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The invention relates to an airplane according to the precharacterising part of claim 1.

The outer skin of airplanes has its inner side provided with an insulating layer of heat-insulating material in order to keep out the extremely low outside temperatures occurring in great flying altitudes. On the other hand, it is necessary to keep previously prepared food and beverages for the passengers cool inside a plane. This cooling is either achieved by using cooling aggregates fed by the power system of the plane, or by using dry-ice. A power supplied cooling system increases the weight of a plane and requires expensive aggregates. Dry-ice cooling, on the other hand, requires considerable work and is troublesome.

US-A-4 057 104 describes an airplane wherein a radar device is disposed in a housing and encapsulated in a cooling chamber in the tip of the vertical stabilizer of the tail unit projecting from the tail end. A refrigerant flows around the cooling chamber. The closed refrigerant circuit passes along the outer wall of the housing so that the housing of the cooling chamber acts as an evaporator and the outer skin of the airplane acts as a condenser of a cooling aggregate that conveys the heat from the radar device to the outer

skin of the housing. Such a cooling device is rather complex and requires a liquid-tight encapsulation of the cooling chamber holding the electric apparatus.

It is an object of the present invention to facilitate the cooling of food and beverages, as well as of other goods in a plane.

In accordance with the present invention, this object is solved with the features indicated in the characterising part of claim 1.

According to the present invention, a cold air chamber is provided immediately behind the outer skin of a plane, which is in heat exchange with the ambient air that is very cold in great flying altitudes. Air from the inside of the plane is cooled in this cold air chamber by heat exchange at the outer skin. This air is lead into a cooling chamber holding the goods to be cooled. This allows to use the low temperature of the ambient air to cool the cooling chamber without ambient air entering the cooling chamber directly. Using a cooling chamber that is arranged behind the outer skin does neither interrupt nor change the outer skin in any way so that the flying qualities of the plane are not impaired. Only a portion of the outer skin is used as a heat exchange area. The inner pressure of the plane prevails in the cold air chamber and in the cooling chamber so that these chambers are a part of the interior of the plane with regard to the pressure therein, while their temperature is influenced by the outside. Both chambers form a recirculating air system, in which the quantity of air circulates, when the door of the cooling chamber is closed, and in which

system the air is cooled in the cold air chamber, while, in the cooling chamber, it transmits coldness to the goods to be cooled.

According to claim 2, a temperature adjusting device is provided that controls the air delivery ratio of the recirculation system such that the temperature prevailing within the cooling chamber is kept at a desired constant temperature value. Should the temperature rise above this desired value, the flow rate of the circulated air is increased, resulting in an intensified cooling in the cooling chamber. If, on the other hand, the temperature in the cooling chamber should drop below a desired value, the circulation of air is reduced, so that less coldness is transmitted from the cold air chamber to the cooling chamber. Valves, e.g., ventilators or fans, may be used as actuators in the control system.

The cooling chamber should be heat-insulated from the inner space of the plane. A further heat-insulation may be provided between the cold air chamber and the cooling chamber.

To bridge the time on the air-field, during which the air in the cold air chamber warms up and the exchange of air between the cold air chamber and the cooling chamber has to be stopped, the cooling chamber is preferably provided with a coldness accumulator. This coldness accumulator may contain, e.g., a fluid or a gel of high coldness capacity.

The cooling device according to the present invention is particularly suited for passenger planes and the

cooling chamber is preferably adapted to receive at least one serving trolley. However, the cooling device may also be used in freight planes in order cool a larger cargo hold for storing perishable goods.

Advantageously, the cooling chamber is arranged directly adjacent to the cold air chamber and separated therefrom only by one single wall. However, the principle of the invention also allows the cooling chamber to be spaced from the cold air chamber and to connect both chambers by a flow-in duct and a flow-out duct.

The following is a detailed description of an embodiment of the present invention with reference to the only Figure in the drawing.

The drawing illustrates a vertical section of a part of the fuselage of a plane.

The plane is provided with a metal outer skin 10, behind which an insulating layer 11 of heat-insulating material is arranged. Behind the insulating layer 11, i.e., on the inside of the plane, the inner fairing 12 is provided.

A part of the outer skin 10 is not provided with the insulating layer 11 in order to form a cold air chamber 13. The air contained in cold air chamber 13 is in heat exchange with the ambient air of the plane via the heat-conductive outer skin 10. Cold air chamber 13 is thermally insulated against the inside of the plane by insulating layers 14. A further insulating layer 15 separates cold air chamber 13 from the cooling chamber 16. At the bottom, cooling chamber 16 is defined by an

intermediate bottom 17 of the plane and provided with a door 18 that opens towards the inside of the plane. All walls of cooling chamber 16, including door 18, are lined with heat-insulating layers 19.

A flow-in duct 20 extends from cold air chamber 13 into the upper portion of cooling chamber 16 and a flow-out duct 21 extends from the lower portion of cooling chamber 16 into cold air chamber 13. The flow-in duct 20 is provided with an air quantity regulating valve 22 and a fan 23; the flow-out duct 21 is provided with an air quantity regulating valve 24. Air quantity regulating valves 22 and 24 and the fan 23 are controlled by a thermostat 25 arranged in the cooling chamber 16. The control lines are indicated by broken lines.

The upper wall of cooling chamber 16 is provided with a coldness accumulator 27 having a plurality of thermally chargeable coldness accumulator elements 28.

The drawing shows an example of the temperatures outside the plane and inside both chambers 13 and 16.

At a temperature of  $-50^{\circ}\text{C}$  on the outside, the temperature inside cold air chamber 13 is  $-30^{\circ}\text{C}$ . By controlling the quantity of air flowing through flow-in duct 20 and flow-out duct 21, an optional temperature in the range between  $-5^{\circ}\text{C}$  and  $+10^{\circ}\text{C}$  can be constantly maintained in cooling chamber 16.

The air cooled in cold air chamber 13 is sucked in by the fan 23 and blown into the upper portion of cooling chamber 16 via flow-in duct 20. The air leaves cooling chamber 16 via flow-out duct 21 leading back to cold

air chamber 13. Thus, cold air chamber 13 and cooling chamber 16 form a closed air recirculation system in which the internal pressure of the plane prevails. Upon reaching the desired temperature in cooling chamber 16, the thermostat 26 switches off the fan 23 and closes air quantity regulating valves 22,24. The coldness accumulator 27 prevents a quick rise in temperature in the cooling chamber 16 when the outer temperature of the plane is too high, thus allowing to bridge times on the air-field without the temperature in the cooling chamber rising to undesired degrees. During the flight, the cold accumulator 27 is recharged.

The cooling chamber 16 is dimensioned such as to be able to receive at least one serving trolley 29 having shelves for storing meals or beverages.

## Claims

1. An airplane having an outer skin (10) and an insulating layer (11) arranged behind said outer skin (10), a cold chamber being arranged immediately behind a portion of said outer skin (10) that is not covered by said insulating layer (11), said cold chamber being in heat exchange with a cooling chamber (16),

characterised in

that said cold chamber is a cold air chamber (13) in which the inner pressure of the plane prevails, that said cooling chamber (16) is accessible from inside the plane by a door (18), and that the inside of said cooling chamber (16) is connected with said cold air chamber via a flow-in duct (20) and a flow-out duct (21).

2. The airplane according to claim 1, characterised in that a temperature controlling device (25) is provided for varying the quantity of air flowing through said flow-in duct (20) and/or said flow-out duct (21) in dependence on the temperature in said cooling chamber (16).

3. The airplane according to claim 2, characterised in that a thermostatically controlled air quantity regulating valve (22;24) is provided in said flow-in duct (20) and/or said flow-out duct (21).

4. The airplane according to one of claims 1 to 3, characterised in that a fan (23) is provided in said flow-in duct (20) and/or said flow-out duct (21).



5. The airplane according to one of claims 1 to 4, characterised in that the inner walls of said cold air chamber (13) are provided with insulating layers (14, 15).

6. The airplane according to one of claims 1 to 5, characterised in that said cooling chamber (16) is adapted to take up at least one serving trolley (29).

7. The airplane according to one of claims 1 to 6, characterised in that said cooling chamber (16) is provided with a coldness accumulator (27).



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