June 1, 1937. T. THEODORSEN ET AL 2,081,963

VAPOR HEATING SYSTEM

Filed Sept. 26, 1935 2 Sheets-Sheet 1

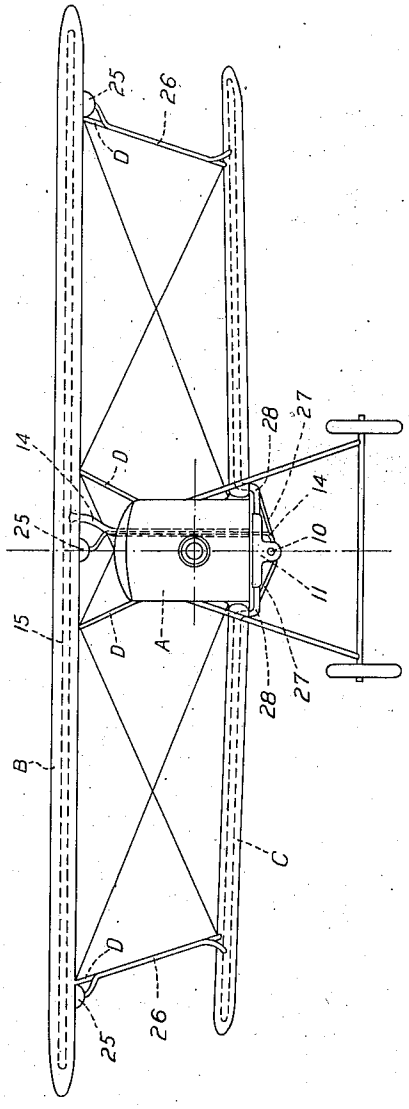


Fig. 1.

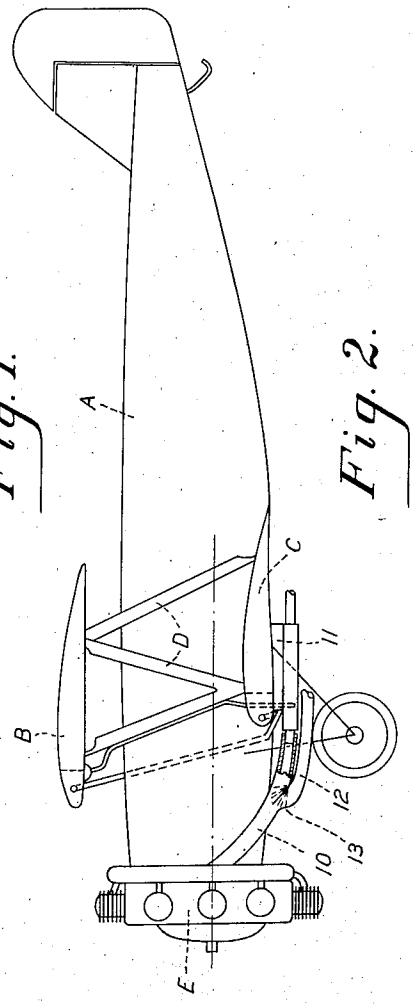


Fig. 2.

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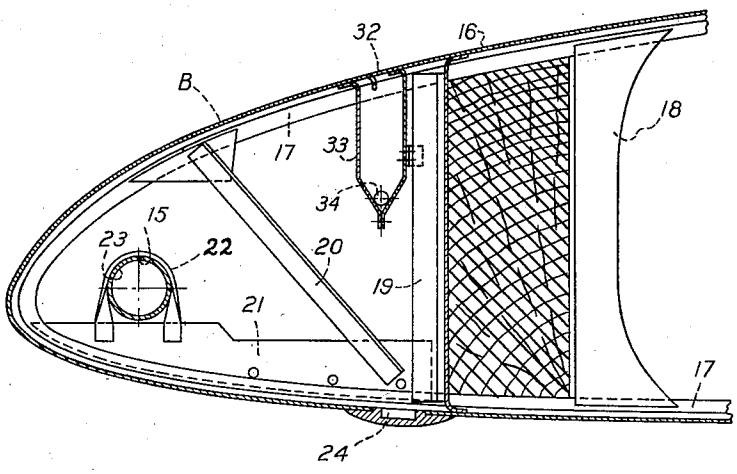


Fig 3.

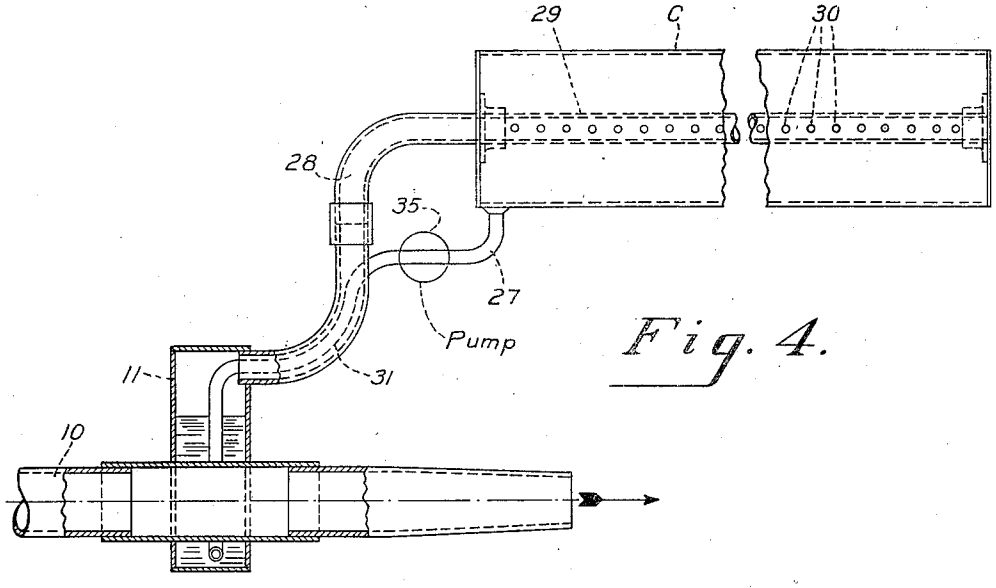


Fig. 4.

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UNITED STATES PATENT OFFICE

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VAPOR HEATING SYSTEM

Theodore Theodorsen, Hampton, and William C. Clay, Buckroe Beach, Va.

Application September 26, 1935, Serial No. 42,234

1 Claim. (Cl. 244—134)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This invention relates to vapor heating systems and it has particular relation to systems for preventing the formation of ice on the exposed surfaces of aircraft.

One of the objects of the present invention is the provision of a simple and efficient system whereby waste heat, preferably from the exhaust of the engine of an airplane, for example, is utilized to vaporize a suitable liquid which is conducted adjacent to the exposed surfaces of the wings to raise the temperature thereof above the freezing point, and thus prevent the formation of ice on said surfaces.

Another object of the invention is the provision of a vapor heating system of the character described which is particularly adaptable in connection with airplanes of the high-wing monoplane type, wherein the dihedral angle of the wing affords a natural drainage of the condensate from the tips of the wing to the roots thereof.

Still another object of the invention is the provision of a vapor heating system which may, by the inclusion of a small pump in the return line or conduit, be utilized in airplanes both of the low-wing monoplane and low-wing biplane types.

A further object of the invention is the provision of a heating system which may, by the utilization of suitably located sumps, be employed in airplanes, the wing of which has no dihedral angle.

A still further object of the invention is the provision of a heating system by means of which heated vapor is applied and concentrated adjacent to the portions of the wing surfaces most subject to the accumulation of ice and the liquid of condensation drained off without disturbing the balance or stability of the craft.

The invention also contemplates the inclusion of means for collecting and draining off water flowing aft from the heated leading edge of the wing or wings so as to prevent it from subsequently freezing upon an unheated portion of the wing and also means for preventing the condensed vapor from freezing in the return pipes of the system.

With these and other objects in view, as well as other advantages which may be incident to the use of the improvements, the invention consists of the parts and combinations thereof hereinafter set forth and claimed, with the understanding that the several necessary elements constituting the same may be varied in proportion and arrangement without departing from the nature and scope of the invention, as defined in the appended claim.

In order to make the invention more clearly understood there are shown in the accompanying drawings, means for carrying the invention into practical effect, without limiting the improvements in their useful application to the particular construction, which, for purpose of explanation, have been made the subject of illustration.

In the accompanying drawings:

Fig. 1 is a diagrammatic front elevational view of a biplane equipped with a vapor heating system for preventing the formation of ice on the wings thereof;

Fig. 2 is a side elevational view of the biplane illustrated in Fig. 1;

Fig. 3 is an enlarged fragmentary transverse sectional view through the leading edge of an airplane wing embodying the present invention, and

Fig. 4 is a detailed fragmentary view, partly in elevation and partly in vertical section, of the vapor heating system as applied to the lower wing of an airplane.

Referring to the drawings, and particularly to Figs. 1 and 2 thereof, the present improved vapor heating system is shown as applied to an airplane of the flat-wing biplane type, which includes in its construction a fuselage A, upper and lower wings B and C, respectively, connecting struts D, and an engine E.

The exhaust manifold 10 of the engine E extends rearwardly beneath the fuselage A and through a closed receptacle or boiler 11, that is suitably mounted beneath the fuselage. The exhaust manifold 10 is provided with a by-pass 12 through which the heated gases from the engine may be diverted by means of a valve 13 when the vapor heating system is not in use.

The boiler 11 is adapted to contain a suitable vaporizable liquid, such as water for example, and communicates adjacent to its upper portion with a vapor outlet pipe or conduit 14 that extends upwardly and communicates at its upper end with a distributor pipe 15 extending longitudinally through the upper wing B (Figs. 1 and 2). This wing may be of any preferred construction but is shown as comprising a metallic covering 16 supported by a frame structure including the members 17, 18, 19, and 20, and also a plurality of spaced plates 21 upon which the distributor pipe 15 is secured by means of straps 22. The distributor pipe 15 is provided with a plurality of apertures 23 along its forward side for projecting the heated vapor in a series of jets against the interior surface of the covering 16 adjacent to the leading edge of the wing. The condensed vapor flows aft along the inner sur-

face of the lower portion of the covering **16** between the plates **21**, which latter prevent the liquid from surging in a direction lengthwise of the wing and into a longitudinally extending drain **24** and thence into a plurality of suitably located pockets or sumps **25**. From the sump **25** the liquid flows downwardly through return pipes **26** secured to the forward struts D and thence into the lower wing C from which it eventually flows back to the boiler **11** through return conduits **27**.

Heated vapor is also supplied to the interior of the lower wings C by means of outlet pipes **28** which communicate on each side of the fuselage A with distributor pipes **29** extending longitudinally through the wings C. The mounting of these pipes may be similar to that described in connection with the pipes **15** and are also provided with a series of apertures **30** for directing jets of heated vapor against the leading edges of the wings C. The condensed vapor is returned to the boiler along with the condensate from the upper wing through the return pipe **27**. If desired, the return pipes **27** may extend, for at least a portion of their lengths, through the main or outlet pipes **28**, as indicated at **31**, in Fig. 4, so as to prevent the condensate from freezing.

Either or both of the wings B and C may be provided with rain slots **32**, Fig. 3, for arresting the passage of melted snow, hail and other water flowing aft from the forward heated portions of the wing, thus preventing the same from freezing on the unheated rear surfaces thereof. The water passing through each of the slots **32** is collected in a receptacle **33** disposed within the wing from which it is drained through an opening **34**.

It will be understood that any suitable easily vaporizable liquid may be employed as a heating medium but is preferably one that will not readily freeze. The wings may or may not be provided with the sumps **25**, depending upon whether or not the wing is flat or of the dihedral type. Also, the return pipe or conduit **27** may be provided with a pump, indicated diagrammatically at **35** in Fig. 4, in the event that the aeroplane is of the low-wing type.

Other modifications and changes in the proportions and arrangement of the parts may be made by those skilled in the art without departing from the spirit and scope of the invention, as defined in the appended claim.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What we claim is:

In an airplane having a fuselage, wings and a motor, a boiler heated by said motor for containing a supply of vaporizable liquid, a main conduit for conducting heated vapor from said boiler to the interior of said wings to heat the same and prevent the formation of ice thereon, said wings having sumps therein for collecting condensed vapor, a return conduit connecting with said sumps for conducting condensed vapor from said wings back to said boiler, a portion of said return conduit passing through said main conduit for at least a portion of its length, to prevent the condensed vapor from freezing, and rain slots provided in said wings for collecting moisture flowing rearwardly from the heated portions of said wings to prevent it freezing on the unheated portions thereof.

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