Sept. 5, 1939. H. WAGNER ET AL 2,171,817

RADIATOR FOR AVIATION ENGINES

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Fig. 1

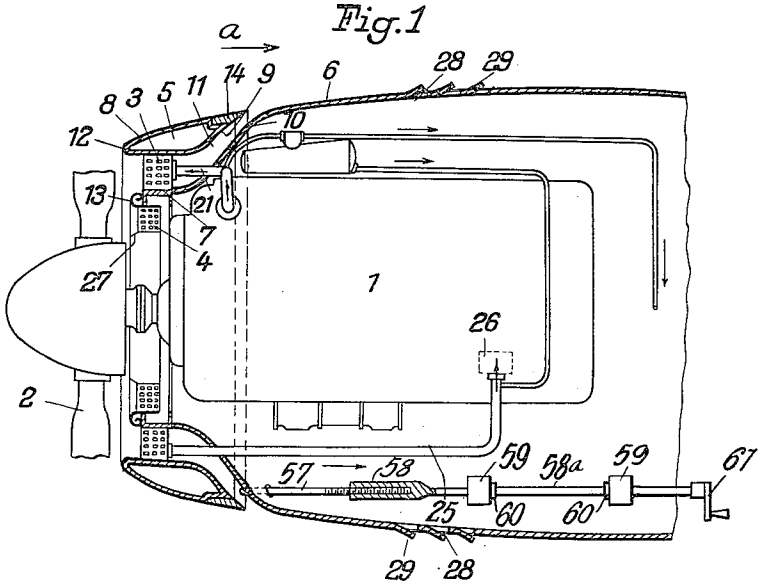


Fig. 2

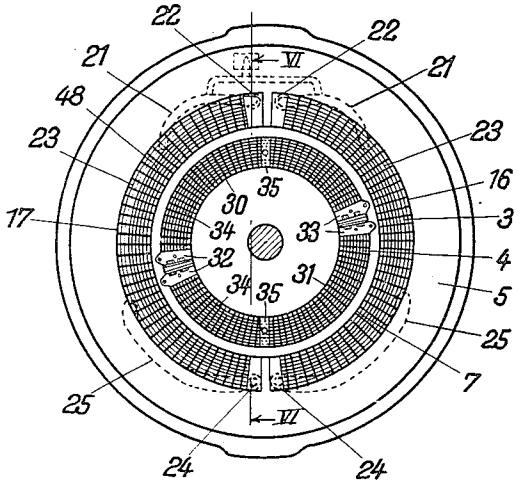
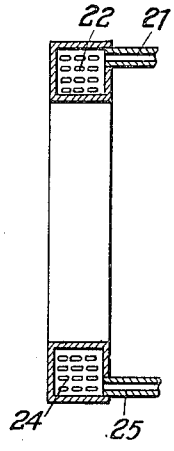


Fig. 6.



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Fig. 3

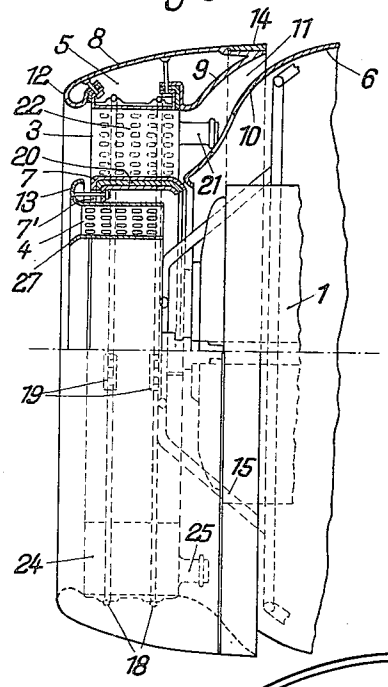
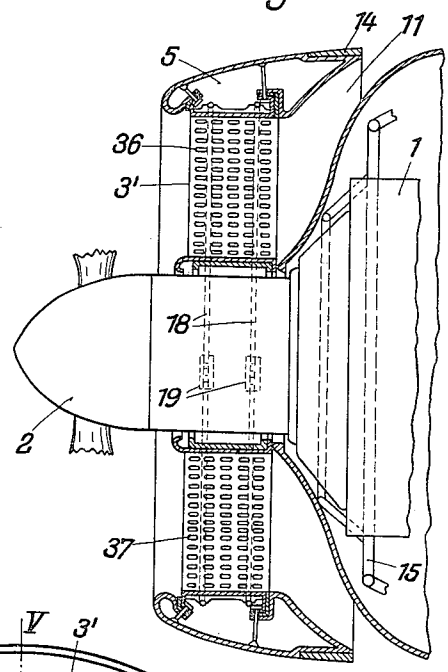


Fig. 5



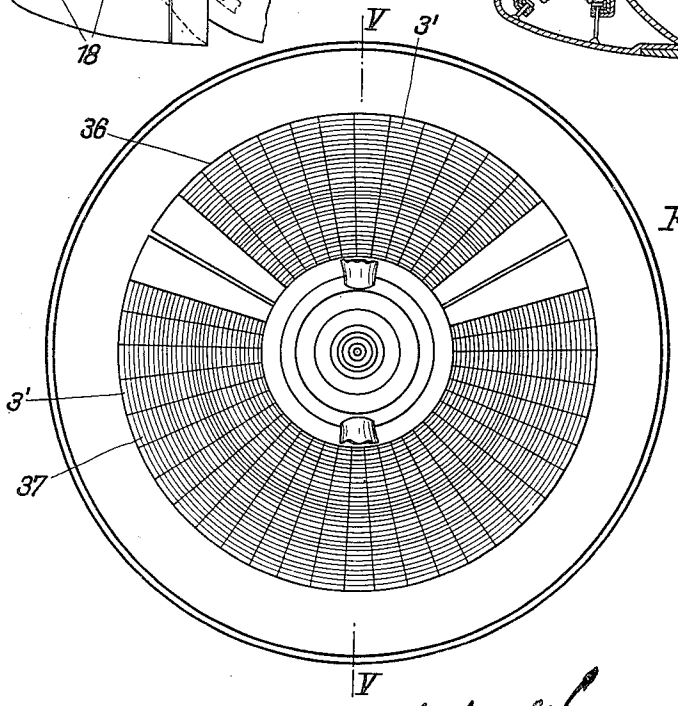


Fig. 4

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RADIATOR FOR AVIATION ENGINES

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In Germany December 22, 1936

11 Claims. (Cl. 123—174)

Our invention relates to radiators for liquid-cooled aviation engines and more especially to radiators of the annular type.

It is an object of our invention to provide a radiator of this kind which answers to a higher degree than similar radiators hitherto designed for the particular requirements of aviation.

Annular radiators have already been suggested for cooling a liquid heated in the operation of an engine and radiators of this type have for instance been arranged on flying machines in front of the engine casing and to the rear of the air propeller in such manner that they surrounded the axis of rotation of the propeller. Since in this arrangement the radiator is arranged within the front contours of parts of the craft (such as the fuselage, engine nacelles and the like) which are provided per se and do not create buoyancy, the additional power for towing the radiator is smaller than with separately arranged radiators. Nevertheless annular liquid radiators still create a comparatively high resistance which is composed of the resistances, which the air flowing across the radiator is required to overcome in front, within and behind the radiator, and the resistances encountered by the air flowing around the radiator at the edges of the radiator and at other obstacles. It is a particular object of this invention to further reduce these resistances and therewith also the energy required to tow the radiator through the air.

According to our invention the radiator is mounted in an annular conduit formed on the inside by the engine casing which approximately forms a circular body, the cross-section of which is constantly reduced in forward direction, and on the outside by a jacket surrounding the radiator. The intake opening of this conduit lies substantially in a plane extending at right angles to the propeller axis. The exhaust end of the conduit is adapted to the contour of the engine casing in such manner that the cooling air issuing from it can flow smoothly along the engine casing. We thereby avoid the formation of whirls in the discharge of the air flowing across the radiator. By utilizing the engine casing for directing the flow of this air we can dispense with the arrangement of special guide plates and therefore obtain a simple construction and a saving in weight. The radiator mounted within the annular conduit is better protected against outer influences likely to injure the radiator. The annular form of the conduit offers the further advantage of adapting itself to the movement of the air current accelerated by the propeller, which current has a component in circumferential direction.

The whirl-free discharge of the air flowing around the outer side of the radiator is obtained thereby that the outer radiator jacket is formed as a hollow annular body in such manner that its outer wall forms the continuous streamlined continuation, of reduced diameter in forward direction, of the engine casing. Thereby the air flowing around the radiator on the outside is imparted by the jacket surrounding the radiator, a direction such that the air can slide along the engine casing without the formation of whirls. Such formation of whirls within the air passages in the radiator is diminished according to this invention by the inner wall of the radiator jacket forming, together with the contraction of the engine casing at the front, an annular nozzle continuously narrowing down from the radiator towards the discharge end. This nozzle reduces the velocity of flow of the air in the air passages of the radiator, so that corresponding to the lower velocity of flow the resistance created by the inner parts of the radiator is reduced. The reduction of the velocity of flow in the air passages of the radiator exerts a favorable action on the power required for towing the radiator through the air since this towing power drops with the third power of the velocity. In contradistinction thereto the reduction of the velocity of flow in the air passages of the radiator reduces the cooling effect per unit of surface only very little since this cooling effect is reduced only in about the proportion of a 75 hundredth power of the velocity. Consequently the nozzle brings about a considerable saving in towing power, while reducing only to an insignificant degree the cooling effect per unit of surface.

In order to avoid the formation of whirls in the intake plane of the liquid radiator, we have arranged the outer wall of the radiator jacket to project beyond the intake plane of the liquid radiator, and this jacket is further formed with an annular rounded bulging portion, which adapts itself to the contour of the outer front edge of the radiator. This rounded annular bulging portion causes the air to enter the air passages of the radiator without whirling and brings about a whirl-free deflection of the air in the direction towards the outer wall of the radiator jacket.

In order to control the degree of cooling, we prefer to make the cross-sectional area of discharge of the annular conduit variable, for instance by arranging the outer jacket of the radi-

ator or an annular slide, arranged at the rear end of the jacket for displacement in the direction of the propeller axis. We may also subdivide the rear edge portion of the outer jacket into a number of oscillatable flaps. We are thus enabled to reduce the velocity of flow and the quantity of air passing through the radiator in such manner that the cooling effect changes. By axially displacing the radiator jacket or a ring arranged at the end of this jacket, we are enabled to keep the adjustment forces small and to avoid an additional air resistance by the variability of the cross-sectional area of discharge.

For the purpose of fixing the radiator in place we prefer providing a ring forming the front end of the engine casing, this ring being rigidly supported on the craft and being shaped to adapt itself to the inner wall of the radiator, serving to carry this radiator. The radiator proper is subdivided into a plurality of parts (segments) in planes extending radially to the propeller axis, these segments being held together by means of contracting members and being pressed against the ring at the front end of the engine casing. The several segments may serve for cooling either different liquids or one and the same liquid. The subdivision of the radiator is also advantageous as far as the mounting in place is concerned, since the radiator can now be mounted and dismounted without the air propeller being first dismounted. The subdivision of the radiator is also advantageous in order to render it exchangeable, so that if part of the radiator is injured, only that part need be exchanged. Apart therefrom the mounting in place of the several parts of the radiator by means of the contracting or pressing members becomes a very simple operation.

We may also arrange another, equally annular liquid radiator in the space enclosed within the main radiator. This second radiator, being arranged in a place where it encounters a less powerful air current, is particularly suitable for the cooling of liquids, such as lubricants, which require less cooling.

We prefer subdividing the inner radiator also radially into a plurality of parts (segments), the joints, which are flanked by the intake and outlet compartments, being arranged in staggered relation to the end faces of the segments of the outer radiator. We thereby facilitate the mounting in place and repairing of the inner radiator and, in view of the staggered arrangement, afford an easier access to the parts conducting the liquid, since the intake and discharge pipes are connected to the segments of the inner and outer radiators in close vicinity to the joints.

In order to also avoid the formation of whirls by the lamellae of the radiator, which together with the fluid ducts delimit the air passages of the radiator, we prefer to adapt the section of these air passages, at least on the intake side of the radiator, to the direction of flow of the air current created by the air propeller (which current possesses a velocity component directed transversely to the propeller axis) in such manner that the entrance of this air current into the radiator occurs as smoothly as possible. We can obtain this for instance by giving the radiator lamellae on the intake side a curved form which enables them to deflect, after the manner of guide vanes, the spiral movement of that part of the propeller current, which is about to enter the radiator, smoothly into the direction in which the air leaving the passages is freed from this spiral component.

In the drawings affixed to this specification and forming part thereof two radiators embodying our invention are illustrated diagrammatically by way of example.

In the drawings

Fig. 1 is an axial section of the front part of the fuselage of an airplane which contains the engine and two concentric radiators,

Fig. 2 being a front view, the air propeller being omitted for the sake of clearness.

Fig. 3 is a side elevation, partly drawn in axial section and to a larger scale, of the two concentric radiators and the parts of the engine casing and the outer jack adjoining them.

Fig. 4 is a front view of the second embodiment, which lacks the inner radiator,

Fig. 5 being an axial section corresponding to Fig. 4,

Fig. 6 is a partial section on the line VI—VI of Figure 2 showing the collector compartments.

Referring to the drawings and first to Figs. 1 to 3, 1 is the engine, 2 is the air propeller, 3 is the outer and 4 the inner radiator. The outer radiator 3 serves for cooling the cooling liquid required by the engine 1. The inner radiator 4 serves for cooling the engine lubricants. The radiators 3 and 4 have annular form and are traversed by the air current generated by the air propeller 2.

The outer radiator 3 is mounted in an annular conduit 11 formed between the jacket 5 surrounding the radiator and the engine casing 6 and the ring 7 arranged on the front end of this casing. The jacket 5 is a hollow annular body, the outer wall of which is streamlined and forms a continuation, of gradually diminishing diameter, for the engine casing 6. The adjacent faces of the jacket 5 and the contracted portion 10 of the engine casing are relatively so positioned that the width of the annular conduit 11 formed between them decreases rearwardly in a nozzle-like manner. The walls of this annular conduit 11 are so shaped that the air passing the radiator 3 can glide smoothly past the engine casing 6.

The outer wall 8 of the jacket surrounding the outer radiator projects beyond the intake plane of the radiator, forming an annular rounded bulging head 12 adjoining the outer front edge of the radiator. Another annular bulging portion 13 adjoins the front edge of the inner radiator.

Owing to the resistance offered to the passage of the air by the radiator 3 and the gradually narrowing conduit 11 only a part of the air flowing towards the radiator 3 can pass through the radiator 3. The annular bulging portion 12 prevents the formation of whirls on the intake side of the radiator. The streamlined shape of the outer wall 8 of the jacket 5, which forms a continuation of the engine casing 6, causes the air flowing around the radiator to flow smoothly along the engine casing 6.

An annular slide 14 arranged for axial movement on the rear end of the jacket 5 serves to regulate the cross sectional area of the outlet of the annular conduit 11 and thus the cooling effect of the radiator 3. Secured to the slide 14 and extending rearwardly therefrom is a sutd 57 in threaded engagement with a nut 58 from which a spindle 58a projects. The latter is mounted for rotation in bearings 59 and is held against axial movement by collars 60. Suitable means, such as a crank 61, is provided on the rod 58 for rotating the latter and moving the an-

nular slide 14 axially to vary the size of the outlet of the conduit 11. Obviously by moving the said slide in the direction of the arrow *a* the conduit outlet is reduced thereby reducing the speed of flow of air through the radiator 3 and decreasing the cooling capacity of the latter. By moving the slide 14 in the opposite direction the size of the conduit outlet is increased and consequently increasing the cooling capacity of the radiator.

The radiator 3 is fixed to the ring 7 which is held in place by supporting members 15 secured to the fuselage. In order to fix the radiator 3 to the ring 7, the radiator is subdivided into two sections 16 and 17. When mounting the radiator in place, these sections are applied against the ring 7 and the metal wires or bands 18 are now placed around the radiator and tightened by means of the swivels 19. The sections 16 and 17 are thus pressed against the ring 7 fixed in place. The rubber ring 20 inserted between the metal ring 7 and each of the sections 16 and 17 serves for preventing injury by friction and for absorbing the shocks which may be transmitted from the engine, during the operation, to the ring 7.

The cooling liquid is conducted through the radiator 3 in the following manner:

The supply pipes 21 conduct the hot cooling liquid escaping from the engine to one of the collector compartments 22 at the top ends of the sections 16 and 17. From the collector compartments the cooling liquid is conducted through the annular pipes 23 to the collector compartments 24 at the bottom ends of the sections 16 and 17. From the collector compartments 24 discharge pipes 25 conduct the cooling liquid to the pump 26 which forces it into the cooling jacket of the engine 1, from which it passes again to the pipes 21.

The radiator 4 arranged concentrically to the radiator 3 is located in a position where it is traversed by less air, the air being conducted smoothly into the air passages of this radiator by the annular bulging portion 13 and the rounded edge 27. After having passed the radiator 4 the air passes the engine 1 and escapes from the engine casing 6 through slots 28. In order to obtain a smooth discharge of the air also at these points, the slots 28 are surrounded by tongues 29 forming part of the engine casing 6 and having the form of guide vanes.

The inner radiator is subdivided into sections 30 and 31, the joints between these sections being arranged in staggered relation to the joints between the sections of the outer radiator 3. An intake compartment 32 and a discharge compartment 33 directly adjoin each joint between the sections 30 and 31, these intake and discharge compartments being connected with each other by the annular cooling pipes 34. The cooling pipes of section 30 communicate with the compartments 35 at the topmost, the cooling pipes of the section 31 with the compartments at the lowermost point, each compartment being provided with a tap or vent screw.

The radially extending lamelae 48, which together with the cooling pipes 23 and 34 of the two radiators delimit the air passages of these radiators, are curved on the intake sides of the radiators after the manner of guide vanes in such manner that they extend about tangentially, at the intake side, to the direction of the spirally flowing air propeller current, so that a smooth intake of the air flowing towards the radiators is obtained.

In the embodiment illustrated in Figs. 4 and 5 an inner radiator is dispensed with, but the outer radiator 3' is subdivided into sections 36 and 37. The smaller section 36 serves for cooling the lubricant, the larger section 37 for cooling the cooling liquid of the engine. In order that also in this embodiment the required cooling effect be obtained, the radial width of the radiator 3' is made correspondingly greater. In all other respects and quite particularly in respect to the way in which the air is guided, this embodiment is the full equivalent of the embodiment illustrated in Figs. 1 to 3.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

We claim:

1. In combination with a vehicle, and particularly with aircraft of the kind including, by itself, projecting structures such as a projecting engine unit, an engine, a casing surrounding said engine, an annular liquid radiator of the type exposed, owing to its motion relative to the surrounding air, to the passage of a cooling air current, means for arranging said radiator on the front end and, at least for the most part, within the front contours of said projecting structure, said radiator including an intake plane and a discharge plane, an annular streamlined jacket surrounding said radiator so as to expose said intake plane to a substantially free inflow of cooling air, said jacket being associated with said casing in spaced relation thereto so as to define an annular air conduit issuing from said discharge plane, the walls of said jacket and said casing defining such air conduit being arranged so as to gradually narrow down the conduit, in a nozzle-like manner, toward an exhaust, whereby the velocity of the cooling air passing through said radiator is rendered extremely low.

2. The combination of claim 1, in which the outer wall of the jacket projects beyond the entrance plane of the radiator and is formed with an annular rounded bulging portion which adjoins the outer front edge of the radiator.

3. The combination of claim 1, in which means are provided for varying the area of passage of the exhaust end of the air conduit.

4. The combination of claim 1, in which the jacket is arranged to be shifted in axial direction.

5. The combination of claim 1, in which an annular slide is arranged at the rear edge of the jacket for axial displacement relative to said jacket.

6. The combination of claim 1, in which a ring fixed to the vehicle adjoins the front end of the engine casing, said ring extending substantially in parallel to the inner radiator wall and serving to support the radiator.

7. The combination of claim 1, in which the radiator is subdivided into radially separated sections, contracting pressure members being provided for holding said sections together and a ring near the front edge of the engine casing, against which said sections are pressed by said pressure members.

8. The combination of claim 1, in which another annular radiator is arranged concentrically to and within said outer radiator.

9. The combination of claim 1, in which another annular radiator is arranged concentrically to and within said outer radiator, each radiator being subdivided into radially separated sections, the joints of one radiator being arranged in staggered relation to the joints of the other radiator, and intake and exhaust com-

partments arranged at the ends of the sections of said inner radiator.

10. The combination of claim 1, in which an air propeller is provided, the air passages in the radiator being so inclined relative to the propeller axis that the propeller wind can smoothly enter the radiator.

11. In combination with a vehicle, and particularly with aircraft of the kind including, by itself, projecting structures such as a projecting engine unit, an annular liquid radiator of the type exposed, owing to its motion relative to the surrounding air, to the passage of a cooling air current, means for arranging said radiator on the front end and, at least for the most part, within the front contours of said projecting structure, said radiator including an intake plane and a discharge plane, means for exposing said intake plane to a substantially free inflow of cooling air, and means associated with said radiator delimiting an annular channel issuing from said discharge plane and gradually narrrowing down, in a nozzle-like manner, toward an exhaust, whereby the velocity of the cooling air passing through said radiator is rendered extremely low.

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