

SYSTEM AND METHOD FOR PROVIDING TEMPERATURE CONTROL

TECHNOLOGICAL FIELD

The presently disclosed subject matter relates to systems and methods for providing temperature control.

5 PRIOR ART

References considered to be relevant as background to the presently disclosed subject matter are listed below:

- US 8,123,460
- WO 2014/006309

- 10 Acknowledgement of the above references herein is not to be inferred as meaning that these are in any way relevant to the patentability of the presently disclosed subject matter.

BACKGROUND

- 15 There are many conventional electronic devices such as, for example, computer systems or avionics, and other types of devices, which generate waste heat during operation thereof. For many such devices, proper cooling thereof is essential, otherwise excessive heat generated by the devices can cause malfunctions and failure thereof. However, for at least some types of electronic devices overcooling the device can also
- 20 potentially damage the devices or affect their proper functioning.

Many air vehicles, including UAV's and manned vehicles, carry such devices, and conventionally, such devices are often convection cooled.

In some cases, an air conditioning system is used for providing a controlled temperature environment to such devices by controllably cooling an airflow in a closed-loop arrangement. In other cases a ram air flow is directly heated, and the heated air flow is exclusively injected directly onto the devices to provide the desired temperature control. Such systems often require relatively high levels of power consumption, as well as a significant installation volume and weight.

GENERAL DESCRIPTION

According to an aspect of the presently disclosed subject matter, there is provided a system for providing a controlled temperature in a control volume, comprising:

a main chamber defining the control volume, and having at least one main chamber inlet and one main chamber outlet;

a mixing chamber having a mixing chamber outlet in selective fluid communication with said main chamber inlet, at least one mixing chamber inlet, and a ram air inlet different from said at least one mixing chamber inlet for allowing a ram airflow at a first temperature to be channeled into said mixing chamber;

a gasflow source in selective fluid communication with said at least one mixing chamber inlet and configured for selectively providing a source gasflow at a second temperature to said mixing chamber, said second temperature being greater than said first temperature;

wherein said mixing chamber is configured for:

- in the presence of said source gasflow in said mixing chamber, selectively allowing said ram airflow and said source gasflow in said mixing chamber to mix therein to provide a mixing chamber outflow to the main chamber (for example via said mixed chamber outlet and said main chamber inlet); or
- in the absence of said source gasflow, selectively allowing said ram airflow in said mixing chamber to flow to the main chamber to thereby provide a mixing chamber outflow;

said mixing chamber outflow being at a third temperature at least at or near said main chamber inlet (for example at entry to said main chamber)

a control system operative to control at least one of said ram airflow, said source gasflow and said mixing chamber outflow to provide a desired said third
5 temperature at least at said main chamber inlet.

In particular, the ram airflow is a cooling ram airflow.

For example, said control system is operative to provide a said third temperature such as to maintain a temperature in said control volume within a preset operating temperature range between a preset minimum temperature and a preset maximum
10 temperature. For example, said preset minimum temperature is -35°C and wherein said preset maximum temperature is +55°C.

For example, the system comprises heating elements for controllably heating said source gasflow to a desired said second temperature. For example, said heating elements are electrical heating elements coupled to at least one of said gasflow source.

15 For example, the system comprises a first temperature sensor in said main chamber at or in the vicinity of said main chamber inlet, the first temperature sensor being in operative communication with said control system. For example, said control system operates to provide a desired said third temperature based at least partially on a sensed inlet temperature as sensed by said first temperature sensor.

20 For example, the system comprises a second temperature sensor in said main chamber at or in the vicinity of said main chamber outlet, the second temperature sensor being in operative communication with said control system. For example, said control system operates to provide a desired said third temperature based at least partially on a sensed outlet temperature as sensed by said second temperature sensor.

25 For example, the control system operates to increase at least one of the source gasflow, the second temperature, and the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature reaching said preset minimum temperature. For example, the control system operates to cease said increase of at least one of the source gasflow, the second temperature, and the mixing chamber

outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature being significantly above said preset minimum temperature.

For example, the control system operates to decrease at least one of the source gasflow and the second temperature, and/or to increase the mixing chamber outflow,
5 responsive to one of said sensed inlet temperature or said sensed outlet temperature reaching said preset maximum temperature. For example, the control system operates to cease said decrease of at least one of the source gasflow and the second temperature, and/or to cease said increase of the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature being significantly below said
10 preset maximum temperature.

For example, the system comprises a first controllable variable pump operatively connected to the control system and configured for controllably varying the magnitude of said source gasflow (i.e., the mass flow rate or volume flow rate thereof) into said mixing chamber. For example, the system further comprises a first controllable valve
15 operatively connected to the control system and configured for selectively closing flow of said source gasflow into said mixing chamber.

For example, the system comprises a second controllable variable pump operatively connected to the control system and configured for controllably varying the magnitude (i.e., the mass flow rate or volume flow rate thereof) of said mixing chamber
20 outflow into said main chamber. For example, the system comprises a flow path connecting said mixing chamber outlet to said main chamber inlet, and the second controllable variable pump is provided along this flow path. For example, the system further comprises a second controllable valve operatively connected to the control system and configured for selectively closing flow of said mixing chamber outflow into
25 said main chamber.

For example, said main chamber comprises an auxiliary outlet, and said gasflow source comprises a recirculation conduit connecting said auxiliary outlet to said mixing chamber inlet and configured for providing a recirculating airflow from said main chamber into the mixing chamber to thereby provide said source gasflow. For example,
30 said recirculation airflow is a first proportion of said mixing chamber outflow. For example, said first proportion is between 0% and 100%, or between 0% and 70%, or

between 30% and 70%, of said mixing chamber outflow. For example, the system comprises a first heating system coupled to said recirculation conduit to selectively heat said recirculation airflow to provide a desired said second temperature to said source gasflow.

5 For example, said gasflow source comprises an auxiliary ram intake, in operation thereof being open to atmospheric air, and an auxiliary conduit connecting said auxiliary ram intake to said mixing chamber inlet, wherein said auxiliary ram intake is configured for selectively channeling an atmospheric auxiliary airflow into the mixing chamber to thereby provide said source gasflow. For example, the system
10 comprises a second heating system coupled to said auxiliary conduit to selectively heat said atmospheric auxiliary airflow to provide a desired said second temperature to said source gasflow.

For example, said gasflow source comprises a pressurized gas container, and a container conduit connecting said pressurized gas container to said mixing chamber
15 inlet and configured for providing a pressurized gasflow into the mixing chamber to thereby provide said source gasflow. For example, the system comprises a third heating system coupled to said container conduit to selectively heat said pressurized gasflow to provide a desired said second temperature to said source gasflow.

For example, the system comprises a main ram intake, in operation thereof being
20 open to atmospheric air, and a ram conduit connecting said main ram intake to said ram air inlet, wherein said main ram intake is configured for selectively channeling said ram airflow into said mixing chamber. The ram air is not heated by artificial means prior to entry into the mixing chamber. Thus the system has an absence of heaters for the ram airflow upstream of the mixing chamber.

25 For example, said main chamber accommodates electronic components. For example, herein said components are operational within said preset temperature range.

According to this aspect of the presently disclosed subject matter, there are also provided systems and methods for providing a controlled temperature in a control volume. Such systems include a main chamber (defining the control volume), a mixing
30 chamber and a gasflow source. The mixing chamber has a mixing chamber outlet in

selective fluid communication with the main chamber, at least one mixing chamber inlet, and a ram air inlet for allowing ram airflow at a first temperature to be channeled into the mixing chamber. The gasflow source provides a source gasflow at a greater, second temperature to the mixing chamber. The mixing chamber provides the mixing chamber outflow at a third temperature by selectively allowing the ram airflow and the source gasflow in the mixing chamber to mix therein, or, by selectively allowing the ram airflow in the mixing chamber to flow to the main chamber (in absence of source gasflow). A controller is operative to provide a desired level for the third temperature.

According to this aspect of the presently disclosed subject matter, there is also provided an air vehicle comprising the system as defined herein with respect to this aspect of the presently disclosed subject matter. For example, the air vehicle is a UAV.

According to an aspect of the presently disclosed subject matter, there is provided a method for providing a controlled temperature in a control volume, comprising:

- providing a ram airflow at a first temperature into a mixing chamber;
selectively providing a source gasflow at a second temperature into said mixing chamber, said second temperature being greater than said first temperature; and
wherein:
 - in the presence of said source gasflow in said mixing chamber, selectively allowing said ram airflow and said source gasflow in said mixing chamber to mix therein to provide a mixing chamber outflow to the control volume; or
 - in the absence of said source gasflow, selectively allowing said ram airflow in said mixing chamber to flow to the control volume to thereby provide a mixing chamber outflow;
- said mixing chamber outflow being at a third temperature at least at or near entry to the control volume;
controlling at least one of said ram, airflow, said source gasflow and said mixing chamber outflow to provide a desired said third temperature at least at or near entry to the control volume.

For example, said third temperature such as to maintain a temperature in said control volume within a preset operating temperature range between a preset minimum

temperature and a preset maximum temperature. For example, said preset minimum temperature is -35°C and wherein said preset maximum temperature is +55°C.

For example, the method comprises providing a heating source and, using the heating source, controllably heating said source gasflow to a desired said second
5 temperature.

For example, the method comprises providing a desired said third temperature based at least partially on a sensed inlet temperature as sensed at or in the vicinity of an inlet of the control volume.

For example, the method comprises providing a desired said third temperature
10 based at least partially on a sensed outlet temperature as sensed at or in the vicinity of an outlet of the control volume. For example, the method comprises increasing at least one of the source gasflow, the second temperature, and the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature reaching said preset minimum temperature. For example, the method comprises ceasing
15 said increase of at least one of the source gasflow, the second temperature, and the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature being significantly above said preset minimum temperature. For example, the method comprises decreasing at least one of the source gasflow and the second temperature, and/or to increase the mixing chamber outflow, responsive to
20 one of said sensed inlet temperature or said sensed outlet temperature reaching said preset maximum temperature. For example, the method comprises ceasing said decrease of at least one of the source gasflow and the second temperature, and/or to cease said increase of the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature being significantly below said preset
25 maximum temperature.

For example, the method comprises controllably varying the magnitude of said source gasflow into said mixing chamber.

For example, the method comprises controllably varying the magnitude of said mixing chamber outflow into the control volume. For example, the method comprises

controllably varying the magnitude of said mixing chamber outflow into the control volume.

For example, the method comprises providing a recirculating airflow from the control volume into the mixing chamber to thereby provide said source gasflow. For example, said recirculation airflow is a first proportion of said mixing chamber outflow, and wherein said first proportion is between 0% and 100%, or between 0% and 70%, or between 30% and 70%, of said mixing chamber outflow. For example, the method comprises selectively heating said recirculation airflow to provide a desired said second temperature to said source gasflow.

For example, the method comprises selectively channeling an atmospheric auxiliary airflow into the mixing chamber, different from said ram, airflow, to thereby provide said source gasflow. For example, the method comprises selectively heating said atmospheric auxiliary airflow to provide a desired said second temperature to said source gasflow.

For example, the method comprises providing a pressurized gasflow into the mixing chamber to thereby provide said source gasflow. For example, the method comprises selectively heating said pressurized gasflow to provide a desired said second temperature to said source gasflow.

For example, the control volume accommodates electronic components.

A feature of at least some examples of the presently disclosed subject matter is that the cooling airflow, after being heated by heat exchange with the components during passage through the control volume, can be recirculated to the mixing chamber, and thus use can be made of this excess heat. In this manner, the ram air can be effectively heated to the desired temperature (in the mixing chamber) without the need for power to be expended in actively heating the ram airflow. In at least some examples, this can lead to a relatively simple, light system for providing a controlled temperature in the control volume, and having low power consumption. Thus, in at least some examples of the presently disclosed subject matter, the required equipment operation conditions (given a particular environmental air temperature) can be achieved with minimum power consumption, providing power saving. For example, a recirculating conduit can be provided between the control volume and the mixing chamber, and pumps can be used for providing a desired magnitude of recirculated flow of the flow in the control volume that is

heated by passage therethrough (i.e., the source gasflow) to the mixing chamber, thereby providing a compact system with low capital cost and low operating costs.

A feature of at least some examples of the presently disclosed subject matter is that a system for providing a controlled temperature in the control volume can be provided that
5 is simple, robust and of low cost.

A feature of at least some examples of the presently disclosed subject matter is that a system for providing a controlled temperature in the control volume can be provided that does not require many "moving parts" and for example can thus omit dynamic flappers, flow control valves, shutoff valves, and so on.

10 A feature of at least some examples of the presently disclosed subject matter is that a system for providing a controlled temperature in the control volume can be provided in which the desired temperature can be provided by controlling fans that drive the source gasflow into said mixing chamber.

A feature of at least some examples of the presently disclosed subject matter
15 is that a system for providing a controlled temperature in the control volume can be provided in which there is homogeneity of the cooling flow into the control volume, in particular homogeneity in the temperature of the cooling flow into the control volume.

BRIEF DESCRIPTION OF THE DRAWINGS

20 In order to better understand the subject matter that is disclosed herein and to exemplify how it may be carried out in practice, examples will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a partial, top-front isometric view of an air vehicle including a system
25 for providing a controlled temperature in a control volume, according to a first example of the presently disclosed subject matter.

Fig. 2 is a partial top-front isometric view of the example of the system of Fig.
1.

Fig. 3 is a partial, detail, top-front isometric view of the mixing chamber of the example of the system of Fig. 1; **Fig. 3(a)** is a cross-sectional side view of the example of Fig. 3.

Fig. 4 is a partial, detail, top-front isometric view of a front part of the example
5 of the system of Fig. 2.

Fig. 5 schematically illustrates the components of the example of the system of Figs. 1 to 4.

Fig. 6 schematically illustrates the components of an alternative variation of the example of the system of Figs. 1 to 4.

10 **Fig. 7** schematically illustrates the components of another alternative variation of the example of the system of Figs. 1 to 4.

Fig. 8 schematically illustrates the components of another alternative variation of the example of the system of Figs. 1 to 4.

15 **DETAILED DESCRIPTION**

Referring to Figs. 1 to 4, there is illustrated a system for providing a controlled temperature in a predefined volume (referred to herein as the control volume), according to a first example of the presently disclosed subject matter, the system being generally designated with the reference numeral **100**. The system **100** comprises a main chamber
20 **200** defining the control volume **V**, a mixing chamber **300**, a gasflow source **400**, and a control system **500** (also referred to interchangeably herein as a controller).

In particular, the system **100** selectively operates as a cooling system, for cooling the control volume **V**, in particular via convection.

Reference is also made to Fig. 5, which schematically illustrates the components
25 of the system **100**, as disclosed herein.

The system **100** is particular configured for use in an air vehicle, for example a UAV, but can also be applied to manned vehicles in a similar manner, *mutatis mutandis*.

In this example, it is desired to regulate the temperature in the control volume **V** so that all parts thereof are kept within a desired temperature range. For example, the control volume **V** contains heat generating components, for example electronic components, that generate heat during operation thereof, and that must or should or that it is desired to be
5 kept within a temperature range **R**, for example between a minimum temperature of about -35° and a maximum temperature of about +55°, to ensure proper working and/or to avoid damaging the components; thus, in this example, it is desired in particular to regulate the temperature in the control volume **V** so that any such heat generating components (e.g. electronic components) therein are kept within the desired temperature range.

10 Referring in particular to Fig. 1 and Fig. 2, the main chamber **200** in this example is provided by an internal portion of the forward fuselage **10** of an air vehicle **1** that includes a torsion box **12** and landing gear bay **14**. In this example, the main chamber **200** is generally bounded by the internal walls **210** of the fuselage **10**, the outer wall **230** of the torsion box **12** and the outer wall **240** of the landing gear bay **14**, and having an aft end
15 wall **290**. It is evident, though, that the main chamber **200** can be extended to or defined by aft bay **17**, or that the main chamber **200** can instead be provided elsewhere in the air vehicle **1**, and/or can be provided as a self contained unit independent of the torsion box **12** and/or of the landing gear bay **14** and/or of the inside of the fuselage **10**, as desired or required.

20 The main chamber **200** comprises a plurality of main chamber outlets **240**, provided in aft end wall **290**, although in alternative variations of this example, the main chamber **200** comprises one main chamber outlet **240**, in the aft end wall or elsewhere. In any case, the main chamber outlets **240** allow outflow of air flowing out of the main chamber **200** into an aft part of the fuselage **10**, and eventually is ejected from the air
25 vehicle via a suitable vent **18**, for example, or to allow outflow of air flowing out of the main chamber **200** directly out of the air vehicle.

The main chamber **200** further comprises a number of main chamber inlets **220** to allow airflow into the main chamber **200** from the mixing chamber **300**. In this example, four main chamber inlets **220** are provided, though in alternative variations of this
30 example, one, two, three, or more than four main chamber inlets **220** can be provided instead.

In this example, the mixing chamber **300** is partly defined by front wall **330a**, rear wall **330b**, and side walls **330c** of the torsion box **12**, and further comprises an upper wall **310** and lower wall **320**, defined by an inside of the fuselage **10**, for example. In alternative variations of this example, the mixing chamber **300** is provided as a self contained unit
5 independent of the torsion box **12** and/or of the inside of the fuselage **10**.

The mixing chamber **300** comprises a number of mixing chamber outlets **340** in selective fluid communication with the control volume **V** via the respective main chamber inlets **220**. In this example, the number of mixing chamber outlets **340** is matched to the number of main chamber inlets **220**, so that air flow into the main chamber **200** is
10 exclusively via the mixing chamber **300**, in particular via the mixing chamber outlets **340**. Thus, in this example four mixing chamber outlets **340** are provided, though in alternative variations of this example, one, two, three, or more than four mixing chamber outlets **340** can be provided instead.

In this example, two of the mixing chamber outlets **340** are in the form of elbow
15 tubings, extending laterally from the side walls **330c** of the mixing chamber **300** (torsion box **12**) and facing generally aft, and two additional mixing chamber outlets **340** are provided on the upper wall **310**.

Referring to Fig. 2 in particular, each of the mixing chamber outlets **340** includes a controllable variable pump **345**. In this example, each pump **345** is in the form of an
20 electric fan, the operation of which is controlled by control system **500**, and each pump **345** is operatively connected to the control system **500**, represented by line **540** in Fig. 5. In alternative variations of this example, each mixing chamber outlet **340** includes a controllable valve, the operation of each valve being controlled by control system **500**, operatively connected thereto. In yet other alternative variations of this example, the
25 controllable valve, and/or the pump **345**, can be omitted from system **100**.

The mixing chamber **300** further comprises at least one mixing chamber inlet **370**, for introducing a gasflow into the mixing chamber **300**, as will become clearer below.

The mixing chamber **300** further comprises a ram air inlet **360** (see Fig. 4), different from the mixing chamber inlet **370**. A main ram intake **399** is mounted to the
30 front wall **330a** of the mixing chamber **300**, having an intake end **397** and ram conduit

396, as best seen in Fig. 4. The intake end **397** is provided on an outside of the fuselage **10**, and thus in operation main ram intake **399** is open to atmospheric air. The ram conduit **396** connects the main ram intake **399** to the ram air inlet **360**, and thus the main ram intake is configured for selectively channeling a ram airflow **RA** (i.e., a flow of ram air having a particular mass flow rate or volume flow rate) into the mixing chamber **300** when the air vehicle **1** is in motion. The ram air inlet **360** thus allows the ram airflow **RA** to be channeled into the mixing chamber **300**. The ram airflow **RA** usually provides a cooling airflow to the mixing chamber **300**.

The mixing chamber **300** can be configured for enhancing mixing of the ram airflow **RA** and the source gasflow **SG**, to promote homogeneity of the mixed chamber outflow **MO**.

For example, in this example, and as best seen in Figs. 3 and 3(a), the mixing chamber **300** comprises a stagnation plate **301** longitudinally spaced from the ram air inlet **360**, onto which the ram airflow **RA** impinges on entering the mixing chamber, and thereafter disperses in many different directions. The source gasflow **SG** enters the mixing chamber **300** via mixing chamber inlets **370**, which are situated above the stagnation plate **301**. This source gasflow **SG** impinges onto the inside of the front wall **330a**, which also acts as a stagnation plate, and thereafter also disperses in many different directions. Both dispersed flows – the ram airflow **RA** and the source gasflow **SG** - provide high levels of turbulence within the mixing chamber **300**, enhancing mixing of the two flows, to promote homogeneity of the mixed chamber outflow **MO**, and thus promotes homogeneity of the temperature of mixed chamber outflow **MO**. Thus, the cooling air provided to the control volume **V** has an improved homogeneity, particularly in temperature thereof.

Optionally, and referring to Fig. 5 in particular, the ram conduit **396** includes a controllable variable valve **355**, for example at or near the ram air inlet **360**. For example, the valve **355** is in the form of an electrically operable butterfly valve, the operation of which is controlled by control system **500**, and each valve **355** is operatively connected to the control system **500**, represented by line **560** in Fig. 5. The valve **355** enables the ram airflow **RA** to be regulated by the control system, and even to be shut off entirely when desired. In alternative variations of this example, each mixing chamber outlet **340** includes a controllable pump, the operation of each pump being controlled by control system **500**,

operatively connected thereto; such a pump can be selectively used to increase the ram airflow **RA** under certain circumstances.

The gasflow source **400** is in selective fluid communication with the mixing chamber inlet **370**, and is configured for selectively providing a source gasflow **SG** (i.e., a
5 flow of air or other gas from the gasflow source and having a particular mass flow rate or volume flow rate) to the mixing chamber **300**.

The gasflow source **400** in this example comprises a recirculation conduit in the form of a bifurcated duct **420** provided above the landing gear bay **14**, as best seen in Fig. 2, though alternative ducting arrangements can also be used instead. The
10 bifurcated duct **420** has two, aft-disposed branches **425** that join to form a single main duct **426**, at a forward end. The gasflow source **400**, in particular each branch **425** has an inlet **430** (corresponding effectively to an auxiliary outlet provided by the main chamber **200**) at an aft end thereof, open to the main chamber **200**. The main duct **426** includes an elbow section **427** downstream of the branches **425**, and a forward section
15 **429** projecting into the mixing chamber **300**. The elbow section **427** is required in this example to account for the difference in height between the landing gear bay **14** and the mixing chamber **300**, and thus can be omitted in alternative variations of this example in which there is no such difference in height, for example. The forward end of the forward section **429** comprises a pair of openings **421** corresponding to the mixing
20 chamber inlet **370**, each opening **421** including a controllable variable pump **450**. In this example, each pump **450** is in the form of an electric fan, the operation of which is controlled by control system **500**, and each pump **450** is operatively connected to the control system **500**, represented by line **530** in Fig. 5. In at least this example, each pump **450** also effectively operates as a shut off valve, such that when it is not operating
25 the source gasflow **SG** to the mixing chamber is reduced to zero, nominally.

The recirculation conduit thus essentially connects the inlet **430** (or auxiliary outlet of the main chamber **200**) to the mixing chamber inlet **370** and is configured for providing a recirculating airflow from the main chamber **200** into the mixing chamber **300** to thereby provide the required source gasflow **SG**.

30 The gasflow source **400** thus selectively allows a portion **Q** of the air flowing through main chamber **200** (i.e., this portion defining the source gasflow **SG**) to be recirculated back into the mixing chamber **300**, via openings **420**, branches **425**, main duct

426 and openings 421, selectively drawn from main chamber 200 by the action of the pumps 450.

The temperature of the ram airflow **RA**, referred to herein as the first temperature **T1**, is variable, and generally depends on atmospheric conditions as well as the airspeed of the air vehicle 1. In this example, the flow rate of the ram airflow **RA** also generally depends on atmospheric conditions (for example altitude) as well as the airspeed of the air vehicle 1. In general, the higher the flying altitude of the air vehicle, the colder temperature **T1** becomes.

The temperature of the source gasflow **SG**, referred to herein as the second temperature **T2**, can also vary. In this example, the gasflow source 400 comprises a heat source in the form of a heating system coupled to said recirculation conduit to selectively heat the recirculation airflow to provide a desired second temperature **T2** to the source gasflow **SG**. In this example, the heating system comprises a heater unit 470, including heating elements configured for controllably heating the source gasflow **SG** to a desired second temperature **T2**. In this example, the heating elements are electrical heating elements coupled to the gasflow source 400, such as to enable thermal communication and heat exchange between the heating elements and the source gasflow **SG**. In this example, the system 100 can optionally be operated without using the heater unit 470, in which case the second temperature **T2** corresponds to the temperature of the airflow though the main chamber 200, at the inlet 430, and thus the temperature **T2** is attained from the heat generated by the components in the volume **V** and removed therefrom by heat exchange with the mixed airflow **MO**. In alternative variations of this example, the heater unit 470 comprises a combustion system for burning a liquid or gaseous fuel in the source gasflow **SG** to selectively provide heat thereto.

In yet other alternative variations of this example, the heater unit 470 can be omitted, and thus the second temperature **T2** corresponds to the temperature of the airflow though the main chamber 200, at the inlet 430, and thus the temperature **T2** is attained from the heat generated by the components in the volume **V** and removed therefrom by heat exchange with the mixed airflow **MO**.

The heater unit 470 is operatively connected to the control system 500, represented by line 550 in Fig. 5.

The second temperature **T2** thus generally depends on the temperature of the airflow through the main chamber **200**, and/or on operation of the heater unit **470**.

In general, the second temperature **T2** is greater than the first temperature **T1**.

In this example, and referring in particular to Fig. 1, a temperature sensor **SA** is
5 provided at or near one of the main chamber inlets **220**, for determining the inlet temperature **T_A** in the control volume **V** corresponding to main chamber inlets **220**. In this example, the temperature sensor **SA** is provided in the main chamber **200**, and is operatively connected to the control system **500**, represented by line **510** in Fig. 5.

Another temperature sensor **SB** is provided at or near one of the main chamber
10 outlets **240**, for determining the outlet temperature **T_B** in the control volume **V** corresponding to main chamber outlets **240**. In this example, the temperature sensor **SB** is provided in the main chamber **200**, and is operatively connected to the control system **500**, represented by line **520** in Fig. 5.

Reference is now made in particular to Fig. 5, which, as already mentioned,
15 schematically illustrates the components of the system **100**, as disclosed above.

The mixing chamber **300** is configured to operate as follows:

(a) In the presence of the source gasflow **SG** flowing into the mixing chamber **300**, the mixing chamber **300** is configured to selectively allow the ram airflow **RA** (provided via the main ram intake **399**) and the source gasflow **SG** (provided
20 by the gasflow source **400**) in the mixing chamber **300** to continuously mix therein, to thereby provide a mixing chamber outflow **MO** (i.e., a flow of mixed air and/or gas from the mixing chamber and having a particular mass flow rate or volume flow rate) to the main chamber **200** (i.e., via the mixed chamber outlets **340** and the main chamber inlets **220**).

(b) In the absence of said source gasflow **SG**, the mixing chamber **300** is
25 configured to selectively allow the ram airflow **RA** in the mixing chamber **300** (provided via the main ram intake **399**) to continuously flow to the main chamber **200**, to thereby provide a mixing chamber outflow **MO** to the main chamber **200** (i.e., via the mixed chamber outlets **340** and the main chamber inlets **220**).

In this example, the source gasflow **SG**, as a portion **Q** of the mixing chamber outflow **MO**, can nominally vary between 0% and 100% of said mixing chamber outflow **MO**. For example, with the pump **450** switched off so that nominally the source gasflow **SG** is zero, portion **Q** is 0%. For example, with the ram airflow **RA** at
5 nominally zero (for example: the air vehicle has zero forward speed, for example on the ground; or very little forward speed close to stall; or where the valve **355** is closed and does not allow ram air to enter the mixing chamber), all of the mixing chamber flow **MO** can be recirculated as source gasflow **SG**, and thus portion **Q** is 100%.

In practice for this example, the system **100** can be set to operate such that this
10 portion **Q** can vary between 0% and 70%, or between 30% and 70% of said mixing chamber outflow **MO**.

The mixing chamber outflow **MO**, at least at or near the main chamber inlets **220**, is at a third temperature **T3**, the magnitude of which depends on the ratio of the ram airflow **RA** to the source gasflow **SG**, as well as on the first temperature **T1** and the second
15 temperature **T2**.

The control system **500** comprises any suitable computer system capable of receiving inputs from several sources, for example temperature sensors **SA** and **SB**, and for outputting command signals, for example to one or more of the pumps **345**, **450**, valve **355** and heat unit **470**, for operation thereof, according to suitable command algorithms or truth
20 tables programmed in the control system **500**, and as set forth herein for example. Alternatively, the control system **500** can comprise an electronic digital or analog control system, operable in a similar manner.

The control system **500** is operative to control at least one of, and optionally any two of or all three of, the ram airflow **RA**, the source gasflow **SG** (optionally including the
25 temperature **T2** thereof) and the mixing chamber outflow **MO**, to modify the third temperature **T3** at least at or near the main chamber inlets **220**, such as to provide a desired inlet temperature **T_A** and/or a desired outlet temperature **T_B**.

In particular, the control system **500** is operative to control the third temperature **T3** and the mixing chamber outflow **MO** such that the control volume temperature, i.e.,
30 the temperature throughout the control volume **V**, remains within a preset operating temperature range between a preset minimum temperature **T_{min}** and a preset maximum

temperature $T_{\max}$. For example, the mixing chamber outflow **MO** can be controlled directly via valve **351** and/or pump **345**, or indirectly by controlling the ram airflow **RA** and/or the source gasflow **SG**.

For example, the preset minimum temperature $T_{\min}$ is -35°C and the preset
5 maximum temperature $T_{\max}$ is about 55°C . The control volume temperature is determined by one or both of the inlet temperature T_A corresponding to main chamber inlets **220**, determined by sensor **SA**, and the outlet temperature T_B corresponding to main chamber outlets **240**, determined by sensor **SB**.

In at least one mode of operation of the control system **500**, the control system **500**
10 operates to control the ram airflow **RA**, and/or source gasflow **SG** and/or the temperature **T2**, and/or and the mixing chamber outflow **MO**, to maintain the inlet temperature T_A greater than the preset minimum temperature $T_{\min}$ and/or to maintain the outlet temperature T_B less than the preset maximum temperature $T_{\max}$. Accordingly, the control system **500** can be programmed with suitable algorithms, with inputs corresponding to one
15 or more of lines **510**, **520**, and outputs corresponding to one or more of lines **530**, **540**, **550**, **560** to operate in this manner.

In one mode of operation, a desired third temperature **T3** is provided by regulating or otherwise controlling the source gasflow **SG** via control system **500**, by controlling the flow rate of the source gasflow **SG** via pumps **450** and/or by controlling the second
20 temperature **T2** thereof via the heating unit **470**. For a fixed mixing chamber outflow **MO**, the higher the flow rate and/or the higher the second temperature **T2** of the source gasflow **SG**, the higher the third temperature **T3** becomes, and thus the higher the inlet temperature T_A and the higher the outlet temperature T_B , which in turn also increases the second temperature **T2** since the source gasflow **SG** originates from the main chamber **200**. The
25 converse also applies, i.e., for a fixed mixing chamber outflow **MO**, the lower the flow rate and/or the lower the second temperature **T2** of the source gasflow **SG**, the lower the third temperature **T3** becomes. In this mode of operation, the system **100** can omit pumps **345**, **360**, and valves **355**, **351** and **451**, and optionally also heating unit **470**, so that the control of the temperature **T3** is exclusively by operating the pump **450** to provide a desired
30 source gasflow **SG** to mix in the mixing chamber with ram airflow **RA**, thereby regulating the temperature at inlet to the control volume **V**.

In another mode of operation, a desired third temperature **T3** is provided by regulating or otherwise controlling the mixing chamber outflow **MO** via control system **500**, for example by controlling the flow rate of ram airflow **RA** via valve **355** and/or changing the airspeed and/or altitude of the air vehicle, and/or by controlling the valve **351** and/or pump **345**. For example, for a source gasflow **SG** having a fixed flow rate and/or a fixed second temperature **T2**, the higher the mixing chamber outflow **MO** (which can be increased for example by increasing the ram airflow **RA**), the lower the third temperature **T3** becomes. The converse also applies, i.e., for a source gasflow **SG** having a fixed flow rate and/or a fixed second temperature **T2**, the lower the mixing chamber outflow **MO** (which can be decreased for example by decreasing the ram airflow **RA**), the higher the third temperature **T3** becomes.

For example, by the control system **500** operating to close the pumps **450**, and thus setting the source gasflow **SG** to zero, the third temperature **T3** is governed by the first temperature **T1**, as well as the magnitude of the mixing chamber outflow **MO**, which is controlled by pumps **345** and/or valve **351**. The pumps **345** and/or valve **351** can also provide a back pressure to the ram airflow **RA**, which thus also affects the magnitude of the ram airflow **RA** into the mixing chamber **300**. As the pumps **345** operate at a higher flow rating and/or as the valve **351** is opened more and more under the control of control system **500**, while the magnitude of the temperature **T3** may not change significantly for a fixed first temperature **T1** (corresponding to constant airspeed and uniform atmospheric conditions), the greater flow rate of the mixing chamber outflow **MO** has a greater impact on the temperature of the main chamber **200**.

Thus, again for the case of zero source gasflow **SG**, when the temperature in the main chamber **200** (as determined by inlet temperature **TA** or outlet temperature **TB**) is higher than temperature **T1**, and it is desired to lower the temperature in the main chamber **200**, the magnitude of the mixing chamber outflow **MO** is controlled by the control system **500** to reduce the measured inlet temperature **TA** or outlet temperature **TB** as desired.

The system **100** has the added feature that the source gas flow **SG** can be provided and further controlled to further control and fine-tune the temperature within the main chamber **200**, and thus avoid temperatures lower than a desired preset minimum temperature and/or avoid exceeding a preset maximum temperature, anywhere within the

control volume **V**. Effectively, this is carried out by mixing relatively warm air of the source gasflow **SG** at second temperature **T2** with the relatively colder air of the ram air flow **RA** at temperature **T1**, to avoid providing very cold air to the control volume **V** when the first temperature **T1** is below the preset minimum temperature **T_{min}**. In such cases, whenever the temperature **T1** of the ram airflow **RA** is unacceptably low, it can be effectively increased by mixing with the source gasflow **SG** at second temperature **T2**.

In the example of Figs. 1 to 4, a relatively warm source gasflow **SG** is economically provided by recirculating at least a portion **Q** of the flow through the control volume **V**, which has been heated by the heat generating components therein, for example by operating pump **450**. This arrangement has few moving parts and often requires little power consumption for a large operating range of conditions for the air vehicle.

Furthermore, an adequate airflow mass flow rate can be provided through the control volume **V** to provide the required cooling, which can be somewhat independent of the first temperature **T1**. In other words, the system **100** can provide a relatively larger cooling airflow (i.e. mixed outflow **MO**) at a moderately cold temperature **T3** (by mixing relatively warm source gasflow **SG** at second temperature **T2** with colder ram inlet flow **RA** at very low temperature **T1**), as opposed to providing a relatively smaller cooling airflow at (i.e. mixed outflow **MO**) at a relatively colder temperature **T3** (by not providing source gasflow **SG** at second temperature **T2**, and thus the mixed outflow **MO** corresponds to the colder ram inlet flow **RA** at very low temperature **T1**). It is possible that in both cases, the same global heat transfer may be achieved in the control volume **V**, and the same final average temperature may be provided in the cooling volume **V**. However, in the second case, some parts of the control volume **V** could be exposed to the very cold airflow at temperature **T3** that is lower than the preset minimum temperature **T_{min}**, while in the first case this can be avoided altogether or the risk thereof significantly minimized by providing a cooling flow that has greater homogeneity in the temperature thereof.

Optionally, and as illustrated in Fig. 5, the system **100** comprises a first controllable valve **351** operatively connected to the control system **500** and configured for selectively closing the mixing chamber outflow **MO** into the main chamber **200**.

Optionally, and as illustrated in Fig. 5, the system **100** comprises a second controllable valve **451**, different from the pump **450**, operatively connected to the control

system **500** and configured for selectively closing the source gasflow SG into the mixing chamber **300**.

Thus, the control system **500** selectively operates to deliver a mixing chamber outflow **MO** at a desired third temperature **T3** based at least partially on inlet temperature **T_A** as sensed by the first temperature sensor **SA**, and/or, the control system **500** operates to provide a mixing chamber outflow **MO** at a desired third temperature **T3** based at least partially on outlet temperature **T_B** as sensed by second temperature sensor **SB**.

Furthermore, the control system **500** selectively operates to increase at least one of the source gasflow **SG**, the second temperature **T2**, and the mixing chamber outflow **MO**, responsive to the inlet temperature **T_A** or the outlet temperature **T_B** reaching the preset minimum temperature **T_{min}**, to correspondingly control the third temperature **T3**. Conversely, the control system **500** selectively operates to cease said increase of at least one of the source gasflow, the second temperature, and the mixing chamber outflow **MO**, responsive to said third temperature being significantly above said preset minimum temperature **T_{min}** and in particular exceeding the preset maximum temperature **T_{max}**.

Furthermore, the control system **500** selectively operates to decrease at least one of the source gasflow **SG** and the second temperature **T2**, and/or to increase the mixing chamber outflow **MO**, responsive to the inlet temperature **T_A** or the outlet temperature **T_B** reaching the preset maximum temperature **T_{max}**, to correspondingly control the third temperature **T3**. Furthermore, the control system **500** selectively operates to cease the decrease of at least one of the source gasflow **SG** and the second temperature **T2**, and/or to cease the increase of the mixing chamber outflow **MO**, to the inlet temperature **T_A** or the outlet temperature **T_B** being significantly below the preset maximum temperature **T_{max}**, to correspondingly control the third temperature **T3**.

In an alternative variation of the example of Figs. **1** to **5**, schematically illustrated in Fig. **6**, the gasflow source **400** comprises an auxiliary ram intake **430A**, instead of the recirculation circuit of Fig. **5**. For example, the auxiliary ram intake **430A** comprises an auxiliary intake end provided on an outside of the fuselage **10**, and thus in operation the auxiliary ram intake **430A** is open to atmospheric air. An auxiliary conduit **440A** connects the auxiliary ram intake to the mixing chamber inlet **370** via variable pump **450** and valve **451**, in a similar manner to that disclosed for the example of Fig. **5**, *mutatis mutandis*. The

auxiliary ram intake **430A** is configured for selectively channeling an atmospheric auxiliary airflow into the mixing chamber **300** to thereby provide the source gasflow **SG**. In the example of Fig. 6, a second heating system **470A** is provided, coupled to the auxiliary conduit **440A** to selectively heat the atmospheric auxiliary airflow channeled by the auxiliary intake **430A**, to provide a desired second temperature **T2** to the source gasflow **SG**. In this example, the source gasflow **SG** is thus independent from the airflow through the main chamber **200**. It is readily evident that the example of Fig. 6 can be modified to add thereto the recirculation circuit of Fig. 5, such that either one or both of the recirculation circuit and the auxiliary ram intake **430A** selectively provide the source gasflow **SG**, as controlled by the control system **500**.

In another alternative variation of the example of Figs. 1 to 5, schematically illustrated in Fig. 7, the gasflow source **400** comprises a pressurized gas container **430B**, instead of the recirculation circuit of Fig. 5. A container conduit **440B** connects the pressurized gas container **430B** to the mixing chamber inlet **370**. The pressurized gas container **430B** can contain any suitable gas in pressurized or liquefied form, for example air, nitrogen, and so on, and is configured for providing a pressurized gasflow into the mixing chamber **300** to thereby provide the required source gasflow **SG**. In the example of Fig. 7, a third heating system **470B** is provided, coupled to the container conduit **440B** to selectively heat the pressurize gasflow, to provide a desired second temperature **T2** to the source gasflow **SG**. In this example, the source gasflow **SG** is thus independent from the airflow through the main chamber **200**. It is readily evident that the example of Fig. 7 can be modified to add the recirculation circuit of Fig. 5, such that either one or both of the recirculation circuit and pressurized gas container **430B** selectively provide the source gasflow **SG**, as controlled by the control system **500**. It is also readily evident that the example of Fig. 7 can be modified to add the auxiliary ram intake **430A** and the auxiliary conduit **440A** and heating system **470A** of the example of Fig. 6, such that either one or both of (a) the pressurized gas container **430B**, and (b) the auxiliary ram intake **430A**, auxiliary conduit **440A** and heating system **470A** of the example of Fig. 6, selectively provide the source gasflow **SG**, as controlled by the control system **500**.

In another alternative variation of the example of Figs. 1 to 5, schematically illustrated in Fig. 8, the gasflow source **400** comprises, in addition to the recirculation circuit of Fig. 5, the auxiliary ram intake **430A** and the auxiliary conduit **440A** and heating

system **470A** of the example of Fig. 6, as well as the pressurized gas container **430B** and heating system **470B** of the example of Fig. 7. In this example, the control system **500** operates one or more of the elements of the gasflow source **400**, i.e., one or more of (i) recirculation circuit and/or heating system **470**, (ii) the auxiliary ram intake **430A** and/or
5 heating system **470A**, and/or (iii) the pressurized gas container **430B** and heating system **470B**, to provide the desired source gasflow **SG** and desired second temperature **T2**.

In the method claims that follow, alphanumeric characters and Roman numerals used to designate claim steps are provided for convenience only and do not imply any particular order of performing the steps.

10 Finally, it should be noted that the word “comprising” as used throughout the appended claims is to be interpreted to mean “including but not limited to”.

While there has been shown and disclosed examples in accordance with the presently disclosed subject matter, it will be appreciated that many changes may be made therein without departing from the spirit of the presently disclosed subject matter.

CLAIMS:

1. System for providing a controlled temperature in a control volume, comprising:
 - a main chamber defining the control volume, and having at least one main chamber inlet and one main chamber outlet;
 - 5 a mixing chamber having a mixing chamber outlet in selective fluid communication with said main chamber inlet, at least one mixing chamber inlet, and a ram air inlet different from said at least one mixing chamber inlet for allowing a ram airflow at a first temperature to be channeled into said mixing chamber;
 - 10 a gasflow source in selective fluid communication with said at least one mixing chamber inlet and configured for selectively providing a source gasflow at a second temperature to said mixing chamber, said second temperature being greater than said first temperature;
 - wherein said mixing chamber is configured for:
 - 15 - in the presence of said source gasflow in said mixing chamber, selectively allowing said ram airflow and said source gasflow in said mixing chamber to mix therein to provide a mixing chamber outflow to the main chamber; or
 - in the absence of said source gasflow, selectively allowing said ram airflow in said mixing chamber to flow to the main chamber to thereby provide a
 - 20 mixing chamber outflow;
 - said mixing chamber outflow being at a third temperature at least at or near said main chamber inlet;
 - a control system operative to control at least one of said ram airflow, said source gasflow and said mixing chamber outflow to provide a desired said third
 - 25 temperature at least at said main chamber inlet; and
 - wherein said gasflow source comprises an auxiliary ram intake, in operation thereof being open to atmospheric air, and an auxiliary conduit connecting said auxiliary ram intake to said mixing chamber inlet, wherein said auxiliary ram intake is configured for selectively channeling an atmospheric auxiliary airflow into the
 - 30 mixing chamber to thereby provide said source gasflow.

2. The system according to claim 1, wherein said control system is operative to provide a said third temperature such as to maintain a temperature in said control volume within a preset operating temperature range between a preset minimum temperature and a preset maximum temperature.
- 5 3. The system according to claim 2, wherein said preset minimum temperature is -35°C and wherein said preset maximum temperature is +55°C.
4. The system according to any one of claims 1 to 3, comprising heating elements for controllably heating said source gasflow to a desired said second temperature.
5. The system according to claim 4, wherein said heating elements are electrical
10 heating elements coupled to said gasflow source.
6. The system according to any one of claims 1 to 5, comprising a first temperature sensor in said main chamber at or in the vicinity of said main chamber inlet, the first temperature sensor being in operative communication with said control system.
7. The system according to claim 6, wherein said control system operates to
15 provide a desired said third temperature based at least partially on a sensed inlet temperature as sensed by said first temperature sensor.
8. The system according to any one of claims 1 to 7, comprising a second temperature sensor in said main chamber at or in the vicinity of said main chamber outlet, the second temperature sensor being in operative communication with said
20 control system.
9. The system according to claim 8, wherein said control system operates to provide a desired said third temperature based at least partially on a sensed outlet temperature as sensed by said second temperature sensor.
10. The system according to any one of claims 7 to 9, wherein the control system
25 operates to increase at least one of the source gasflow, the second temperature, and the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature reaching said preset minimum temperature.
11. The system according to claim 10, wherein the control system operates to cease said increase of at least one of the source gasflow, the second temperature, and the
30 mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature being significantly above said preset minimum temperature.
12. The system according to any one of claims 7 to 11, wherein the control system operates to decrease at least one of the source gasflow and the second temperature,

and/or to increase the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature reaching said preset maximum temperature.

13. The system according to claim 12, wherein the control system operates to cease
5 said decrease of at least one of the source gasflow and the second temperature, and/or to cease said increase of the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature being significantly below said preset maximum temperature.

14. The system according to any one of claims 1 to 13, comprising a first
10 controllable variable pump operatively connected to the control system and configured for controllably varying the magnitude of said source gasflow into said mixing chamber.

15. The system according to claim 14, further comprising a first controllable valve operatively connected to the control system and configured for selectively closing flow of said source gasflow into said mixing chamber.

15 16. The system according to any one of claims 1 to 15, comprising a second controllable variable pump operatively connected to the control system and configured for controllably varying the magnitude of said mixing chamber outflow into said main chamber.

17. The system according to claim 16, further comprising a second controllable
20 valve operatively connected to the control system and configured for selectively closing flow of said mixing chamber outflow into said main chamber.

18. The system according to any one of claims 1 to 17, wherein said main chamber comprises an auxiliary outlet, and said gasflow source further comprises a recirculation conduit connecting said auxiliary outlet to said mixing chamber inlet and configured for
25 providing a recirculating airflow from said main chamber into the mixing chamber to thereby provide said source gasflow.

19. The system according to claim 18, wherein said recirculation airflow is a first proportion of said mixing chamber outflow.

20. The system according to claim 19, wherein said first proportion is between 0%
30 and 100% of said mixing chamber outflow.

21. The system according to claim 19 or claim 20, wherein said first proportion is between 30% and 70% of said mixing chamber outflow.

22. The system according to any one of claims 18 to 21, comprising a first heating system coupled to said recirculation conduit to selectively heat said recirculation airflow to provide a desired said second temperature to said source gasflow.
23. The system according to any one of claims 1 to 22, comprising a second heating
5 system coupled to said auxiliary conduit to selectively heat said atmospheric auxiliary airflow to provide a desired said second temperature to said source gasflow.
24. The system according to any one of claims 1 to 23, wherein said gasflow source further comprises a pressurized gas container, and a container conduit connecting said pressurized gas container to said mixing chamber inlet and configured for providing a
10 pressurized gasflow into the mixing chamber to thereby provide said source gasflow.
25. The system according to claim 24, comprising a third heating system coupled to said container conduit to selectively heat said pressurized gasflow to provide a desired said second temperature to said source gasflow.
26. The system according to any one of claims 2 to 25, further comprising a main
15 ram intake, in operation thereof being open to atmospheric air, and a ram conduit connecting said main ram intake to said ram air inlet, wherein said main ram intake is configured for selectively channeling said ram airflow into said mixing chamber.
27. The system according to any one of claims 1 to 26, wherein said main chamber accommodates electronic components.
- 20 28. The system according to claim 27, wherein said components are operational within said preset temperature range.
29. An air vehicle comprising the system as defined in any one of claims 1 to 28.
30. The air vehicle according to claim 29, wherein the air vehicle is a UAV.
31. Method for providing a controlled temperature in a control volume, comprising:
25 (A) providing a ram airflow at a first temperature into a mixing chamber;
(B) selectively providing a source gasflow at a second temperature into said mixing chamber, said second temperature being greater than said first temperature; comprising selectively channeling an atmospheric auxiliary airflow into the mixing chamber, different from said ram, airflow, to thereby provide said source gasflow;
30 and wherein:

- in the presence of said source gasflow in said mixing chamber, selectively allowing said ram airflow and said source gasflow in said mixing chamber to mix therein to provide a mixing chamber outflow to the control volume; or
 - in the absence of said source gasflow, selectively allowing said ram airflow
- 5 in said mixing chamber to flow to the control volume to thereby provide a mixing chamber outflow;

said mixing chamber outflow being at a third temperature at least at or near entry to the control volume;

- (C) controlling at least one of said ram airflow, said source gasflow and said mixing
- 10 chamber outflow to provide a desired said third temperature at least at or near entry to the control volume.

32. The method according to claim 31, wherein said third temperature such as to maintain a temperature in said control volume within a preset operating temperature range between a preset minimum temperature and a preset maximum temperature.

- 15 **33.** The method according to claim 32, wherein said preset minimum temperature is -35°C and wherein said preset maximum temperature is +55°C.

34. The method according to any one of claims 31 to 33, comprising providing a heating source and, using the heating source, controllably heating said source gasflow to a desired said second temperature.

- 20 **35.** The method according to any one of claims 31 to 34, comprising providing a desired said third temperature based at least partially on a sensed inlet temperature as sensed at or in the vicinity of an inlet of the control volume.

- 36.** The method according to any one of claims 31 to 35, comprising providing a desired said third temperature based at least partially on a sensed outlet temperature as
- 25 sensed at or in the vicinity of an outlet of the control volume.

37. The method according to claim 36, comprising increasing at least one of the source gasflow, the second temperature, and the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature reaching said preset minimum temperature.

- 30 **38.** The method according to claim 37, comprising ceasing said increase of at least one of the source gasflow, the second temperature, and the mixing chamber outflow,

responsive to one of said sensed inlet temperature or said sensed outlet temperature being significantly above said preset minimum temperature.

39. The method according to claim 36, comprising decreasing at least one of the source gasflow and the second temperature, and/or to increase the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature reaching said preset maximum temperature.

40. The method according to claim 39, comprising ceasing said decrease of at least one of the source gasflow and the second temperature, and/or to cease said increase of the mixing chamber outflow, responsive to one of said sensed inlet temperature or said sensed outlet temperature being significantly below said preset maximum temperature.

41. The method according to any one of claims 31 to 40, comprising controllably varying the magnitude of said source gasflow into said mixing chamber.

42. The method according to any one of claims 31 to 41, comprising controllably varying the magnitude of said mixing chamber outflow into the control volume.

43. The method according to claim 42, comprising controllably varying the magnitude of said mixing chamber outflow into the control volume.

44. The method according to any one of claims 31 to 43, further comprising providing a recirculating airflow from the control volume into the mixing chamber to thereby provide said source gasflow.

45. The method according to claim 44, wherein said recirculation airflow is a first proportion of said mixing chamber outflow, and wherein said first proportion is between 30% and 70% of said mixing chamber outflow.

46. The method according to any one of claims 31 to 45, comprising further providing a pressurized gasflow into the mixing chamber to thereby provide said source gasflow.

47. The method according to any one of claims 31 to 46, wherein the control volume accommodates electronic components.