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COOLING SYSTEM FOR AIRPLANES AND AEROSTATS

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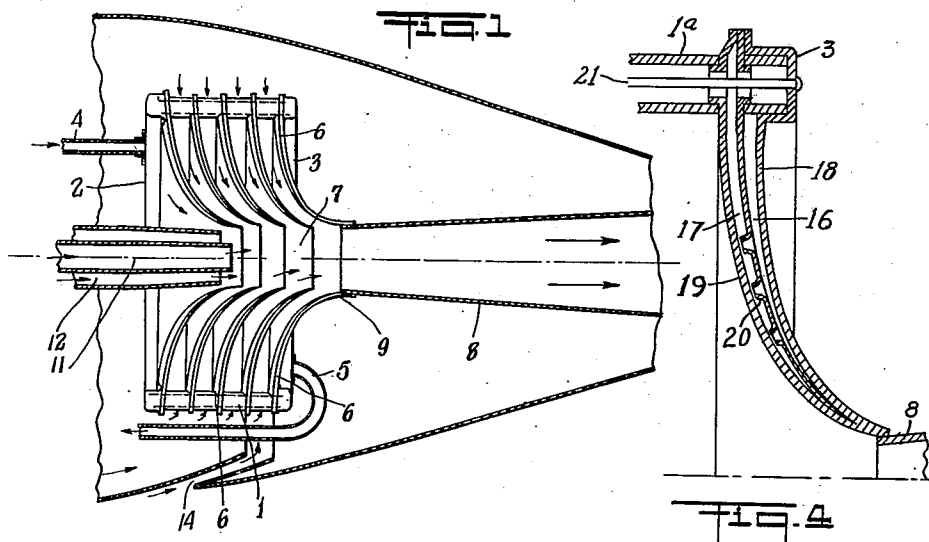


FIG. 2

FIG. 3

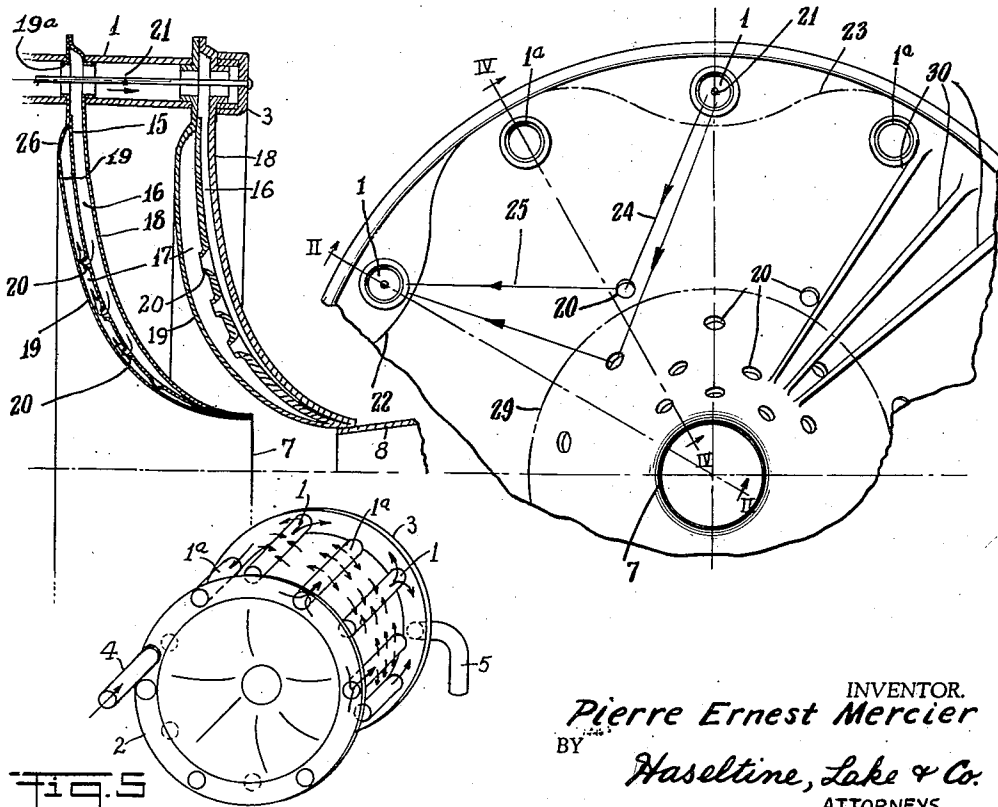


FIG. 5

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COOLING SYSTEM FOR AIRPLANES AND
AEROSTATS

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8 Claims. (Cl. 257-125)

The present invention has reference to cooling systems particularly for airplane and aerostat engines.

The types of radiators employed for cooling airplane and aerostat engines are generally supplied with outside air by means of dynamic intakes. These intakes disturb the general flow of the air about the flying machine, and absorb especially at high speeds a great part of its power.

On the other hand it is commonly known that if it is desired to make use of a minimum volume of cooling air, the speed with which the air passes across the radiant surfaces must be kept within certain limits (not too small, not too large), it being necessary that a radiant system should satisfy greatly varying running conditions, from slow-speed flight to maximum speed. Complicated arrangements are generally needed to maintain the cooling air output within desired limits.

One of the principal objects of the present invention is to provide a novel type of radiator in which the cooling air enters through the periphery of the radiant member at relatively low speed and is given an increasing acceleration as it moves towards the center of the member. A further object of the invention is to impart to the cooling air admitted radially an increasing axial component of movement so that it finally emerges in a direction parallel to that of the radiant member. A still further object of the invention is to cause the circulation of the cooling air by injector action, the energy for which is furnished by a source of compressed air or by the exhaust gases of the engine or by a combination of both. A still further object of the invention is to provide means for utilizing air admitted from the exterior through a slot or slots in a wing, fuselage or nacelle structure (which slots are frequently employed to reduce or eliminate the drag of the boundary layer) as part of the air to be circulated in the cooling system.

These and other objects of the invention which will appear from the following description and appended claims have been accomplished by the apparatus which will now be described with reference to the accompanying drawing non-limitatively illustrating one form of the invention.

In said drawing—

Figure 1 is a longitudinal view partly in section of the cooling system;

Figure 2 is a detail showing on a larger scale two of the hollow flared fluid circulating and directing members used in the system, being a partial section taken on line II—II in Figure 3, while Figure 3 is a partial end view (partly diagram-

matic) on a larger scale of the cooling system shown in Figure 1.

Figure 4 shows a detail view of one of the hollow flared members in partial section as taken on line IV—IV in Figure 3.

Figure 5 is a diagrammatic perspective of the cooling or heat exchange portion of the system showing the circulation pipes without any obscuring detail.

Throughout the views, the same references indicate the same or like parts.

Referring to the drawing, the radiator comprises a plurality of tubes 1, 1a preferably circularly arranged around a common axis and provided with headers 2 and 3. The supply of liquid from the cooling system of the engine is furnished through pipe 4 and returned through pipe 5. Cooling air is caused to pass over and between the tubes from the periphery towards the center by means of a plurality of annular, hollow flared members 6, each having a central opening 7 and being arranged in spaced nested relation thus providing passages for cooling air. The hollow flared members act as air directing vanes, their curvature being such that the air coming from the periphery through the openings between the circularly arranged tubes 1 is drawn inwardly and given an axial component of movement so that it emerges in a direction substantially parallel to the tubes 1 and is discharged into a divergent tube 8 leading to the exterior, preferably in the rear of the fuselage, wing or nacelle structure of the airplane. As shown at 9 the tube 8 is secured to or merged into the rearwardly extending nozzle portion of the rearmost of the flared members 6, thus forming therewith a restricted throat and facilitating smooth uninterrupted flow of air.

The energy for injecting the air is derived from a source of compressed air, such for example as a turbo compressor, through a suitable discharge pipe 11 or from the exhaust gases of the engine through pipe 12, or, as shown particularly in Fig. 1, from a combination of compressed air through pipe 11 and exhaust gases through pipe 12. By the injector action of these gases, it will be seen that the air which enters the system through the passages between the tubes 1 and the peripheral edges of the members 6 at a relatively low speed, has its speed accelerated, and by reason of the curvature of the flared members, is given a component of axial movement so that it is ejected at a relatively high speed in a direction parallel to the tubes 1 and to the axis of the cooling system into the divergent tube 8 in

which it expands and through the exit 13 of which it is discharged again at a slightly reduced velocity. Advantageously, the cooling system may be so arranged adjacent to a slot 14 in the wing or nacelle structure, that air drawn in through said slot for the purpose of diminishing or eliminating the drag of the boundary layer may be used as the cooling air of the system. There is an advantage in using compressed air and/or exhaust gases for the injection as these are dependent on the operation of the engine and automatically vary with the altitude and pressure.

As will be seen more particularly from Figs. 2 and 3, the vanes or flared members 6 are hollow and are each provided with a diaphragm or partition 15 partly or wholly dividing the same into two extended mutually adjacent and parallel cavities or compartments 16 and 17 respectively. It will thus be seen that each vane or flared member has two cooling surfaces 18 and 19 respectively, exposed to the cooling air and as shown particularly in Figs. 2 and 3, the liquid to be cooled may pass from one of the tubes 1 into one of the cavities or compartments 16 or 17 of one of the vanes or flared members and pass through perforations 20 in the diaphragm 15 into the other compartment or cavity parallel and adjacent thereto and travel upward therein and from thence pass into the next adjacent of the tubes 1. In other words, the circulation of the liquid to be cooled is from one of the tubes 1 into one of the compartments of a hollow vane thence into the other compartment of the hollow vane and from thence into the next adjacent of the tubes 1 and so on. This is more particularly to be seen from Fig. 3.

Owing to the form imparted by stamping to each of the exterior faces 18 and 19 of the vanes or flared members near the connecting rod 21, the sinuous profile of which is indicated at 22 for the face 18, and 23 for the face 19, each of the cavities such as 16 and 17 communicates with a different one of the tubes 1, which serve for the distribution for the cooling liquid. Thus in Fig. 2 each cavity 16 is shown in communication with one of the tubes 1 by means of an internal hollow sleeve 19a, while in Fig. 4, the cavity 17 communicates similarly with a tube 1a.

The connecting rods 21 and the corresponding tubes 1 and 1a are therefore preferably present in even number, and alternately connected to one or the other cavity according to the extension of the periphery of the vane or flared member concerned for effecting the supply and the evacuation of the liquid. The path followed by the liquid inside the flared members is shown diagrammatically following the course 24 in the cavity 16 and the course 25 in the cavity 17, as shown in Figs. 2, 3 and 4, while the path of the liquid to the header 2 and from the header 2 to and from the tubes 1 and 1a and finally to the header 3, and then to the return pipe 5, is shown in Fig. 5.

Perforations 20 in partition 15 permit the liquid to pass from one cavity to the other. It is clear that, without departing from the scope of the invention, it would be possible to provide for an inner periphery or termination upon the interior diaphragm with an edge at, and forming a circuit about 29, or any other system of baffles or heat exchange channels added to or substituted for the central diaphragm and its perforations. If desired radial ribs such as 30 may be stamped on the exterior faces of the vanes or flaring members to increase the heat exchange surfaces. The

elements constituting a vane or flaring member may be secured together near their inner edges in any appropriate manner, e. g., by welding.

What I claim and desire to secure by Letters Patent of the United States is:

1. In an airplane, aerostat or other craft having means for circulating a cooling fluid, a radiator comprising a plurality of tubes communicating with said means and arranged in a spaced group about a common axis, a plurality of flared members surrounding the axis which are so curved as to conduct air from the periphery of said members towards said common axis and to discharge the same substantially parallel with said axis, and means for accelerating the flow of air between said flared members from the said periphery towards said common axis, said flared members being hollow and having a perforated diaphragm dividing the same into two compartments, one of said compartments being in communication with one of said tubes and the other of said compartments being in communication with another of said tubes to provide for a circulation of fluid from one of said tubes through the two compartments in succession in each flared member and then to another of said tubes.

2. In an airplane, aerostat or other craft having means for circulating a cooling fluid, a radiator comprising a plurality of tubes communicating with said means and arranged in a spaced group about a common axis, a plurality of flared members surrounding the axis which are so curved as to conduct air from the periphery of said members towards said common axis and to discharge the same substantially parallel with said axis, and tubular means for injecting gases axially of said tubes for accelerating the flow of air between said flared members from the said periphery towards said common axis, said flared members being hollow and having a perforated diaphragm dividing the same into two compartments, one of said compartments being in communication with one of said tubes and the other of said compartments being in communication with another of said tubes to provide for a circulation of fluid from one of said tubes through the two compartments in succession in each flared member and then to another of said tubes.

3. In an airplane, aerostat or other craft having means for circulating a cooling fluid, a radiator including tubular means for projecting gases along a given axis, a series of hollow double walled flaring members substantially concentric with said axis and disposed in spaced relation so as to be effective to conduct air from the periphery thereof toward said axis and discharge the air in substantial parallelism with said axis, a plurality of fluid inlet ports in the peripheral portions of said flaring members upon one side thereof, a plurality of fluid outlet ports also disposed in the peripheral portions of said flaring members upon the other side thereof, and an interior partition disposed between the walls of each flaring member and extending from the periphery thereof between the inlet and outlet ports a sufficient distance toward said axis to conduct the cooling fluid down from the inlet ports along one wall toward said axis and up along the other wall toward the outlet ports adjacent the periphery.

4. In an airplane, aerostat or other craft having means for circulating a cooling fluid, a radiator including tubular means for projecting gases along a given axis, a series of hollow double

walled flaring members substantially concentric with said axis and disposed in spaced relation so as to be effective to conduct air from the periphery thereof toward said axis and discharge the air in substantial parallelism with said axis, a plurality of fluid inlet ports in the peripheral portions of said flaring members upon one side thereof, a plurality of fluid outlet ports also disposed in the peripheral portions of said flaring members upon the other side thereof, and interior means within each flaring member increasing the distance between the inlet ports and outlet ports thereof, and effective to conduct the cooling fluid from the inlet ports a distance along one wall from said port and a corresponding distance in a return direction along the other wall toward the outlet ports.

5. A radiator for an airplane, aerostat or other craft according to claim 1, having means for decreasing the velocity of the air before its discharge from the airplane.

6. A radiator for an airplane, aerostat or other craft according to claim 2, having means for

decreasing the velocity of the gases before their discharge from the airplane.

7. A radiator according to claim 1, having hollow ring shaped headers at the ends of the series of flared members with the inlet ports of said members connected to one header and the outlet ports thereof connected to the other header and both headers connected to the fluid circulating means.

8. A radiator according to claim 2, having the peripheral portions of the chambers within each flared member sinuous in form with the tubes supplying the inlet ports of said flared members connected to the radially projecting portion of one chamber in each member while bypassing the peripheral portion of the other chamber, and the tubes for the outlet ports of said flared members being connected to the radially projecting portion of said other chamber in each member while bypassing the peripheral portion of said one or first chamber in each flared member.

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