temperature sensors, thus comprises a self -contained, stand-alone, independent operative component that can be utilized in conjunction with any hot melt adhesive supply unit (ASU).

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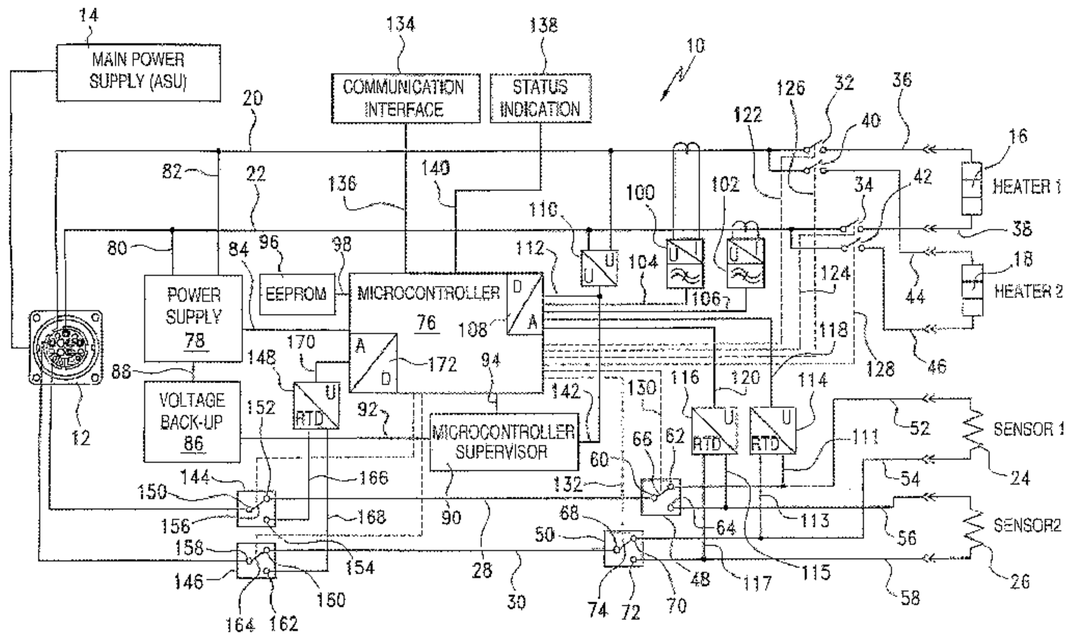
(54) Title: REDUNDANT CONTROL CIRCUIT FOR HOT MELT ADHESIVE HOSE ASSEMBLY HEATER CIRCUITS AND TEMPERATURE SENSORS



(57) Abstract: A hot melt adhesive hose assembly has a redundant control circuit fixedly mounted thereon which comprises a pair of heater circuits and a pair of temperature sensors. Should a failure occur within the first one of the heater circuits, or within a first one of the temperature sensors, electrical switch mechanisms are activated so as to effectively remove the first, failed heater circuit or the first failed temperature sensor from the hot melt adhesive hose assembly electrical circuitry, and substantially simultaneously therewith, electrically connect the second one of the heater circuits or the second one of the temperature sensors to the hot melt adhesive hose assembly electrical circuitry. The hot melt adhesive hose assembly, with its redundant control circuit comprising the pair of heater circuits and the pair of temperature sensors, thus comprises a self -contained, stand-alone, independent operative component that can be utilized in conjunction with any hot melt adhesive supply unit (ASU).

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REDUNDANT CONTROL CIRCUIT FOR HOT MELT ADHESIVE HOSE ASSEMBLY HEATER CIRCUITS AND TEMPERATURE SENSORS

FIELD OF THE INVENTION

The present invention relates generally to hot melt

adhesive dispensing systems, and more particularly to a new and improved redundant control circuit, for use in connection with a hot melt adhesive hose assembly, which effectively has redundant components inherently incorporated therein, such as, for example, redundant hot melt adhesive heater circuits, and redundant hot melt adhesive temperature sensors, as well as suitable switching mechanisms, whereby the hot melt adhesive hose assembly, including the heater circuits, the temperature sensors, and the switching mechanisms, effectively comprises a stand-alone, self-contained, or independent operative component that can be utilized in conjunction with any adhesive supply unit (ASU) and its temperature controller. Accordingly, should a failure occur within one of the hot melt adhesive heater circuits, or within one of the hot melt adhesive temperature sensors, the switching mechanisms may be suitably actuated so as to effectively withdraw the failed hot melt adhesive heater circuit, or the failed hot melt adhesive temperature sensor, from its operative or functional disposition within the electrical circuitry, and to substantially simultaneously therewith insert the backup or redundant hot melt adhesive heater circuit, or the backup or redundant hot melt adhesive temperature sensor, into the control circuitry whereby the hot melt adhesive hose assembly does not need to be replaced immediately but can be subsequently replaced in accordance with, for example, normal scheduled maintenance procedures, the hot melt adhesive dispensing production line does not need to be shut down for repairs whereby extensive downtime to replace the failed hot melt adhesive hose assembly is effectively able to be avoided, and the hot melt adhesive dispensing production line can continue to operate without any production downtime.

BACKGROUND OF THE INVENTION

In connection with hot melt adhesive dispensing systems, failures can generally occur within two different categories, that is, mechanical failures due to wear, or electrical failures due to electrical malfunctions. More particularly, in connection with the different types of electrical failures that can be experienced, electrical failures can occur, such as, for example, either within the heater circuit which is used to maintain the hot melt adhesive material, that is flowing through the hot melt adhesive hose assembly, at a predetermined temperature level, or within the temperature sensor which is operatively or thermally associated with the hot melt adhesive hose assembly in order to effectively detect the temperature level of the hot melt adhesive material, which is flowing through the hot melt adhesive hose assembly, and which effectively controls the heater circuit, through means of the adhesive supply unit (ASU) and its temperature controller, so as to ensure that the desired temperature level of the hot melt adhesive material, which is flowing through the hot melt adhesive hose assembly, is in fact maintained. Maintenance of the proper or desired temperature level of the hot melt adhesive material, which is flowing through the hot melt adhesive hose assembly, is therefore of course critical in order to ensure that the hot melt adhesive material will have the proper viscosity characteristics so as to be properly dispensed and therefore provide the desired adhesive properties once the hot melt adhesive material is in fact deposited onto a particular substrate. In either case, that is, whether a failure is experienced in connection with the heater circuit, or in connection with the temperature

sensor, such failures typically cause the hot melt adhesive dispensing production line to be shut down for extended periods of time, in order to implement the repair or replacement of the failed components, whereby valuable production time is lost.

A hot melt adhesive dispensing apparatus employing redundant temperature sensing devices is disclosed within United States Patent Application Publication **2005/0092736** which was published on May 5, 2005 in the name of **Raterman et al.** More particularly, as can be appreciated from **FIGURE 1**, which substantially corresponds to **FIGURE 1** of the aforenoted patent publication, the adhesive dispensing apparatus of **Raterman et al.** is generally indicated by the reference character 10 and is seen to comprise an adhesive dispensing gun 20 for depositing adhesive material 22 onto a substrate 24. The adhesive dispensing gun 20 is mounted upon a manifold 18, and a supply tank or adhesive supply unit (ASU) 16, containing a supply of the adhesive material 22, is fluidically connected to the manifold 18 by means of a hose assembly 12 and a pump 14, with an inlet end 42 of the hose assembly 12 being fixedly connected to the pump 14 while an outlet end 44 of the hose assembly 12 is fixedly connected to the manifold 18. The hose assembly 12 is also provided with a wire harness 28 which is connected to a controller 32, through means of an electrical connector 80, which is mounted upon the supply tank or adhesive supply unit (ASU) 16, and the supply tank or adhesive supply unit (ASU) 16 also includes a heater 26 which is selectively controlled so as to maintain the adhesive material 22, disposed within the supply tank or adhesive supply unit (ASU) 16, within a predetermined temperature range.

The hose assembly 12 further comprises a heating element and a pair of temperature sensing devices, not illustrated within **FIGURE 1** but fully disclosed within the aforenoted patent publication to **Raterman et al.**, wherein the pair of temperature sensing devices sense the temperature of the adhesive material flowing through the hose assembly 12, and wherein further, the pair of temperature sensing devices are alternatively electrically connected to the controller 32 so as to in fact monitor the temperature of the adhesive material 22 flowing through the hose assembly 12. The controller 32 monitors the temperature from one or both of the two temperature sensing devices and controls the operation of the heating element, based upon the readings from the particular one or both of the two temperature sensing devices so as to maintain the hot melt adhesive material at a desired temperature level. If one of the two temperature sensing devices is found to be malfunctioning or failing, then that particular one of the two temperature sensing devices is deactivated and the other one of the two temperature sensing devices is activated or remains active so as to function within the heater control system. The switch-over between the two temperature sensing devices may be either accomplished manually, such as, for example, by hard wiring the temperature sensing devices to the controller input, or automatically through means of a suitable relay or other control operation or circuit incorporated within the controller 32.

While the hot melt adhesive dispensing apparatus employing the redundant temperature sensing devices, as disclosed within the aforenoted patent application publication to **Raterman et al.**, is operationally satisfactory, several

operational drawbacks of the apparatus are also apparent from the disclosure. For example, it is initially noted that while redundant temperature sensing devices are disclosed, there is no disclosure of redundant heating elements. This is critically important in that, as has been noted hereinbefore, electrical failures can occur within the heater circuit which is used to maintain the hot melt adhesive material, that is flowing through the hot melt adhesive hose assembly, at a predetermined temperature level, as well as within the temperature sensor which detects the temperature level of the hot melt adhesive material that is flowing through the hot melt adhesive hose assembly. Furthermore, and just as importantly, if not more importantly, as has also been noted hereinbefore, the redundant temperature sensing devices of the **Raterman et al.** apparatus or system are intimately connected to the temperature controller 32 that forms an integral part of the adhesive supply unit (ASU) 16. Accordingly, the hose assembly 12 is intimately dependent upon, and can only be used in conjunction with, the particular temperature controller 32 and the particular adhesive supply unit (ASU) 16. Viewed from a slightly different perspective or point of view, the hose assembly 12 of **Raterman et al.** does not comprise a stand-alone, self-contained, or independent operative component that can readily be used in conjunction with any adhesive supply unit (ASU), or viewed in a still similar manner, the hose assembly 12 of **Raterman et al.** cannot be disconnected from a particular adhesive supply unit (ASU) and readily operatively connected to another adhesive supply unit (ASU).

A need therefore exists in the art for a new and improved redundant control circuit, for use in conjunction

with a hot melt adhesive hose assembly, wherein redundant electrical components could effectively be incorporated such that if a failure occurs within a particular electrical component, the failed electrical component could effectively be removed from its operative or functional disposition within the electrical circuitry, and the other electrical component could effectively be operatively or functionally incorporated into the electrical circuitry. In this manner, the hot melt adhesive dispensing production line would not need to be shut down for extended periods of time, in order to implement the replacement of the failed hot melt adhesive hose assembly, whereby valuable production time would not be lost. In addition, a need exists in the art for a new and improved redundant control circuit, for use in conjunction with hot melt adhesive hose assembly, wherein the hot melt adhesive hose assembly, having the heater circuits, the temperature sensors, and the switching mechanisms incorporated therein, effectively comprises a stand-alone, self-contained, or independent operative component which can be utilized in conjunction with any adhesive supply unit (ASU) and its temperature controller.

SUMMARY OF THE INVENTION

The foregoing and other objectives are achieved in accordance with the teachings and principles of the present invention through the provision of a new and improved redundant control circuit which comprises a pair of heater circuits which are adapted to be wrapped around the external

peripheral surface of a hot melt adhesive hose assembly core, a pair of temperature sensors which are also adapted to be disposed in contact with the external peripheral surface of the hose core, and a plurality of switching mechanisms which are also an integral component part of the redundant control circuit and the hot melt adhesive hose assembly. Accordingly, the new and improved hot melt adhesive hose assembly, including the heater circuits, the temperature sensors, and the plurality of switching mechanisms, effectively comprises a self-contained, stand-alone, or independent operative component that can be utilized in conjunction with any adhesive supply unit (ASU) and its temperature controller. A first one of the heater circuits would initially be electrically connected to the hot melt adhesive hose assembly electrical circuitry, and in a similar manner, a first one of the temperature sensors would likewise be electrically connected to the hot melt adhesive hose assembly electrical circuitry.

Subsequently, should a failure occur within the first one of the heater circuits, then one or more of the electrical switching mechanisms would be activated so as to effectively remove the first, failed heater circuit from the hot melt adhesive hose assembly electrical circuitry, and substantially simultaneously therewith, electrically connect the second one of the heater circuits into the hot melt adhesive hose assembly electrical circuitry. Similar switching procedures would also be implemented in connection with the pair of temperature sensors should a failure occur within a first one of the temperature sensors initially incorporated within the hot melt adhesive hose assembly electrical circuitry. In this manner, the hot melt adhesive hose assembly

does not need to be replaced immediately but can be subsequently replaced in accordance with, for example, normal scheduled maintenance procedures, the hot melt adhesive dispensing production line does not need to be shut down for repairs whereby extensive downtime to replace the failed hot melt adhesive hose assembly is effectively able to be avoided, and the hot melt adhesive dispensing production line can continue to operate without any production downtime.

The invention in one embodiment pertains to a hot melt adhesive hose assembly having a redundant control circuit fixedly connected thereto, comprising a power source which is operatively associated with a hot melt adhesive supply unit (ASU), an electrical connector mounted upon one end of a hot melt adhesive hose assembly for electrical connection to the power source operatively associated with the adhesive supply unit (ASU), and a pair of heater assemblies, wherein each one of the pair of heater assemblies is adapted to be operatively associated with the hot melt adhesive hose assembly so as to heat the hot melt adhesive material, fluidically conducted internally within the hot melt adhesive hose assembly, to a predetermined temperature level. Switching means provide for selectively electrically connecting each one of the pair of heater assemblies to the power source by a pair of power lines, and means are provided for monitoring the functionality of each one of the pair of heater assemblies. Means control the switching means so as to initially electrically connect a first one of the heater assemblies to the power source and to electrically connect a second one of the heater assemblies to the power source while disconnecting the first one of the heater assemblies from the power source if the first one of the heater assemblies is determined to be defective by the monitoring means. The electrical connector, the pair of heater assemblies, the switching means, the means for monitoring the functionality of each one of the pair of heater assemblies, and the means for controlling the switching means are fixedly connected to the hot melt adhesive hose assembly such that the hot melt adhesive hose assembly, including the electrical connector, the pair of heater assemblies, the switching means, the means for

monitoring the functionality of each one of the pair of heater assemblies, and the means for controlling the switching means, effectively comprises a self-contained, stand-alone, independent operative component that can be utilized in conjunction with any adhesive supply unit (ASU).

The invention further comprehends a method of controlling electrical components of a hot melt adhesive hose assembly by means of a redundant control circuit, comprising the steps of providing a power source, mounting an electrical connector upon one end portion of the hot melt adhesive hose assembly for electrically connecting the hot melt adhesive hose assembly to the power source, operatively mounting a pair of heater assemblies upon the hot melt adhesive hose assembly so as to heat the hot melt adhesive material, fluidically conducted internally within the hot melt adhesive hose assembly, to a predetermined temperature level, operatively mounting switching means upon the hot melt adhesive hose assembly for selectively electrically connecting each one of the pair of heater assemblies to the power source by means of power lines which are electrically connected to the power source through means of the electrical connector, and operatively mounting a temperature sensor upon the hot melt adhesive hose assembly so as to sense the temperature level of the hot melt adhesive material, being fluidically conducted internally within the hot melt adhesive hose assembly, whereby the pair of heater assemblies can be energized in accordance with the temperature levels sensed by the temperature sensor so as to maintain the temperature level of the hot melt adhesive material, being conducted internally within the hot melt adhesive hose assembly, at the predetermined temperature level. Monitoring means are used to monitor the functionality of each one of the pair of heater assemblies, and the method further includes controlling the first switching means so as to initially electrically connect a first one of the heater assemblies to the power source, to electrically connect a second one of the heater assemblies to the power source while disconnecting the first one of the heater assemblies from the power source if the first one of the heater assemblies is

determined to be defective by the monitoring means, whereby operation of the hot melt adhesive hose assembly does not have to be shut down if one of the pair of heater assemblies is defective.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other features and attendant advantages of the present invention will be more fully appreciated from the following detailed description when considered in connection with the accompanying drawing wherein:

FIGURE 1 is a perspective view of a conventional, **PRIOR ART** hot melt adhesive dispensing system wherein redundant temperature sensing devices are operatively associated with the hot melt adhesive hose assembly; and

FIGURE 2 comprises an electronic circuit diagram schematically illustrating the new and improved redundant control circuit, operatively associated with a hot melt adhesive hose assembly, and developed in accordance with the principles and teachings of the present invention, and showing the cooperative parts thereof, wherein a pair of redundant heater circuits and a pair of redundant temperature sensors, along with a first pair of switching mechanisms opera-

tively connected to the pair of redundant heater circuits, and a second pair of switching mechanisms operatively connected to the pair of redundant temperature sensors, are operatively incorporated within the new and improved electronic control circuit such that should a failure occur within a first one of the pair of redundant heater circuits, then the first pair of switching mechanisms will be activated so as to effectively remove the first, failed heater circuit from the hot melt adhesive hose assembly electrical circuitry, and substantially simultaneously therewith, electrically connect the second one of the pair of redundant heater circuits to the hot melt adhesive hose assembly electrical circuitry, while in a similar manner, should a failure occur within a first one of the pair of redundant temperature sensors, then the second pair of switching mechanisms will be activated so as to effectively remove the first, failed temperature sensor from the hot melt adhesive hose assembly electrical circuitry, and substantially simultaneously therewith, electrically connect the second one of the pair of redundant temperature sensors to the hot melt adhesive hose assembly electrical circuitry, whereby immediate replacement of the failed heater circuit or failed temperature sensor is no longer necessary and can be delayed until the implementation of normally scheduled maintenance procedures.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and more particularly to **FIGURE 2** thereof, the new and improved redundant con-

trol circuit, which has been developed in accordance with the principles and teachings of the present invention and which shows the cooperative parts thereof, and which is adapted to be operatively associated with a hot melt adhesive hose assembly, such as, for example, that disclosed within the copending Canadian Application File No. 2,597,222 entitled **HOT MELT ADHESIVE HOSE ASSEMBLY HAVING REDUNDANT COMPONENTS,** filed on May 3, 2006, and which has been laid upon on November 16, 2006 is disclosed and is generally indicated by the reference character 10. As is well known in the hot melt adhesive material dispensing art, hot melt adhesive material is normally supplied to a hot melt adhesive supply unit (ASU), also not shown, in a heated state, and a heater circuit or heater assembly is conventionally operatively associated with the hot melt adhesive hose assembly in order to maintain the hot melt adhesive material at a predetermined temperature level, while the same is being conducted through the hot melt adhesive hose assembly, such that the hot melt adhesive material will have or exhibit the proper viscosity properties when the hot melt adhesive material is dispensed from the applicator end of the hot melt adhesive hose assembly.

In addition, a temperature sensor is likewise conventionally operatively associated with the hot melt adhesive hose assembly so as to effectively detect or sense the temperature level of the hot melt adhesive material being conducted through the hot melt adhesive hose assembly, whereby such detected or sensed temperature level is effectively or appropriately used to control, through means of a suitable

temperature controller, the energization of the heater circuit or heater assembly so as to again ensure the fact that the hot melt adhesive material is being heated to, and maintained at, the proper temperature level while the same is being conducted through the hot melt adhesive hose assembly such that the hot melt adhesive material will have or exhibit the proper viscosity properties when the hot melt adhesive material is dispensed from the applicator end of the hot melt adhesive hose assembly. As has been noted hereinbefore, electrical failures can occur within hot melt adhesive material dispensing systems either within, for example, the heater circuit or heater assembly which is used to maintain the hot melt adhesive material, which is flowing through the hot melt adhesive hose assembly, at a predetermined temperature level, or within the temperature sensor which is operatively or thermally associated with the hot melt adhesive hose assembly in order to effectively detect the temperature level of the hot melt adhesive material, which is flowing through the hot melt adhesive hose assembly, and to effectively control, through means of a suitable temperature controller, the energization of the heater circuit or heater assembly so as to effectively ensure that the desired temperature level of the hot melt adhesive material, which is flowing through the hot melt adhesive hose assembly, is in fact maintained.

Maintenance of the proper or desired temperature level of the hot melt adhesive material is of course critical in order to ensure that the hot melt adhesive material will be properly dispensed, and will provide the desired adhesive properties, once the hot melt adhesive material is in fact deposited onto a particular substrate. In either case, that

is, whether a failure is experienced in connection with the heater circuit or heater assembly, or in connection with the temperature sensor, such failures typically cause the hot melt adhesive dispensing production line to be shut down for extended periods of time, in order to implement the replacement of the hot melt adhesive hose assembly, whereby valuable production time is lost. It has therefore been determined that it would be desirable to effectively incorporate redundant heater circuits or heater assemblies, as well as redundant temperature sensors, into the hot melt adhesive hose assembly, and to provide a new and improved redundant control circuit for effectively controlling the activation or energization of the redundant heater circuits or heater assemblies, as well as the redundant temperature sensors, such that if a failure occurs within a particular one of the heater circuits or heater assemblies, or within a particular one of the temperature sensors, the failed heater circuit or heater assembly, or the failed temperature sensor, could readily and immediately be effectively removed from its operative or functional disposition within the electrical circuitry, and the other corresponding heater circuit or heater assembly, or temperature sensor, could readily and immediately be operatively or functionally incorporated into the electrical circuitry. In this manner, the hot melt adhesive dispensing production line would not need to be shut down for extended periods of time, in order to implement the replacement of the failed hot melt adhesive hose assembly, whereby valuable production time would not be lost.

More particularly, then, it is seen that the new and improved redundant control circuit 10A, for achieving the

aforenoted desirable results, comprises an electrical connector 12 which is part of a hot melt adhesive hose assembly and which is adapted to receive electrical power from a suitable main power supply 14 which is operatively associated with an adhesive supply unit (ASU), not shown, a pair of heater circuits or heater assemblies 16,18 which are electrically connected to the electrical connector 12 by means of a first pair of primary power lines 20,22, and a pair of temperature sensors 24,26 which are electrically connected to the electrical connector 12 by means of a second pair of primary power lines 28,30. It is noted that while each one of the temperature sensors 24,26 may comprise, and has been designated in **FIGURE 2** as a resistance temperature detector (RTD), each temperature sensor 24,26 may alternatively comprise a thermistor, or a thermocouple. It is further seen that the opposite ends of the first heater circuit or heater assembly 16 are electrically connected to the first pair of primary power lines 20,22 by means of a first pair of switch mechanisms 32,34 and a first pair of auxiliary connection lines 36,38, while the opposite ends of the second heater circuit or heater assembly 18 are electrically connected to the first pair of primary power lines 20,22 by means of a second pair of switch mechanisms 40,42 and a second pair of auxiliary connection lines 44,46.

Accordingly, it can readily be appreciated that when, for example, the first pair of switch mechanisms 32,34, operatively associated with the first heater circuit or first heater assembly 16, are both disposed at their **CLOSED** positions, while the second pair of switch mechanisms 40,42, operatively associated with the second heater circuit or second

heater assembly 18, are both disposed at their **OPEN** positions, the first heater circuit or first heater assembly 16 will be electrically connected into the overall redundant control circuit 10 and will be electrically connected to the electrical connector 12 so as to receive electrical power therefrom in order to heat the hot melt adhesive hose assembly, not shown. Conversely, when, for example, the second pair of switch mechanisms 40,42, operatively associated with the second heater circuit or second heater assembly 18, are both disposed at their **CLOSED** positions, while the first pair of switch mechanisms 32,34 operatively associated with the first heater circuit or first heater assembly 16, are both disposed at their **OPEN** positions, the second heater circuit or second heater assembly 18 will be electrically connected into the overall redundant control circuit 10 and will be electrically connected to the electrical connector 12 so as to receive electrical power therefrom in order to heat the hot melt adhesive hose assembly, not shown.

Continuing further, it is similarly seen that the opposite ends of the first temperature sensor 24 are electrically connected to the second pair of primary power lines 28,30 by means of a third pair of single-throw, double-pole switch mechanisms 48,50 and a third pair of auxiliary connection lines 52,54, while the opposite ends of the second temperature sensor 26 are electrically connected to the second pair of primary power lines 28,30 by means of the third pair of single-throw, double-pole switch mechanisms 48,50 and a fourth pair of auxiliary connection lines 56,58. It is more particularly seen that the first single-throw, double-pole switch mechanism 48, of the third pair of single-throw, doub-

le-pole switch mechanisms 48,50, actually comprises a common terminal 60, a pair of alternatively selectable terminals 62, 64, and a switch member 66, while in a similar manner, the second single-throw, double-pole switch mechanism 50, of the third pair of single-throw, double-pole switch mechanisms 48,50, actually comprises a common terminal 68, a pair of alternatively selectable terminals 70,72, and a switch member 74.

Accordingly, as was the case with the first and second heater circuits or first and second heater assemblies 16,18, when, for example, the third pair of switch mechanisms 48,50 are both disposed at their **UPPER CLOSED** positions at which the switch members 66,74 are disposed in contact with and electrically connected to the upper selectable terminals 62, 70, while simultaneously the switch members 66,74 are disposed in **OPEN** states with respect to the lower selectable terminals 64,72, then the first temperature sensor 24 will be electrically connected into the overall redundant control circuit 10 and will be electrically connected to the electrical connector 12 so as to receive electrical power therefrom in order to monitor the temperature level of the hot melt adhesive hose assembly, not shown, so as to, in turn, effectively control the one of the first or second heater circuits, or first or second heater assemblies, 16,18 that is currently electrically connected into the overall circuit 10. Conversely, when, for example, the third pair of switch mechanisms 48,50 are both disposed at their **LOWER CLOSED** positions at which the switch members 66,74 are disposed in contact with and electrically connected to the lower selectable terminals 64,72, while simultaneously the switch members 66,74 are dis-

posed in **OPEN** states with respect to the upper selectable terminals 62,70, then the second temperature sensor 26 will be electrically connected into the overall redundant control circuit 10 and will be electrically connected to the electrical connector 12 so as to receive electrical power therefrom in order to monitor the temperature level of the hot melt adhesive hose assembly, not shown, so as to, in turn, effectively control the one of the first or second heater circuits, or first or second heater assemblies, 16,18 that is currently electrically connected into the overall redundant control circuit 10.

The redundant control circuit 10 is seen to further comprise a microcontroller 76 which is supplied with electrical power from a secondary power supply unit 78, and it is seen that the secondary power supply unit 78 is electrically connected to the primary power lines 20,22 through means of secondary power lines 80,82, and still further, the secondary power supply unit 78 is electrically connected to the microcontroller 76 through means of a tertiary power line 84. A voltage backup unit 86 is electrically connected to the secondary power supply unit 78 by means of an electrical connection line 88, and the voltage backup unit 86 is also electrically connected to a microcontroller supervisor unit 90 by means of an electrical connection line 92 while the microcontroller supervisor unit 90 is, in turn, electrically connected to the microcontroller 76 by means of an electrical connection line 94. Still further, an **EEPROM** type memory unit 96 is electrically connected to the microcontroller 76 by means of an electrical connection line 98, and it is noted that the functions and operations of these various electrical compon-

ents, that is, for example, the microcontroller 76, the voltage backup unit 86, the microcontroller supervisor unit 90, and the **EEPROM** type memory unit 96 will be discussed and explained shortly hereafter.

Continuing further, in accordance with additional features characteristic of the new and improved redundant control circuit 10 developed in accordance with the principles and teachings of the present invention, a first current-voltage transformer or converter 100 is electrically connected to or across the primary power line 20, while a second current-voltage transformer or converter 102 is electrically connected to or across the primary power line 22. The current voltage transformers or converters 100,102 are adapted to respectively detect the current levels within the primary power lines 20,22, which alternatively feed power to the first or second heater circuits, or first or second heater assemblies, 16,18 through means of the switch mechanisms 32,34, and 40, 42, and to convert such current levels to corresponding voltage levels which are then fed into the microcontroller 76 by means of data communication lines 104,106. A first analog-to-digital converter 108 is incorporated within the microcontroller 76, and the data communication lines 104,106 are electrically connected to the first analog-to-digital converter 108 whereby the incoming analog voltage levels can be converted, by means of the first analog-to-digital converter 108, into digital voltage values which can then of course be processed by means of the microcontroller 76. In addition, a first voltage detector 110 is electrically connected to, or across, the primary power lines 20, 22 so as to detect the voltage level existing between the two primary power lines

20,22, and the detected voltage level is fed into the first analog-to-digital converter 108 of the microcontroller 76 by means of a data communication line 112 such that the incoming analog voltage level can be converted, by means of the first analog-to-digital converter 108, into a digital voltage value which can be processed by means of the microcontroller 76. In a similar manner, second and third temperature sensor-voltage converters 114,116 are respectively electrically connected to, or across, the third and fourth pairs of auxiliary connection lines 52,54, and 56,58, by means of connection lines 111,113 and 115,117, so as to detect or determine the voltage levels existing between the third and fourth pairs of auxiliary connection lines 52,54, and 56,58, and the detected voltage levels are respectively fed into the first analog-to-digital converter 108 of the microcontroller 76 by means of data communication lines 118,120 such that the incoming analog voltage levels can likewise be converted, by means of the first analog-to-digital converter 108, into digital voltage values which can be processed by means of the microcontroller 76.

In connection with the operation of the new and improved redundant control circuit 10 of the present invention, when the adhesive supply unit (ASU), not shown, is activated, the main power supply 14 operatively associated with the adhesive supply unit (ASU) applies or transmits power to the electrical connector 12 whereby a direct current (DC) voltage will be generated and the microcontroller 76 is booted or activated. The **EEPROM** type memory unit 96 stores various parameters and operational profiles operatively associated with the different components comprising the electronic control

circuit 10, such as, for example, the various current, voltage, power values, duty cycles, and the like, generated by, or operatively characteristic of, the heater circuits or heater assemblies 16,18, and the temperature sensors 24,26, as conveyed to the microcontroller 76 by means of the aforenoted data communication lines 104,106,112,118,120. Accordingly, the microcontroller 76 will retrieve the most current data stored within the **EEPROM** type memory unit 96, and will perform various system checks comprising the current levels, voltage levels, power levels, the duty cycle, and the like.

In addition, the microcontroller 76 will activate particular ones of the switch mechanisms 32,34,40,42,48,50, which are respectively connected to the microcontroller 76 by means of signal lines 122,124,126,128,130,132, such that particular ones of the switch mechanisms 32,34,40,42,48,50 will be moved to their **CLOSED** positions. In this manner, a particular one of the first or second heater circuits or heater assemblies 16,18, as well as a particular one of the first or second temperature sensors 24,26, will effectively be incorporated into the operative system comprising the redundant control circuit 10. It is also noted that the redundant control circuit 10 further comprises a communication interface 134 which is electrically connected to the microcontroller 76 by means of a data communication line 136, and a status indication means 138 which is electrically connected to the microcontroller 76 by means of a data communication line 140. The communication interface 134 may comprise, for example, a computer keyboard, a display panel, and the like, while the status indication means may comprise, for example, green and red LEDs, indicator lights, and the like.

It is further noted that the voltage backup unit 86 serves several functions, such as, for example, providing energy for a predetermined time period, such as, for example, several seconds, after the adhesive supply unit (ASU) has, for example, initiated a shut-down of the first or second heater circuits, or the first or second heater assemblies, 16,18, in accordance with an end-of-cycle mode of operation wherein the residual energy provided by means of the voltage backup unit 86 can nevertheless maintain the microcontroller supervisor 90 active so as to, for example, shut down the microcontroller in a controlled manner or mode. In a similar manner, the voltage backup unit 86 can provide energy during those time periods within which the first or second heater circuits, or the first or second heater assemblies, 16,18 are being operated in accordance with low duty cycles.

Still further, it is noted that in addition to the voltage detector 110 being electrically connected to the microcontroller 76 by means of data communication line 112, the voltage detector 110 is also electrically connected to the microcontroller supervisor 90 by means of a data communication line 142. Accordingly, if, for example, the voltage detector 110 detects a significantly low voltage level, or the loss of voltage, for a predetermined period of time, such as, for example, several seconds, then the voltage backup unit 86 can provide sufficient power to enable the current operating system parameters to be stored within the **EEPROM** type memory unit 96, and for the microcontroller supervisor 90 to again shut down the microcontroller 76 in a controlled manner or mode. It is lastly noted that at all other times, the microcontroller supervisor 90 serves to monitor the microcontrol-

ler 76 in order to determine and verify the fact that the microcontroller 76 is operating properly or within normal parameters.

It is to be noted that during normal hot melt adhesive dispensing operations or procedures, or during normal hot melt adhesive application cycles, if, for example, the switch mechanisms 32,34 have been previously moved to their **CLOSED** positions so as to electrically incorporate or connect the first heater circuit or first heater assembly 16 into the redundant control circuit 10, while the switch mechanisms 40, 42 have been previously moved to their **OPEN** positions so as to electrically disconnect or isolate the second heater circuit or second heater assembly 18 from the redundant control circuit 10, and if subsequently, for example, a heater failure is detected as a result of, for example, a significant change in the heater current as detected by means of the current-voltage transformers or converters 100,102, and as compared to, for example, the normal heater current profile data stored within the **EEPROM** type memory unit 96, then the microcontroller 76 will initiate a switchover of the switch mechanisms, by means of suitable signals transmitted over the signal lines 122,124,126,128, so as to move switch mechanisms 32,34 to their **OPEN** positions whereby the first heater circuit or first heater assembly 16 will now be electrically disconnected or isolated from the redundant control circuit 10, and substantially simultaneously therewith, to move the switch mechanisms 40,42 to their **CLOSED** positions whereby the second heater circuit or second heater assembly 18 will now be electrically connected to or incorporated within the redundant control circuit 10. It is also to be noted that a

heater failure can manifest itself in the form of a ground fault in connection with, for example, the first heater circuit or first heater assembly 16 if the first heater circuit or first heater assembly 16 is the heater circuit or heater assembly electrically connected to or incorporated within the redundant control circuit 10. In particular, not only should the heater circuit or heater assembly current values detected by means of the current-voltage converters or transformers 100,102 effectively be in accordance with the normal heater current profile data stored within the **EEPROM** type memory unit 96, but the detected values should also be the same within both of the primary power lines 20,22. If this is not the case, the first heater circuit or first heater assembly 16 may have a ground fault. Still yet further, if the current values, detected within both of the primary power lines 20, 22, change suddenly, although the duty cycle remains constant, this may indicate a defective heater circuit or heater assembly whereby a switchover between the first and second heater circuits or first and second heater assemblies 16,18 would again be warranted.

It is lastly noted, in connection with the operations and connections of the first and second heater circuits or first and second heater assemblies 16,18 within the redundant control circuit 10, that it may be desirable to simultaneously activate all of the switch mechanisms 32,34,40,42 to their **CLOSED** positions such that both of the first and second heater circuits or first and second heater assemblies 16,18 are electrically connected to or incorporated within the electronic control circuit 10 for a predeterminedly short period of time, subsequent to which, one set of the switch

mechanisms 32,34,40,42 would again be activated so as to be disposed at their **OPENED** position so as to serve their redundant objective. Activating all of the switch mechanisms 32, 34,40,42 to their **CLOSED** positions such that both of the first and second heater circuits or first and second heater assemblies 16,18 are electrically connected to or incorporated within the redundant control circuit 10 enables the system to operate in accordance with a "boost" mode whereby, for example, a rapid heating of the hot melt adhesive hose assembly to the predetermined desired temperature value within a relatively short period of time may be achieved. Alternatively, both of the first and second heater circuits or first and second heater assemblies 16,18 may be electrically connected to or incorporated within the redundant control circuit 10 under low supply voltage conditions, whereas, conversely, if the supply voltage is relatively high, the use of only one of the first and second heater circuits or first and second heater assemblies 16,18 may be necessary.

In connection with the redundant temperature sensors 24,26, it is to be noted that during normal hot melt adhesive dispensing operations or procedures, or during normal hot melt adhesive application cycles, switch members 66,74 may be respectively moved, for example, to their illustrated **CLOSED** positions at which the switch members 66,74 will be respectively electrically connected to terminals 62,70 so as to electrically incorporate or connect the first temperature sensor 24 into the redundant control circuit 10, whereas conversely, the switch members 66,74 will effectively be disposed at their **OPEN** positions with respect to terminals 64,72 so as to effectively electrically disconnect or isolate the sec-

ond temperature sensor 26 from the redundant control circuit 10. During this time, both temperature sensors 24,26 are continuously monitored by means of the temperature sensor voltage converters 114,116 respectively connected across auxiliary connection lines 52,54, and 56,58, and any time a failure or an abnormality appears to have been detected in connection with one of the temperature sensors 24,26, the temperature sensors 24,26 will effectively be tested further so as to determine or verify which one of the temperature sensors 24,26 is in fact actually defective.

For example, both temperature sensors should exhibit or generate the same detected voltage values. If an open or short circuit is detected within a particular one of the temperature sensors 24,26, then clearly that particular one of the temperature sensors 24,26 is defective. Accordingly, if, for example, it is determined that temperature sensor 26 is in fact defective, then the switch members 66,74 are maintained at their illustrated positions so as to maintain the temperature sensor 24 electrically connected to, or incorporated within, the redundant control circuit 10, and to concomitantly maintain the temperature sensor 26 electrically disconnected or isolated from the redundant control circuit 10. On the other hand, or conversely, if, for example, it is determined that the temperature sensor 24 is in fact defective, then signals will be transmitted from the microcontroller 76 to the switch mechanisms 48,50, by means of signal lines 130,132, so as to cause the switch members 66,74 to switch positions whereby switch member 66 will now be electrically connected to terminal 64 and switch member 74 will be electrically connected to terminal 72. In this manner,

temperature sensor 26 will be electrically connected to, or incorporated within, the redundant control circuit 10, and temperature sensor 24 will be electrically disconnected or isolated from the redundant control circuit 10.

Continuing further, as has been noted hereinbefore, if an abnormality is detected in connection with the operations of the temperature sensors 24,26, then the temperature sensors 24,26 must be tested in order to determine which one of the temperature sensors 24,26 is in fact operating properly and accurately sensing the temperature level of the hot melt adhesive hose assembly. Various modes or techniques for testing the temperature sensors 24,26 are of course envisioned. For example, in accordance with a first mode or technique for testing the temperature sensors 24,26, if the current that is detected, by means of the respective one of the current-voltage transformers or converters 100,102 which are operatively associated with the particular one of the first and second heater circuits or first and second heater assemblies 16,18 which is electrically connected to or incorporated in the redundant control circuit 10, is within a valid range of values, then the temperature level of the hot melt adhesive hose assembly, as sensed by means of each one of the temperature sensors 24,26, that is, the temperature level of the hot melt adhesive hose assembly, as sensed by means of both of the temperature sensors 24,26, must attain a predetermined value. If this is not the case, that is, if such a temperature level is not in fact sensed or determined by each one or both of the temperature sensors 24,26, then either the particular one of the temperature sensors 24,26 which is not in fact sensing the proper temperature level is not properly

mounted upon or operatively connected to the hot melt adhesive hose assembly, or the particular one of the temperature sensors 24,26 which is not in fact sensing the proper temperature level is defective. In accordance with a second mode or technique for testing the temperature sensors 24,26, it is similarly noted that the temperature level of the hot melt adhesive hose assembly, as sensed by means of each one of the temperature sensors 24,26, that is, the temperature level of the hot melt adhesive hose assembly, as sensed by means of both of the temperature sensors 24,26, must attain predetermined values as a function of the duty cycle. In other words, the temperature levels of the hot melt adhesive hose assembly, as sensed by means of both of the temperature sensors 24,26, is directly proportional to the duty cycle. Accordingly, if the duty cycle is increased, an increased temperature level should be sensed, and correspondingly, if the duty cycle is decreased, a decreased temperature level should be sensed. If a particular one of the temperature sensors 24,26 is not in fact sensing the proper temperature level, in accordance with the predetermined variations in the duty cycle, then that particular one of the temperature sensors 24,26 is defective.

Continuing further, a last unique feature characteristic of the present invention will now be described. It is to be appreciated, for example, that sometimes, despite the fact that the two temperature sensors 24,26 are in fact working properly, and that they are accurately sensing the temperature level of the hot melt adhesive hose assembly, they do not in fact sense and generate the same temperature values. This may be due, for example, to the fact that the tempera-

ture sensors are being utilized in connection with relatively large applicator heads and may be physically located at substantially different locations within the applicator head. Therefore, it is desirable, under such conditions, to effectively build or configure a simulated temperature sensor which can effectively generate output values which comprise averaged values with respect to the temperature values actually sensed and generated by means of the two temperature sensors 24,26. These averaged values generated by means of the simulated temperature sensor will then be utilized to ultimately control the first or second heater circuits, or first or second heater assemblies, 16,18. Accordingly, in order to in fact achieve this feature or objective, it is noted that the redundant control circuit 10 may comprise an additional pair of single-throw, double-pole switch mechanisms 144,146, which may be similar to the single-throw, double-pole switch mechanisms 48,50, and a simulated temperature sensor-voltage converter 148 which is utilized in conjunction with the additional pair of single throw, double-pole switch mechanisms 144,146. The simulated temperature sensor-voltage converter 148 is effectively built or configured from suitable hardware and software incorporated within the microcontroller 76 after processing pertinent information derived from the temperature sensor-voltage converters 114,116, and the resulting simulated temperature sensor-voltage converter 148 can be adapted to be interactive with various types of adhesive supply units.

More particularly, it is noted that the additional pair of single throw, double-pole switch mechanisms 144,146, together with the simulated temperature sensor-voltage con-

verter 148, effectively form an optional or alternative sub-circuit which may effectively be electrically connected to or incorporated within the overall redundant control circuit 10, or electrically disconnected from and isolated from the overall redundant control circuit 10. As was the case with the single-throw, double-pole switch mechanisms 48,50, the single-throw, double-pole switch mechanism 144 comprises a common terminal 150, a pair of alternatively selectable terminals 152,154, and a switch member 156, and in a similar manner, the single-throw, double-pole switch mechanism 146 comprises a common terminal 158, a pair of alternatively selectable terminals 160,162, and a switch member 164. Still further, it is seen that auxiliary connection lines 166,168 respectively connect the simulated temperature sensor-voltage converter 148 to the terminals 154,162 of the switch mechanisms 144, 146, and that a data communication line 170 connects the simulated temperature sensor-voltage converter 148 to a second analog-to-digital converter 172 which is incorporated within the microcontroller 76. In addition, it is also seen that signal lines 174,176 respectively interconnect the microcontroller 76 to the switch mechanisms 144,146 so as to cause the switch members 156,164 thereof to achieve switching functions as desired.

Accordingly, it can be appreciated still further that when the switch members 156,164 of the switch mechanisms 144,146 are disposed at their illustrated positions, the temperature sensors 24,26 are electrically connected to or incorporated within the redundant control circuit 10 as has been previously described. On the other hand, when it is desired to effectively electrically connect or incorporate the

simulated temperature sensor-voltage converter 148 within the redundant control circuit 10, suitable signals are transmitted from the microcontroller 76 so as to cause the switch members 156,164 to switch over from their illustrated positions, at which the switch members 156,164 are respectively connected to terminals 152,160, to their alternative positions at which the switch members 156,164 will be respectively connected to terminals 154,162. Therefore, the first and second temperature sensors 24,26 are effectively disconnected or isolated from the redundant control circuit 10 such that their generated or sensed temperature output signals are not utilized to control the heater circuits or heater assemblies 16,18, however, their generated or sensed temperature output signals, as transmitted to the microcontroller 76 through means of the temperature sensor-voltage converters 114,116, are nevertheless constantly utilized in conjunction with the simulated temperature sensor-voltage converter 148 and the temperature levels developed by means of the simulated temperature sensor-voltage converter 148 in order to more accurately control the heater circuits or heater assemblies 16, 18.

It is lastly noted, in conjunction with the simulated temperature sensor-voltage converter 148, that even when the simulated temperature sensor-voltage converter 148 is being employed, the redundant control circuit 10 still exhibits redundancy in that both of the temperature sensors 24,26 are being used to generate their temperature level or value outputs, and are being used in conjunction with the simulated temperature sensor-voltage converter 148. In addition, if one of the temperature sensors 24,26 proves to be

defective, or fails, the microcontroller 76 will effectively ignore the generated temperature level or value outputs derived from such defective or failed temperature sensor and will utilize the temperature level or value outputs derived from the other temperature sensor. Since the active temperature sensor might be generating temperature level or value outputs which are higher or lower than the averaged temperature level or value outputs generated by both temperature sensors 24,26, the microcontroller 76 may cause the simulated temperature sensor-voltage converter 148 to compensate accordingly based upon the temperature levels or value outputs previously derived from the temperature sensors 24,26 and stored, for example, as profiles within the **EEPROM** type memory unit 96.

It is lastly noted that, in conjunction with the overall redundant control circuit 10 which is adapted to be operatively associated with a hot melt adhesive hose assembly, and in accordance with a unique and novel feature characteristic of the present invention, the entire redundant control circuit 10 is adapted to be integrally connected to the hot melt adhesive hose assembly, in a manner similar to that disclosed within the aforenoted Canadian Patent Application File No. 2,597,222 which is entitled **HOT MELT ADHESIVE HOSE ASSEMBLY HAVING REDUNDANT COMPONENTS**, and which was filed on May 3, 2006, inventor **Daniel D. Bourget et al.**, wherein the switch mechanisms were fixedly connected to the hot melt adhesive hose assembly, and wherein further, the hot melt adhesive hose assembly is, in turn, adapted to be operatively connected to the adhesive supply unit (ASU) 14 through means of the electrical connector 12.

It is therefore to be appreciated and understood still further that in accordance with the unique and novel structural features, principles, and teachings of the present invention, the new and improved hot melt adhesive hose assembly, which includes the heater circuits or heater resistance wires 16, 18, the temperature sensors 24,26, the switch mechanisms 32, 34,40,42,66,74,156,164, and the microcontroller 76, as well as the other electrical components as disclosed within **FIGURE 2**, effectively comprises a self-contained, stand-alone, or independent operative component that can be utilized in conjunction with any adhesive supply unit (ASU).

Thus, it may be seen that in accordance with the principles and teachings of the present invention, there has been disclosed and described a redundant control circuit which is integrally incorporated within or upon a hot melt adhesive hose assembly and which comprises a pair of heater circuits or heater assemblies, wherein each one of the pair of heater circuits or heater assemblies is adapted to heat the hot melt adhesive hose assembly to a predetermined temperature level, and a pair of temperature sensors wherein each one of the temperature sensors is used to sense the temperature of the hot melt adhesive hose assembly and to provide temperature data which will be used to control energization of the heater circuits or heater assemblies in order to maintain the desired temperature level. The new and improved hot melt adhesive hose assembly, which includes the heater circuits or heater assemblies, the temperature sensors, and the switch mechanisms, as well as the other electrical components operatively associated therewith, effectively comprises a self-contained, stand-alone, or independent operative compon-

ent that can be utilized in conjunction with any adhesive supply unit (ASU). A first one of the heater circuits or heater assemblies is initially electrically connected to the hot melt adhesive hose assembly electrical circuitry, and in a similar manner, a first one of the temperature sensors is likewise electrically connected to the hot melt adhesive hose assembly electrical circuitry. Subsequently, should a failure occur within the first one of the heater circuits or heater assemblies, then one of the electrical switch mechanisms would be activated so as to effectively remove the first, failed heater circuit or heater assembly from the hot melt adhesive hose assembly electrical circuitry, and substantially simultaneously therewith, electrically connect the second one of the heater circuits or heater assemblies to the hot melt adhesive hose assembly electrical circuitry. Similar switching procedures will also be implemented in connection with the pair of temperature sensors should a failure occur within a first one of the temperature sensors initially incorporated within the hot melt adhesive hose assembly electrical circuitry.

Obviously, many variations and modifications of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

WHAT IS CLAIMED IS:

1. A hot melt adhesive hose assembly having a redundant control circuit fixedly connected thereto, comprising:

a power source which is operatively associated with a hot melt adhesive supply unit (ASU);

an electrical connector mounted upon one end of a hot melt adhesive hose assembly for electrical connection to said power source operatively associated with said adhesive supply unit (ASU);

a pair of heater assemblies, wherein each one of said pair of heater assemblies is adapted to be operatively associated with said hot melt adhesive hose assembly so as to heat the hot melt adhesive material, fluidically conducted internally within said hot melt adhesive hose assembly, to a predetermined temperature level;

first switching means for selectively electrically connecting each one of said pair of heater assemblies to said power source by means of first power lines;

a pair of temperature sensors, wherein each one of said pair of temperature sensors is adapted to be operatively associated with said hot melt adhesive hose assembly so as to sense the temperature level of the hot melt adhesive material being fluidically conducted internally within said hot melt adhesive hose assembly, wherein said sensed temperature levels are used for effectively controlling the energization of each one of said pair of heater assemblies so as to maintain the temperature level of the hot melt adhesive material, being conducted internally within said hot melt adhesive hose assembly, at said predetermined temperature level;

second switching means for selectively electrically connecting each one of said pair of temperature sensors to said power source by means of second power lines;

first means for monitoring the functionality of each one of said pair of heater assemblies;

second means for monitoring the functionality of each one of said pair of temperature sensors; and

means for controlling said first and second switching means so as to initially electrically connect a first one of said heater assemblies and a first one of said temperature sensors to said power source, to electrically connect a second one of said heater assemblies to said power source while disconnecting said first one of said heater assemblies from said power source if said first one of said heater assemblies is determined to be defective by said first monitoring means, and to electrically connect a second one of said temperature sensors to said power source while disconnecting said first one of said temperature sensors from said power source if said first one of said temperature sensors is determined to be defective by said second monitoring means,

said electrical connector, said pair of heater assemblies, said first switching means, said pair of temperature sensors, said second switching means, said first means for monitoring the functionality of each one of said pair of heater assemblies, said second means for monitoring the functionality of each one of said pair of temperature sensors, and said means for controlling said first and second switching means being fixedly connected to said hot melt adhesive hose assembly such that said hot melt adhesive hose assembly, including said electrical connector, said pair of heater assemblies, said first switching means, said pair of temperature sensors, said second switching means, said first means for monitoring the functionality of each one of said pair of heater assemblies, said second means for monitoring the functionality of each one of said pair of temperature sensors, and said means for controlling said first and second switching means, effectively comprises a self-contained, stand-alone, independent operative component that can be utilized in conjunction with any adhesive supply unit (ASU).

2. The redundant control circuit as set forth in claim 1, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a pair of current-voltage converters electrically connected to said first power lines.

3. The redundant control circuit as set forth in claim 1, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a voltage detector electrically connected across said first power lines.

4. The redundant control circuit as set forth in claim 1, wherein:

said means for monitoring each one of said pair of temperature sensors comprises a pair of temperature sensor-voltage converters electrically connected across said second power lines.

5. The redundant control circuit as set forth in claim 1, wherein;

said means for controlling said first and second switching means comprises a microcontroller.

6. The redundant control circuit as set forth in claim 5, further comprising:

memory means, operatively associated with said microcontroller, for storing operational profiles characteristic of said redundant control circuit, said pair of heater assemblies, and said pair of temperature sensors.

7. The redundant control circuit as set forth in claim 1, further comprising:

a simulated temperature sensor configured by said microcontroller as a function of temperature data received from said pair of temperature sensors; and

third switching means for electrically connecting said simulated temperature sensor to said power source by means of said second power lines, while electrically disconnecting said pair of temperature sensors from said second power lines.

8. The redundant control circuit as set forth in claim 1, further comprising:

said first switching means comprises two pairs of switches operatively connected to said first power lines;

said second switching means comprises two pairs of switches operatively connected to said second power lines;

wherein a first switch of a first pair of switches of said first switching means, and a first switch of a second pair of switches of said first switching means, operatively connects a first one of said pair of heater assemblies to said first power lines, while a second switch of said first pair of switches of said first switching means, and a second switch of a second pair of

switches of said first switching means, operatively connects a second one of said pair of heater assemblies to said second power lines; and

wherein a first switch of a first pair of switches of said second switching means, and a first switch of a second pair of switches of said second switching means, operatively connects a first one of said pair of temperature sensors to said second power lines, while a second switch of said first pair of switches of said second switching means, and a second switch of a second pair of switches of said second switching means, operatively connects a second one of said pair of temperature sensors to said second power lines.

9. A hot melt adhesive hose assembly having a redundant control circuit fixedly connected thereto, comprising:

a power source which is operatively associated with a hot melt adhesive supply unit (ASU);

an electrical connector mounted upon one end of a hot melt adhesive hose assembly for electrical connection to said power source operatively associated with said adhesive supply unit (ASU);

a pair of heater assemblies, wherein each one of said pair of heater assemblies is adapted to be operatively associated with said hot melt adhesive hose assembly so as to heat the hot melt adhesive material, fluidically conducted internally within said hot melt adhesive hose assembly, to a predetermined temperature level;

switching means for selectively electrically connecting each one of said pair of heater assemblies to said power source by a pair of power lines;

means for monitoring the functionality of each one of said pair of heater assemblies; and

means for controlling said switching means so as to initially electrically connect a first one of said heater assemblies to said power source, to electrically connect a second one of said heater assemblies to said power source while disconnecting said first one of said heater assemblies from said power source if said first one of said heater assemblies is determined to be defective by said monitoring means;

said electrical connector, said pair of heater assemblies, said switching means, said means for monitoring the functionality of each one of said pair of heater assemblies, and said means for controlling said switching means being fixedly connected to said hot melt adhesive hose assembly such that said hot melt adhesive hose assembly, including said electrical connector, said pair of heater assemblies, said switching means, said means tot monitoring the functionality of each one of said pair of heater assemblies, and said means for controlling said switching means, effectively comprises a self-contained, stand-alone, independent operative component that can be utilized in conjunction with any adhesive supply unit (ASU).

10. The redundant control circuit as set forth in claim 9, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a pair of current-voltage converters electrically connected to first power lines electrically connecting said pair of heater assemblies to said power source.

11. The redundant control circuit as set forth in claim 10, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a voltage detector electrically connected across said power lines.

12. The redundant control circuit as set forth in claim 9, wherein:

said means for controlling said switching means comprises a microcontroller.

13. The redundant control circuit as set forth in claim 12, further comprising:

memory means, operatively associated with said microcontroller, for storing operational profiles characteristic of said redundant control circuit, and said pair of heater assemblies.

14. The redundant control circuit as set forth in claim 9, further comprising:

said switching means comprises two pair of switches operatively connected to said pair of power lines;

wherein a first switch of a first pair of switches of said switching means, and a first switch of a second pair of switches of said switching means, operatively connects a first one of said pair of heater assemblies to said pair of power lines, while a second switch of said first pair of switches of said switching means, and a second switch of a second pair of switches of said switching means, operatively connects a second one of said pair of heater assemblies to said pair of power lines.

15. A hot melt adhesive hose assembly having a redundant control circuit fixedly connected thereto, comprising:

a power source which is operatively associated with a hot melt adhesive supply unit (ASU);

an electrical connector mounted upon one end of a hot melt adhesive hose assembly for electrical connection to said power source operatively associated with said adhesive supply unit (ASU);

a pair of heater assemblies, wherein each one of said pair of heater assemblies is adapted to be operatively associated with said hot melt adhesive hose assembly so as to heat the hot melt adhesive material, fluidically conducted internally within said hot melt adhesive hose assembly, to a predetermined temperature level;

a temperature sensor, wherein said temperature sensor is adapted to be operatively associated with said hot melt adhesive hose assembly so as to sense the temperature level of the hot melt adhesive material being fluidically conducted internally within said hot melt adhesive hose assembly, wherein said sensed temperature level is used for effectively controlling the energization of each one of said pair of heater assemblies so as to maintain the temperature level of the hot melt adhesive material, being conducted internally within said hot melt adhesive hose assembly, at said predetermined temperature level;

switching means for selectively electrically connecting each one of said pair of heater assemblies to said power source by a pair of power lines;

means for monitoring the functionality off each one of said pair of heater assemblies; and

means for controlling said switching means so as to initially electrically connect a first one of said heater assemblies to said power source, to electrically connect a second one of said heater assemblies to said power source while disconnecting said first one of said heater assemblies from said power source if said first one of said heater assemblies is determined to be defective by said monitoring means;

said electrical connector, said pair of heater assemblies, said switching means, said means for monitoring the functionality of each one of said pair of heater assemblies, and said means for controlling said switching means being fixedly connected to said hot melt adhesive hose assembly such that said hot melt adhesive hose assembly, including said electrical connector, said pair of heater assemblies, said switching means, said means for monitoring the functionality of each one of said pair of heater assemblies, and said means for controlling said switching means, effectively comprises a self-contained, stand-alone, independent operative component that can be utilized in conjunction with any adhesive supply unit (ASU).

16. The redundant control circuit as set forth in claim 15, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a pair of current-voltage converters electrically connected to said first power lines.

17. The redundant control circuit as set forth in claim 15, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a voltage detector electrically connected across said first power lines.

18. The redundant control circuit as set forth in claim 15, wherein:

said means for controlling said first and second switching means comprises a microcontroller.

19. The redundant control circuit as set forth in claim 18, further comprising:

memory means, operatively associated with said microcontroller, for storing operational profiles characteristic of said redundant control circuit, said pair of heater assemblies, and said pair of temperature sensors.

20. The redundant control circuit as set forth in claim 15, further comprising:

said first switching means comprises a first pair of switches operatively connected to said first power lines; and

said second switching means comprises a second pair of switches operatively connected to said second power lines;

wherein a first one of said first pair of switches, and a first one of said second pair of switches, operatively connects a first one of said pair of heater assemblies to said first power lines, while a second one of said first pair of switches, and a second one of said second pair of switches, operatively connects a second one of said pair of heater assemblies to said second power lines.

21. The redundant control circuit as set forth in claim 15, further comprising:

said switching means comprises two pair of switches operatively connected to said pair of power lines;

wherein a first switch of a first pair of switches of said switching means, and a first switch of a second pair of switches of said switching means, operatively connects a first one of said pair of heater assemblies to said pair of power lines, while a second switch of said first pair of switches of said switching means, and a second switch of a second pair of switches of said switching means, operatively connects a second one of said pair of heater assemblies to said pair of power lines.

22. A redundant control circuit for use in connection with a hot melt adhesive hose assembly, comprising:

a power source;

an electrical connector adapted to be mounted upon one end portion of the hot melt adhesive hose assembly for electrically connecting the hot melt adhesive hose assembly to said power source;

a pair of heater assemblies, wherein each one of said pair of heater assemblies is adapted to be operatively mounted upon the hot melt adhesive hose assembly so as to heat the

hot melt adhesive material, fluidically conducted internally within the hot melt adhesive hose assembly, to a predetermined temperature level;

first switching means, adapted to be operatively mounted upon the hot melt adhesive hose assembly, for selectively electrically connecting each one of said pair of heater assemblies to said power source by means of first power lines which are electrically connected to said power source through means of said electrical connector;

a pair of temperature sensors, wherein each one of said pair of temperature sensors is adapted to be operatively mounted upon with the hot melt adhesive hose assembly so as to sense the temperature level of the hot melt adhesive material, being fluidically conducted internally within the hot melt adhesive hose assembly, whereby said pair of heater assemblies can be energized in accordance with said temperature levels sensed by said pair of temperature sensors so as to maintain the temperature level of the hot melt adhesive material, being conducted internally within the hot melt adhesive hose assembly, at said predetermined temperature level;

second switching means, adapted to be operatively mounted upon the hot melt adhesive hose assembly, for selectively electrically connecting each one of said pair of temperature sensors to said power source by means of second power lines that are electrically connected to said power source through said electrical connector;

first means for monitoring the functionality of each one of said pair of heater assemblies;

second means for monitoring the functionality of each one of said pair of temperature sensors; and

means, adapted to be operatively mounted upon the hot melt adhesive hose assembly, for controlling said first and second switching means so as to initially electrically connect a first one of said heater assemblies and a first one of said temperature sensors to said power source, to electrically connect a second one of said heater assemblies to said power source while disconnecting said first one of said heater assemblies from said power source if said first one of said heater assemblies is determined to be defective by said first monitoring means, and to electrically connect a second one of said temperature sensors to said power source while

disconnecting said first one of said temperature sensors from said power source if said first one of said temperature sensors is determined to be defective by said second monitoring means,

whereby operation of the hot melt adhesive hose assembly does not have to be shut down if one of said pair of heater assemblies and said pair of temperature sensors is defective.

23. The redundant control circuit as set forth in claim 22, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a pair of current-voltage converters electrically connected to said first power lines.

24. The redundant control circuit as set forth in claim 22, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a voltage detector electrically connected across said first power lines.

25. The redundant control circuit as set forth in claim 22, wherein:

said means for monitoring each one of said pair of temperature sensors comprises a pair of temperature sensor-voltage converters electrically connected across said second power lines.

26. The redundant control circuit as set forth in claim 22, wherein:

said means for controlling said first and second switching means comprises a microcontroller.

27. The redundant control circuit as set forth in claim 26, further comprising:

memory means, operatively associated with said microcontroller, for storing operational profiles characteristic of said redundant control circuit, said pair of heater assemblies, and said pair of temperature sensors.

28. The redundant control circuit as set forth in claim 22, further comprising:

a simulated temperature sensor configured by said microcontroller as a function of temperature data received from said pair of temperature sensors; and

third switching means for electrically connecting said simulated temperature sensor to said power source by means of said second power lines, while electrically disconnecting said pair of temperature sensors from said second power lines.

29. A redundant control circuit for an electrical system mounted upon a structural member, comprising:

a power source;

an electrical connector adapted to be mounted upon one end portion of the structural member for electrically connecting the structural member to said power source;

at least one pair of electrical components disposed within the electrical system and adapted to be mounted upon the structural member;

switching means, adapted to be operatively mounted upon the structural member, for selectively electrically connecting each one of said at least one pair of electrical components to said power source by means of power lines which are electrically connected to said power source through means of said electrical connector;

means for monitoring the functionality of each one of said at least one pair of electrical components; and

means, adapted to be operatively mounted upon the structural member, for controlling said switching means so as to initially electrically connect a first one of said at least one pair of electrical components to said power source, and to electrically connect a second one of said at least one pair of electrical components to said power source while disconnecting said first one of said at least one pair of electrical components from said power source if said first one of said at least one pair of electrical components is determined to be defective by said monitoring means,

whereby operation of the electrical system does not have to be shut down if one of said at least one pair of electrical components is defective.

30. The redundant control circuit as set forth in claim 29, wherein:

said electrical system comprises an electrical system operatively associated with the structural member which comprises a hot melt adhesive hose assembly; and

said at least one pair of electrical components comprises a pair of heater assemblies and a pair of temperature sensors.

31. The redundant control circuit as set forth in claim 30, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a pair of current-voltage converters electrically connected to first power lines electrically connecting said pair of heater assemblies to said power source.

32. The redundant control circuit as set forth in claim 31, wherein:

said means for monitoring each one of said pair of heater assemblies comprises a voltage detector electrically connected across said first power lines.

33. The redundant control circuit as set forth in claim 30, wherein:

said means for monitoring each one of said pair of temperature sensors comprises a pair of temperature sensor-voltage converters electrically connected across second power lines electrically connecting said pair of temperature sensors to said power source.

34. The redundant control circuit as set forth in claim 30, wherein:

said means for controlling said switching means comprises a microcontroller.

35. The redundant control circuit as set forth in claim 34, further comprising:

memory means, operatively associated with said microcontroller, for storing operational profiles characteristic of said redundant control circuit, said pair of heater assemblies, and said pair of temperature sensors.

36. The redundant control circuit as set forth in claim 34, further comprising:

a simulated temperature sensor configured by said microcontroller as a function of temperature data received from said pair of temperature sensors; and

third switching means for electrically connecting said simulated temperature sensor to said power source by means of said second power lines, while electrically disconnecting said pair of temperature sensors from said second power lines.

37. A method of controlling electrical components of a hot melt adhesive hose assembly by means of a redundant control circuit, comprising the steps of:

providing a power source;

mounting an electrical connector upon one end portion of the hot melt adhesive hose assembly for electrically connecting the hot melt adhesive hose assembly to said power source;

operatively mounting a pair of heater assemblies upon the hot melt adhesive hose assembly so as to heat the hot melt adhesive material, fluidically conducted internally within the hot melt adhesive hose assembly, to a predetermined temperature level;

operatively mounting first switching means upon the hot melt adhesive hose assembly for selectively electrically connecting each one of said pair of heater assemblies to said power source by means of first power lines which are electrically connected to said power source through means of said electrical connector;

operatively mounting a pair of temperature sensors upon the hot melt adhesive hose assembly so as to sense the temperature level of the hot melt adhesive material, being fluidically conducted internally within the hot melt adhesive hose assembly, whereby said pair of heater assemblies can be energized in accordance with said temperature levels sensed by said pair of temperature sensors so as to maintain the temperature level of the hot melt adhesive material, being conducted internally within the hot melt adhesive hose assembly, at said predetermined temperature level;

operatively mounting second switching means upon the hot melt adhesive hose assembly for selectively electrically connecting each one of said pair of temperature sensors to said power source by means of second power lines which are electrically connected to said power source through said electrical connector;

monitoring the functionality of each one of said pair of heater assemblies;

monitoring the functionality of each one of said pair of temperature sensors; and

controlling said first and second switching means so as to initially electrically connect a first one of said heater assemblies and a first one of said temperature sensors to said power source, to electrically connect a second one of said heater assemblies to said power source while

disconnecting said first one of said heater assemblies from said power source if said first one of said heater assemblies is determined to be defective by said first monitoring means, and to electrically connect a second one of said temperature sensors to said power source while disconnecting said first one of said temperature sensors from said power source if said first one of said temperature sensors is determined to be defective by said second monitoring means,

whereby operation of the hot melt adhesive hose assembly does not have to be shut down if one of said pair of heater assemblies and said pair of temperature sensors is defective.

38. The method as set forth in claim 37, further comprising the steps of:

configuring a simulated temperature sensor as a function of temperature data received from said pair of temperature sensors; and

providing third switching means for electrically connecting said simulated temperature sensor to said power source by means of said second power lines, while electrically disconnecting said pair of temperature sensors from said second power lines.

39. The method as set forth in claim 37, further comprising the step of:

controlling said first and second switching means so as to electrically connect both of said pair of heater assemblies to said power source so as to provide the hot melt adhesive assembly with a boost in order to rapidly heat the hot melt adhesive material being conducted internally within the hot melt adhesive hose assembly.

40. The method as set forth in claim 37, further comprising the step of:

using a pair of current-voltage converters electrically connected to said first power lines for monitoring each one of said pair of heater assemblies.

41. The method as set forth in claim 37, further comprising the step of:

using a voltage detector electrically connected across said first power lines for monitoring each one of said pair of heater assemblies.

42. The method as set forth in claim 37, further comprising the step of:

using a pair of temperature sensor-voltage converters electrically connected across said second power lines for monitoring each one of said pair of temperature sensors.

43. The method as set forth in claim 37, further comprising the step of:

using a microcontroller to control said first and second switching means.

44. The method as set forth in claim 43, further comprising the step of:

utilizing memory means, operatively associated with said microcontroller, for storing operational profiles characteristic of said redundant control circuit, said pair of heater assemblies, and said pair of temperature sensors.

45. A method of controlling electrical components of a hot melt adhesive hose assembly by means of a redundant control circuit, comprising the steps of:

providing a power source;

mounting an electrical connector upon one end portion of the hot melt adhesive hose assembly for electrically connecting the hot melt adhesive hose assembly to said power source;

operatively mounting a pair of heater assemblies upon the hot melt adhesive hose assembly so as to heat the hot melt adhesive material, fluidically conducted internally within the hot melt adhesive hose assembly, to a predetermined temperature level;

operatively mounting switching means upon the hot melt adhesive hose assembly for selectively electrically connecting each one of said pair of heater assemblies to said power source by means of power lines which are electrically connected to said power source through means of said electrical connector;

operatively mounting a temperature sensor upon the hot melt adhesive hose assembly so as to sense the temperature level of the hot melt adhesive material, being fluidically conducted internally within the hot melt adhesive hose assembly, whereby said pair of heater assemblies can be energized in accordance with said temperature levels sensed by said temperature sensor so as

to maintain the temperature level of the hot melt adhesive material, being conducted internally within the hot melt adhesive hose assembly, at said predetermined temperature level;

using monitoring means to monitor the functionality of each one of said pair of heater assemblies; and

controlling said first switching means so as to initially electrically connect a first one of said heater assemblies to said power source, to electrically connect a second one of said heater assemblies to said power source while disconnecting said first one of said heater assemblies from said power source if said first one of said heater assemblies is determined to be defective by said monitoring means,

whereby operation of the hot melt adhesive hose assembly does not have to be shut down if one of said pair of heater assemblies is defective.

46. The method as set forth in claim 45, further comprising the step of:

controlling said first and second switching means so as to electrically connect both of said pair of heater assemblies to said power source so as to provide the hot melt adhesive assembly with a boost in order to rapidly heat the hot melt adhesive material being conducted internally within the hot melt adhesive hose assembly.

47. The method as set forth in claim 45, further comprising the step of:

using a pair of current-voltage converters electrically connected to said power lines for monitoring each one of said pair of heater assemblies.

48. The method as set forth in claim 45, further comprising the step of:

using a voltage detector electrically connected across said power lines for monitoring each one of said pair of heater assemblies.

49. The method as set forth in claim 45, further comprising the step of:

using a microcontroller to control said switching means.

50. The method as set forth in claim 49, further comprising the step of:

utilizing memory means, operatively associated with said microcontroller, for storing operational profiles characteristic of said redundant control circuit, said pair of heater assemblies, and said temperature sensor.

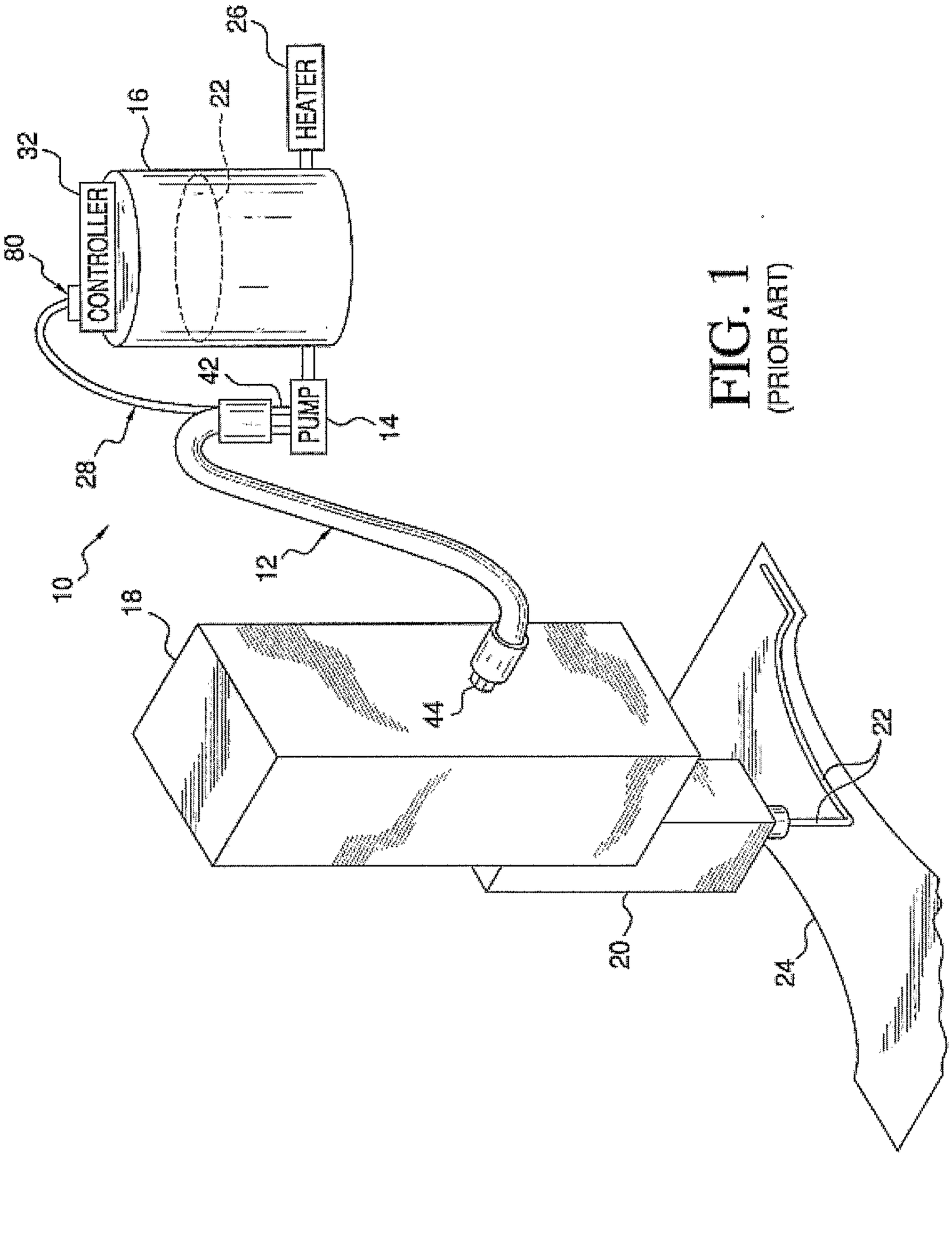
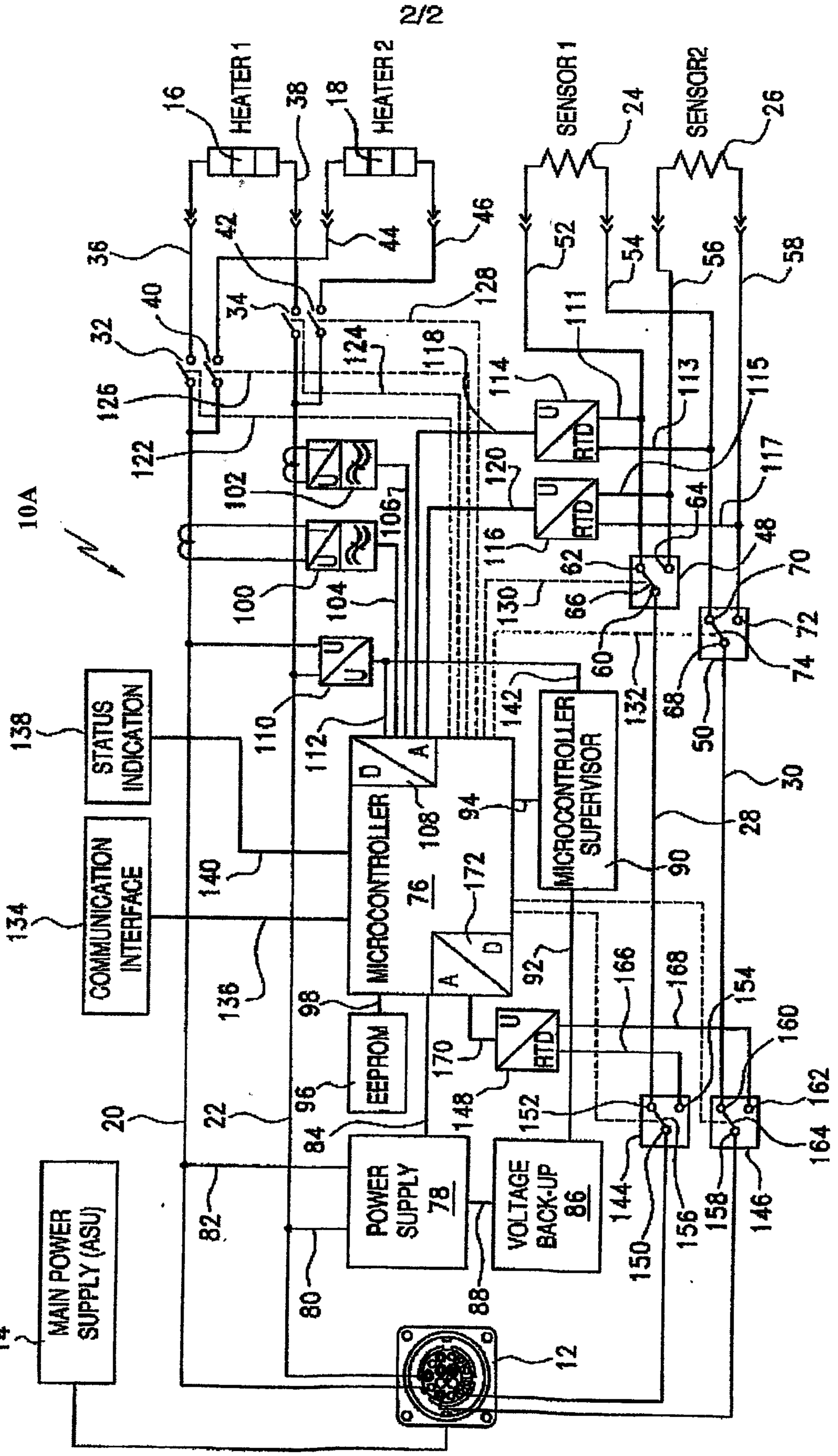


FIG. 1
(PRIOR ART)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HEATER 2
SENSOR 1
SENSOR2
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COMMUNICATION INTERFACE
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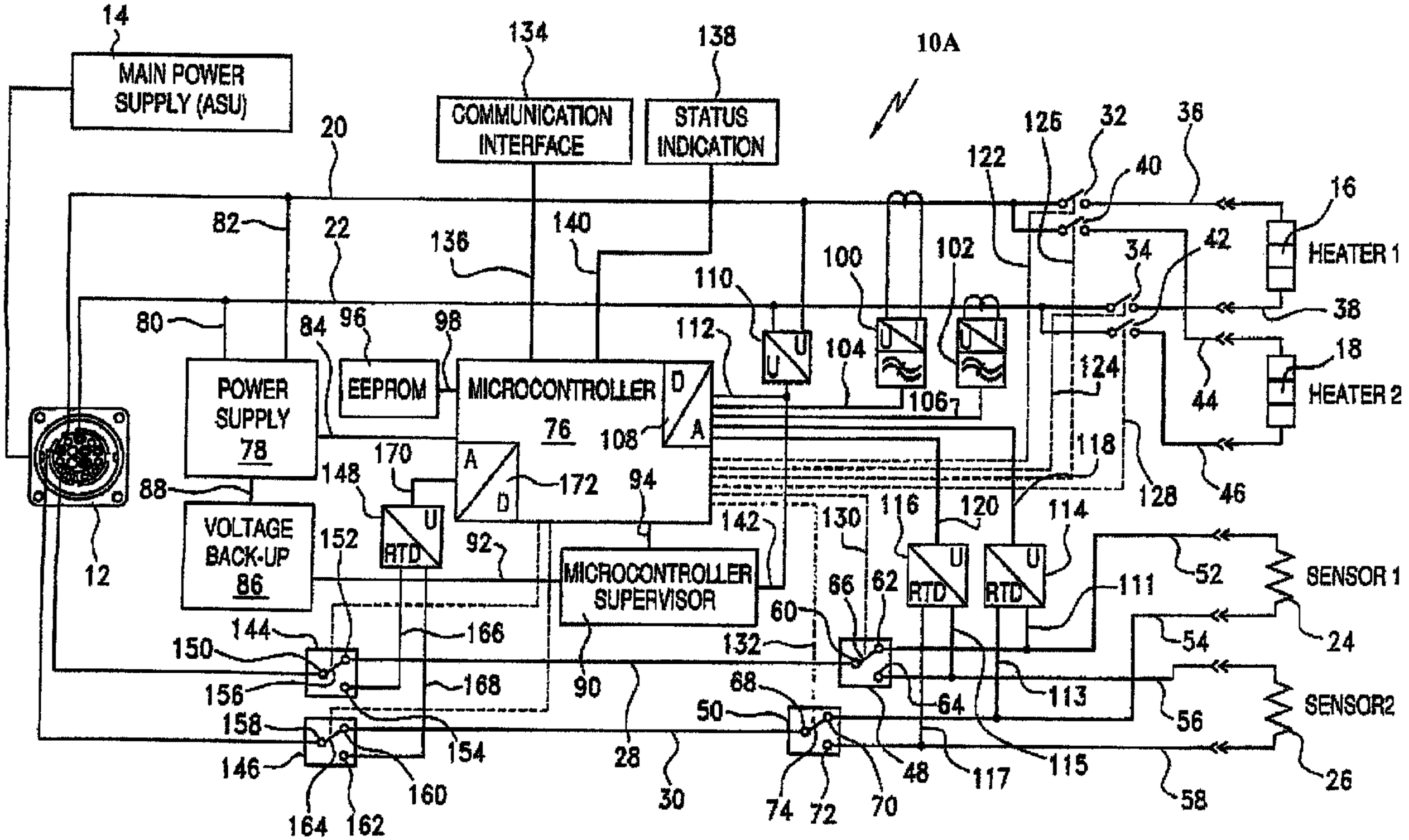
76
EEPROM
POWER SUPPLY
78
MICROCONTROLLER SUPERVISOR
VOLTAGE BACK-UP
86
MAIN POWER SUPPLY (ASU)
RTD
A
D
U

FIG. 2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COMMUNICATION INTERFACE
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82
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140
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126
32
36
40
16
HEATER 1
34
42
38
100
102
110
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104
106
80
84
96
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POWER SUPPLY 78
EEPROM
MICROCONTROLLER 76
D
A
108
124
44
18
HEATER 2
118
128
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170
148
172
94
88
VOLTAGE BACK-UP 86
152
92
MICROCONTROLLER SUPERVISOR
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120
114
12
RTD
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SENSOR 1
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SENSOR2
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