Oct. 31, 1933. J. H. SMITH 1,932,681

AEROPLANE STRUCTURE

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FIG. 1.

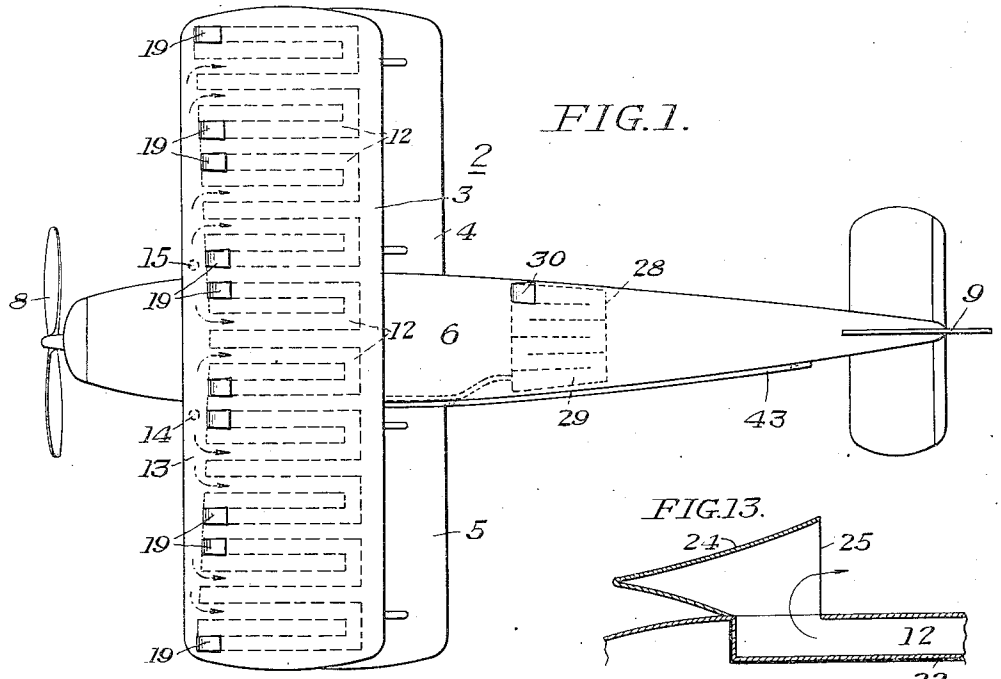


FIG. 13.

FIG. 12.

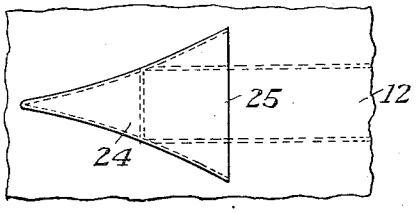
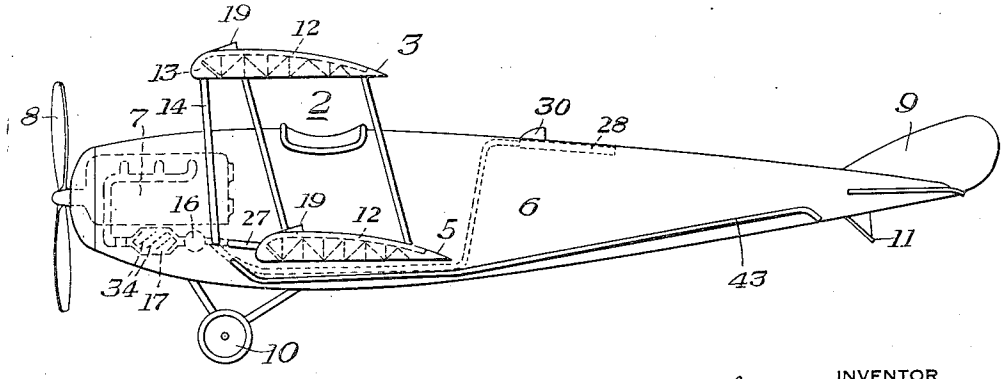


FIG. 2.



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AEROPLANE STRUCTURE

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FIG. 3.

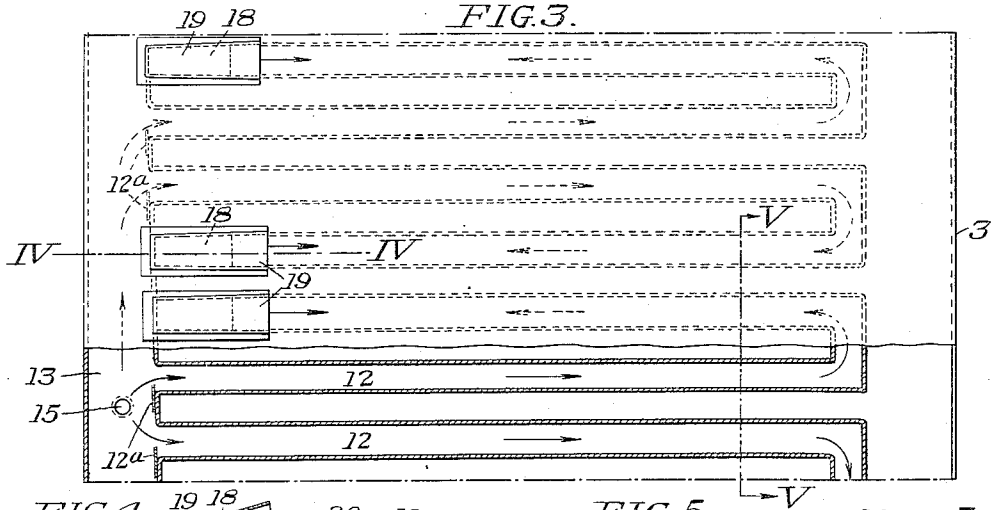


FIG. 4.

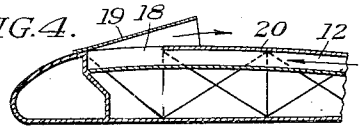


FIG. 5.

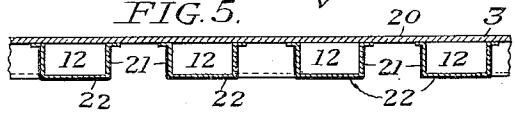


FIG. 6.

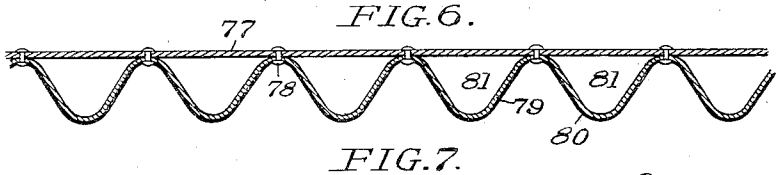


FIG. 7.

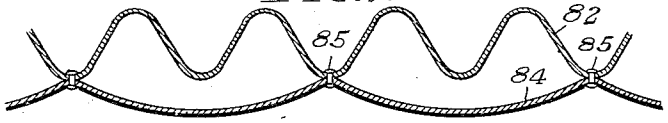


FIG. 8.

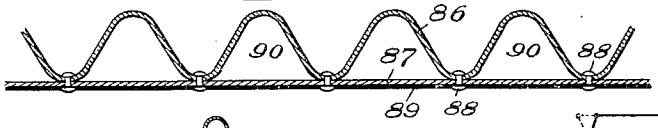


FIG. 9.

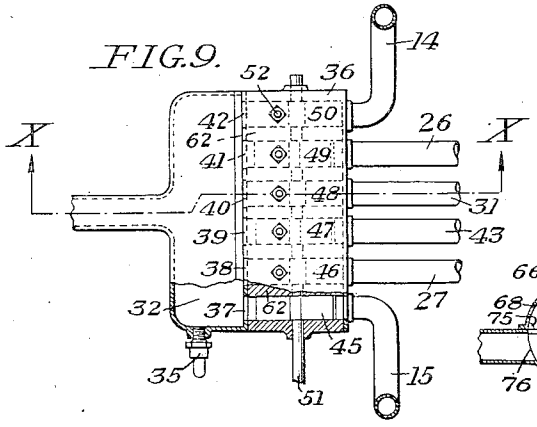


FIG. 10.

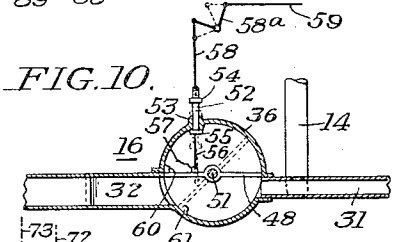
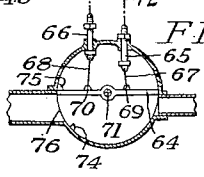


FIG. 11.



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UNITED STATES PATENT OFFICE

1,932,681

AEROPLANE STRUCTURE

John Hays Smith, Camp Hill, Pa.

Application April 5, 1929. Serial No. 352,762

27 Claims. (Cl. 244—31)

My invention relates to aeroplanes and more particularly to apparatus for controlling the temperature at the wings and surfaces of the aeroplane in order to prevent the formation of layers of ice, sleet and snow, and at the same time to reduce the noise of the engine exhaust.

Commercial aviation has heretofore been considerably handicapped by reason of the formation of deposits of snow, sleet and ice on the surfaces of aeroplanes during stormy weather and when temperature conditions are near the dew point. Under such conditions the weight of the accumulations of moisture either in a solid or semi-solid state adds to the weight of the aeroplane.

In some cases the additional weight of the accumulation is sufficient to force the aeroplane down. The presence of the accumulation also impairs the stability of the aeroplane by upsetting the hydro-dynamical balance of the aeroplane. The result of these conditions is that aeroplanes in flight are frequently forced down and proposed flights are delayed pending more favorable weather conditions, both of which occurrences deter commercial aviation activities. When planes are forced down there is a danger of injury and destruction to the plane and to the pilot and passengers. When planes are confined to the earth there is a loss of earning power.

Efforts have heretofore been made to prevent the accumulation of such deposits by applying oil to the exposed surfaces of an aeroplane. Oil is at best only effective for a short time, as when the first ice or snow slides off from an oiled surface, it takes part of the oil with it. Thereafter the ice or snow adheres to the surface and cannot be shaken off. Accordingly, the oiling of such surfaces does not afford adequate protection.

Efforts have been made to discharge exhaust gases directly into the hollow body of an aeroplane wing. In these constructions the heat from the exhaust gases is dissipated at the lower surfaces of the wings, as well as at the upper surfaces. As there are no appreciable accumulations on the lower surfaces the effectiveness of the heat dissipated at the lower surfaces is lost. I am not aware that this has ever been accomplished.

I provide means for maintaining exposed surfaces of the aeroplane at a temperature above the freezing point so that the accumulation of frozen bodies of water or snow is avoided. Moisture either in a liquid or frozen condition when deposited on the surfaces of the aeroplane, and particularly on the upper surfaces of the wings, is maintained in or reduced to a liquid condition so that it drips or flows off from the aeroplane. This causes and maintains a film of liquid which allows ice to slide off, operating as lubricating film as in case of oil.

The heat available from the exhaust of an aeroplane engine is sufficiently great to melt down accumulations of snow and ice forming on the upper wing surfaces of such an aeroplane if the heat is properly applied to only those surfaces liable to have deposits formed thereon. I provide means for conducting exhaust gases from the engine and distributing the gases into effective heat exchanging relation to substantially the entire upper wing surfaces of the aeroplane and to desired portions of fuselage or other exposed structures of the areoplane, preferably by applying the heat in streaks. This contemplates fanning out the exhaust gases in a thin layer and applying the heat in streaks, utilizing the intervening metallic surface for conducting heat, so that none of the exterior surface will freeze over or tolerate a sleet and ice load.

Provision is made for discharging the exhaust gases from ports disposed at zones of very positive or negative pressure on the areoplane surfaces by hoods covering the discharge port, of suitably calculated curvature to produce negative pressure in said discharge port and thereby increase the normal negative pressure distribution upon said aeroplane surfaces.

By distributing said exhaust gases after utilizing their heat for melting down accumulations of snow and ice on the aeroplanes, into such zones of very low positive or negative pressure, I induce a flow of exhaust gases through passageways where their heat is transferred to the aeroplane surfaces without increasing the back or exhaust pressure on the aeroplane engine. The heat dissipating means also serves as a muffler or silencer for the engine exhaust.

The accompanying drawings illustrate the present preferred embodiments of the invention, in which

Figure 1 is a plan view of an aeroplane embodying my invention,

Figure 2 is a side elevational view thereof,

Figure 3 is an enlarged view partially in elevation and partially in section of a portion of an aeroplane wing embodying my invention,

Figure 4 is a cross sectioal view of a portion of an aeroplane wing taken substantially along the section line IV—IV of Figure 3,

Figure 5 is a cross sectional view of the upper portion of an aeroplane wing taken along the section line V—V of Figure 3,

Figure 6 is a similar view of a modified form of a wing structure,

Figure 7 is a similar view of another form of wing structure,

Figure 8 is a similar view of a further modified form of a wing structure,

Figure 9 is a plan view partially in section of a control valve for the heater,

Figure 10 is a cross sectional view thereof taken along the section line X—X of Figure 9,

Figure 11 is a cross sectional view similar to Figure 10, of a modified form of control valve.

Figure 12 is a plan view of a modified form of port structure, and

Figure 13 is a sectional view thereof.

Referring to Figures 1 to 5, inclusive, and 9 and 10, an aeroplane 2 embodying my invention is illustrated as comprising a plurality of wings 3, 4 and 5, although it is to be understood that the invention is applicable to planes having different winged arrangements. Wing 3 is illustrated as the upper wing in a biplane while wings 4 and 5 are the lower wings located on opposite sides of a fuselage 6. The fuselage 6 may be of any form and supports a motor or engine 7, propeller blades 8, steering mechanism 9, wheels 10 and a stick or landing gear 11.

To provide means for heating the upper surfaces of the wings 3, 4 and 5, in order to prevent accumulation of bodies of snow and ice, I provide a plurality of heat distributing ducts 12 connected with the exhaust of the engine. The heat distributing ducts 12 in the wing 3 are connected to a chamber 13, which, in turn, is connected by heat lagged conduits 14 and 15 on opposite sides of the fuselage to a control or multi-part butterfly valve 16 which is connected through an expansion chamber or muffler 17 connected to the discharge end of the motor or engine 7. The effective width of the chamber 13 varies outwardly from the ducts 14 and 15 in order to compensate for the falling off in volume of the products of combustion delivered to areas toward the ends of the wings.

The heat distributing ducts 12 are illustrated in the form of end ducts of a general U-shape, one end of which communicates with the chamber 13 located at one edge of the wing 2. The chamber 13 is illustrated as being at the forward edge of the wing, although it is to be understood that the positioning of the chamber 13 and the shape and direction of the distributing ducts may be varied as desired within the spirit of the invention. The other ends of the ducts 12 terminate in ports 18 which are covered with rearwardly shaping hoods 19. The hoods 19 open rearwardly slightly above the upper surface 20 of the aeroplane wings. The hoods 18 are preferably placed in the zone of low positive pressure or negative pressure which exists near the forward edge of such wings in order to secure the advantage of the reduced atmospheric pressure in these areas. By placing the ports 18 and hoods 19 in this area of reduced pressure, an induced flow of the exhaust gases through the chamber 13 and ducts 12 is obtained without creating any additional back pressure on the exhaust of the engine. The flow of gas through each duct is controllable by a slidable plate 12^a, if desired.

Referring particularly to Figures 4 and 5, the upper surface 20 of the wing 3 is preferably made of metal, a common form of which is aluminum and its alloys. The ducts 12 are formed by welding or riveting metallic troughs 21 to the undersurface of the sheet constituting the surface 20. The troughs 21 are illustrated as being of rectangular shape, although it is to be understood that other shapes can be utilized within the spirit of the invention.

The outer surfaces of the troughs 21 are preferably covered with a layer 22 of heat insulating material, one form of which is a layer of asbestos, silocel, or the like, put thereon. The presence of the heat lag 22 prevents the dissipation of the heat conveyed by the ducts 12 to the inner surface of the aeroplane wing. As the major accumulations of ice and snow are on the upper surfaces of the wings, the dissipation of the heat into the interior of the wing where it might be ultimately liberated from the lower surfaces of the wing, serves no useful purpose since there is usually no deposit of ice or snow to be removed therefrom. Such procedure would waste the heat exhaust heat.

The openings 18 at the ends of the ducts 12 are designed so that there are no restriction passages between the under-surfaces of the hoods 19 and the edges of the sheets constituting the surface 20. By having the hoods 19 open backwardly the exhaust gases ultimately discharged are directed over the outer surface of the wings and do not oppose the forward movement of the aeroplane.

Referring to Figures 12 and 13, the hoods 19 may be replaced by hoods 24 having suitably calculated curvilinear surfaces which of themselves produce negative pressure at the discharge port. The hoods 24 are illustrated as having a conoidal shape with the faces slightly curved with the apex pointing in the direction of movement of the aeroplane. As the aeroplane moves forward, air flowing around the hoods 24 produce a condition of negative pressure at the mounts 25 thereof.

The wings 4 and 5 are constructed similarly to the wing 3 except that they are placed on opposite sides of the fuselage and are connected to the valve 16 by separate heat lagged pipes or conduits 26 and 27 respectively.

A heating unit 28 having ducts 29 and hoods 30, corresponding to the ducts 12 and hoods 19 on the wings 3, 4 and 5, respectively is mounted near the upper rear surface of the fuselage 6 so that it will liberate heat to remove accumulations of ice and/or snow on the upper surface of the fuselage. It is to be understood that the size of the heating unit 28 may be varied to cooperate with a greater or less extent over the surface of the fuselage. It is also to be understood that similar heating units 28 may be applied to the side walls of the fuselage if desired.

Referring to Figures 2, 9 and 10, the valve 16 comprises a chamber 32 into which exhaust gases from the engine are conducted after having passed through the chamber 17. The muffler chamber 17 is provided with diagonal blades 34 for revolving and mixing gases before passing to the valve 16. A pressure relief valve 35 is inserted in the chamber 16 to prevent the accumulation of excess pressure in the chamber 16, which pressure might build up against the engine and thereby reduce the engine efficiency. The valve 16 is provided with a tubular portion 36 having a number of ports 37, 38, 39, 40, 41 and 42 communicating with the chamber 32. On the substantially diametrical sides of the tubular portion 36 to the several openings 37 to 42, inclusive, are other openings communicating with the pipes 15, 27 and exhaust pipe 43, the pipe 31, the pipe 26 and the pipe 14, respectively. Communication between the several ports 37 to 42, inclusive, and

their cooperating pipe lines, is controlled by a series of pivotally mounted plates 45, 46, 47, 48, 49 and 50, respectively. The several plates are mounted on a rod 51 extending through bosses formed on the several plates.

For controlling the position of the several plates and thereby determine whether exhaust gases are delivered through any particular pipe, I provide a series of sliding pistons 52, one of which cooperates with each plate. The pistons slide through bosses 53 formed on the tubular portion 36. Adjustable nuts 54 and 55 on each piston 52 determines the amount of its downward and upward movement respectively through the box 53. The lower end of each piston is pivotally connected by a rod 56 to an eye 57 formed on the blade. The outer end of the piston 52 is connected by a rod 58 to one arm of a bell crank 58a. The other arm of a bell crank is connected by a rod 59 to a control handle mounted in the fuselage (not shown). The amount of movement of each blade within the tubular portion 36 is further limited by steps 60 and 61. As shown in Figure 10, when the bell crank 58a engages the step 60, products of combustion pass from the chamber 32 to the port 39, the lower half of the tubular portion 36 and into the pipe 31. Spacing plates 62, positioned between the several plates 45 to 50, inclusive, prevent longitudinal movement of the products of combustion in the tubular portion 36 of the valve 16. When the bell crank 58 is moved to its dotted line position, the plate 48 is moved to the dotted line position or to engagement with the stop 61, whereby the port 39 is closed off from the pipe 31.

Referring to Figure 11, if flexible connections between the fuselage and a plate 64, corresponding to any one of the plates 45 to 50, inclusive, shown in Figure 9, is had by providing a pair of pistons 65 and 66 for each plate, the pistons 65 and 66 are connected by flexible connections such as cables 67 and 68 respectively to eyes 69 and 70 mounted on opposite sides of a shaft 71.

Flexible connections such as cables 72 and 73 are attached to the outer ends of the pistons 65 and 66. Accordingly upon pulling either of the connections 72 and 73 and the other connection is loose or slack, the plate 64 is turned between stops 74 and 75 to open or close a port 76.

During seasons of warm weather or where a plane is used in a tropical country, the valve 16 may be removed from the plane and the exhaust pipe 43 connected directly to the chamber 17. The ducts 14, 15, 26, 27 and 31 and the heating unit 38 could also be removed, thereby reducing the weight of the plane. However, it is to be understood that the combined weight of the valve 16 and associated heating parts is not such as to interfere materially with the lifting power of an aeroplane.

Referring to Figure 6, I have shown a modified form of upper wing surface in which a sheet 77 constituting the upper surface of an aeroplane wing is connected by rivets 78 to a corrugated sheet 79. The undersurface of the corrugated sheet 79 is covered with a layer of heat lagging material. This form of wing surface is constructed of substantially stock shapes. The spaces 81 defined by the plate 77 and the depressions in the plate 79 are used for conducting the products of combustion along the surface of the plate 77. The sheets 77 and 79 are brought together and the rivets 78 inserted without the expenditure of unnecessary labor since the sheet 77 has substantially a flat surface to which the stock corrugations are readily attached.

In this form of the invention, the ratio of the heated portion of the wing surface to the perimeter of the duct for conducting the products of combustion beneath the surface, is large.

Referring to Figure 7, I have shown a corrugated sheet 82 constituting an upper wing surface. To provide heating ducts for such a structure, a sheet 84 is secured by rivets 85 to spaced troughs in the sheet 82. A heat lagging is placed on the surface of the sheet 84, or the lagging itself functions as sheet 84.

Referring to Figure 8, where a corrugated sheet 86 is utilized for a wing surface, a substantially flat plate 87 may be secured by rivets 88 to successive troughs of the corrugated plate. A layer of heat lagging 89 is placed on the lower surface of the sheet 87 to prevent the dissipation of heat inwardly to the aeroplane wing. In this construction stock corrugated and flat plates are used, and hence the weight and the area of the plate 87 required to form heat carrying spaces 90 is reduced to a minimum since the plate 87 is flat. Accordingly the weight of the aeroplane wing is kept low. The gauge of the plate 87 may be very small since it is only required to confine the products of combustions. And it is within the spirit of the invention to use alternate troughs only for heating.

It is to be understood that the rivets 78, 85 and 88, shown in Figures 6, 7 and 8, respectively, may be dispensed with where welding is employed or the rivets may be retained and welding also practiced if desired.

While I have shown and described certain preferred embodiments of the invention, it is to be understood that the invention may be otherwise embodied and practiced within the spirit of the invention and scope of the appended claims.

I claim as my invention:

1. An aeroplane wing comprising an upper surface and a plurality of substantially parallel heating ducts secured to the undersurface thereof, whereby in effect a substantially continuous body of heated fluid is applied to the undersurface only of said aeroplane surface, said ducts being formed in part by said surfaces.

2. An aeroplane structure comprising an exposed surface on which deposits of congealed moisture may collect and a plurality of segregated imperforate heating ducts internal to and formed in part by said surface in close proximity thereto and in intimate heat transferring relation thereto, the distance between said ducts being such that all of said surface is maintained at a temperature above freezing by the direct application of heat to said surface by said ducts and by the conduction of heat from said ducts into the portion of said surface lying therebetween.

3. An aeroplane structure comprising an exposed surface on which deposits of congealed moisture may collect and a plurality of segregated imperforate heating ducts internal to and formed in part by said surface and in class proximity thereto and in intimate heat transferring relation thereto, the distance between said ducts being such that all of said surface is maintained at a temperature above freezing by the direct application of heat to said surface by said ducts and by the linear conduction of heat through said surface into the portions of said surface lying between the ducts.

4. An aeroplane comprising an exposed sheet,

a plurality of heat ducts mounted therein and in intimate heat transferring relation to said sheet, walls defining a common chamber in communication with ends of said ducts, means for supplying exhaust gases to said chamber, the other ends of said ducts opening externally of said sheet in zones of low atmospheric pressure near the leading edge, whereby movement of the products of combustion through said ducts is in part induced by the differences in pressure existing at different parts of the aeroplane.

5. An aeroplane comprising an exposed sheet, a plurality of heat ducts mounted therein and in intimate heat transferring relation to said sheet, means for supplying exhaust gases to said common chamber, the other ends of said ducts opening externally of said sheet in zones of low atmospheric pressure near the leading edge, whereby movement of the products of combustion through said ducts is in part induced by the differences in pressure existing at different parts of the aeroplane, and hoods for covering said openings.

6. An aeroplane wing comprising an upper and a lower sheet connected to form a closed space, a plurality of heat ducts mounted in heat transferring relation to said upper sheet, walls defining a common chamber in communication with ends of said ducts, means for supplying exhaust gases to said chamber, the other ends of said ducts opening externally of one of said sheets in zones of low atmospheric pressure, whereby movement of the products of combustion through said ducts is in part induced by the difference in pressure existing at different parts of the aeroplane wing, and hoods for covering said openings, opening to the rear of the direction of the normal movement of the aeroplane wing and shaped to cause an induced movement of exit gases.

7. A valve structure comprising a casing defining a reception chamber for gases, a plurality of discharge ports, and a separate and independent controlled valve associated with each discharge port for selectively permitting gases to traverse said ports at the will of an operator.

8. A valve structure comprising a housing defining a chamber for the reception of gases, a plurality of discharge ducts, a shaft and a plurality of separate valves movably mounted on said shaft for selectively controlling the movement of gases from said chamber to said discharge ducts.

9. A valve structure comprising a housing defining a chamber for the reception of gases, a plurality of discharge ducts, a shaft and a plurality of valves movably mounted on said shaft for selectively controlling the movement of gases from said chamber to said discharge conduits, and means for actuating said valves.

10. An aircraft wing structure comprising an exposed surface on which deposits of congealed liquid may be formed, and means for preventing the formation of such deposits comprising a plurality of wing walls constituting in effect a portion of said surface for defining passageways by which heat is applied to said surface.

11. An aeroplane wing structure comprising an exposed surface structure on which deposits of congealed water may form, and means for preventing the accumulation of such deposits comprising a plurality of wing walls in effect constituting cells within said exposed surface structure for defining spaces by which the temperature at different portions of said surface is selectively controlled.

12. An aeroplane structure comprising an exposed surface on which deposits of congealed water may form, and means for preventing the formation of such deposits comprising a plurality of walls cooperating with said surface for defining open ended ducts for gases and in effect dividing said surface into portions supplied with heat from different ducts.

13. An aeroplane structure comprising an exposed surface, and a plurality of heat ducts for substantially all of said surface formed in part by portions of the material constituting said surface, whereby said surface material constitutes portions of said ducts.

14. An aeroplane structure comprising surfacing material, a duct for heating said material, and a hood for covering a discharge opening of said duct, said hood being shaped to cause an induced movement of exit gases.

15. An aeroplane structure comprising surfacing material, a duct for heating said material, and a hood for covering a discharge opening of said duct, said hood being shaped to cause an induced movement of exit gases and positioned in a zone of rarefaction on said surface.

16. In an aeroplane structure, an exposed surface, and means for preventing the formation of congealed deposits of moisture on said surface comprising a plurality of heating ducts at least in part formed by portions of said surface and spaced from each other, the distance between said ducts being such that the intervening areas of the surface are heated by the conduction of heat through the material of said surface whereby substantially the entire surface is heated by the direct application of heat from said ducts or by conduction of heat therefrom.

17. In an aeroplane structure, an exposed surface, and means for preventing the formation of congealed deposits of moisture on said surface comprising a plurality of heating ducts spaced from each other, at least one wall of each of which is formed by the material of said surface.

18. In an aeroplane wing structure, an exposed surface, and means for preventing the formation of congealed deposits of moisture thereon comprising a plurality of return-bent, spaced heating ducts extending transversely of and formed at least in part by the surface structure.

19. An aeroplane wing comprising upper and lower enclosing sheets, means forming a plurality of parallel spaced heating ducts within said wing, said means including part of the upper sheet and spaced apart from the lower sheet, a common manifold supplying a plurality of said ducts with a heating fluid for the purpose set forth.

20. The structure as set forth in claim 19 wherein said ducts open externally of their associated sheets.

21. In an aeroplane having a wing structure comprising upper and lower surfaces; means to heat one of said surfaces by a heating fluid, said means comprising a plurality of ducts in parallel incorporated with and forming part of said surface and spaced one from another whereby the entire surface will be heated owing to linear conduction of heat through the intermediate material of the surface between the spaced means, and manifold means to supply a heating fluid to said first named means.

22. A structure as defined in claim 21 wherein the manifold is so proportioned that said heating means will receive a substantially uniform supply of heating fluid and wherein the heating fluid is exhaust gas from a motive power means of the aeroplane.

23. The structure as defined in claim 21 wherein said first named means is incorporated in and forms part of said upper surface of said wing structure.

24. The structure as defined by claim 21 and a selective control valve intermediate said manifold and said first named means whereby the heating fluid may be selectively directed to various portions of said surface.

25. The structure as defined in claim 21 wherein said ducts forming part of said surface include a corrugated sheet of material secured to said surface at intervals to thereby form passages for the heating fluid.

26. The structure as defined in claim 21 wherein the first means is thermally insulated from the interior of the wing.

27. The structure as defined in claim 21 wherein means are disposed in the zone of rarefaction and facing to the rear of the direction of motion of said aeroplane structure for ejecting heating fluid from said ducts.

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