Aug. 8, 1939. R. B. BEISEL ET AL 2,168,599

AIR REGULATING MEANS

Filed Jan. 3, 1934 2 Sheets-Sheet 1

Fig. 1.

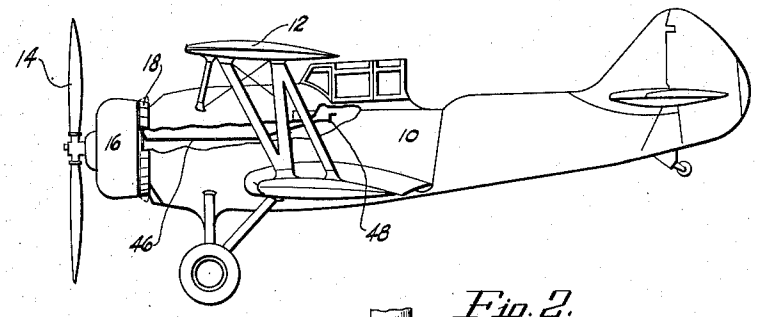


Fig. 2.

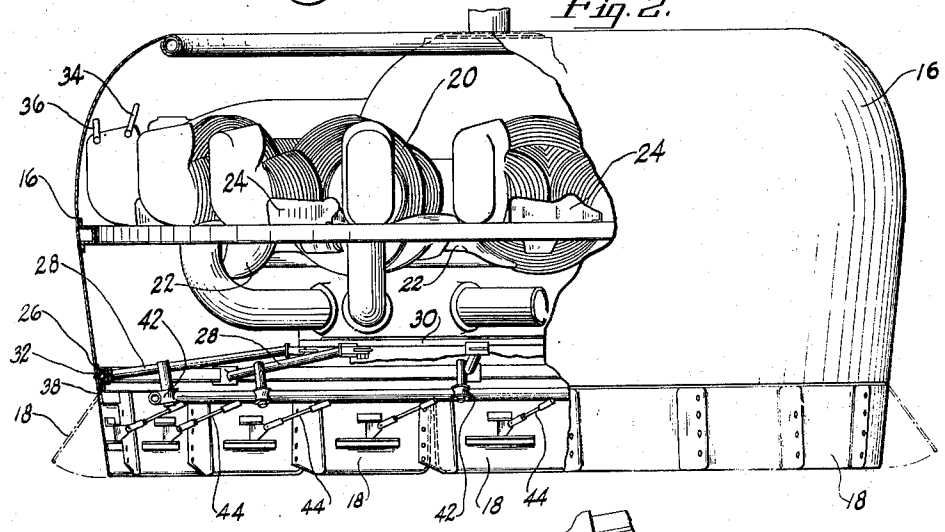
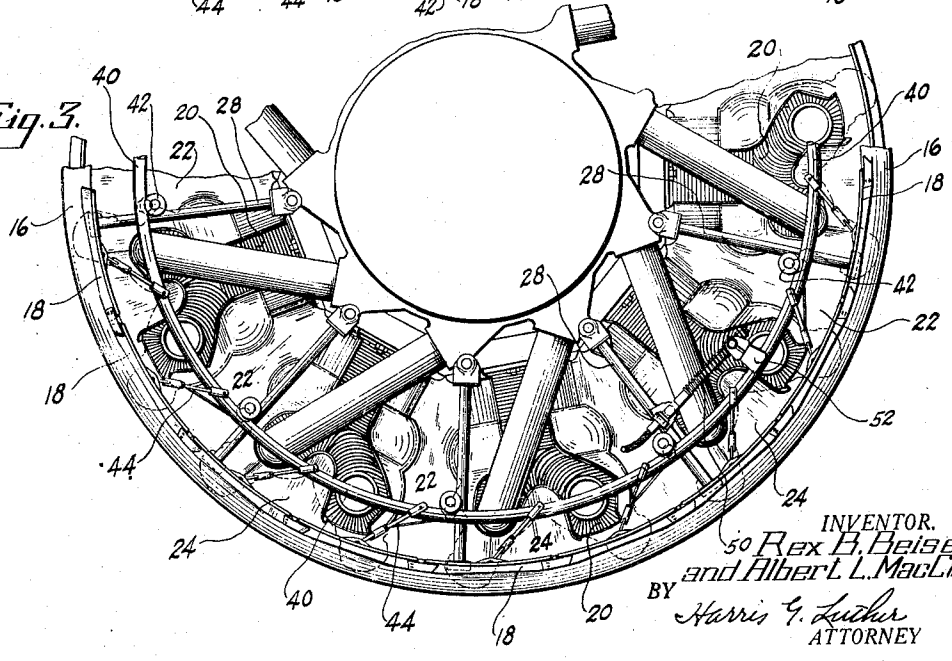


Fig. 3.



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Fig. 4

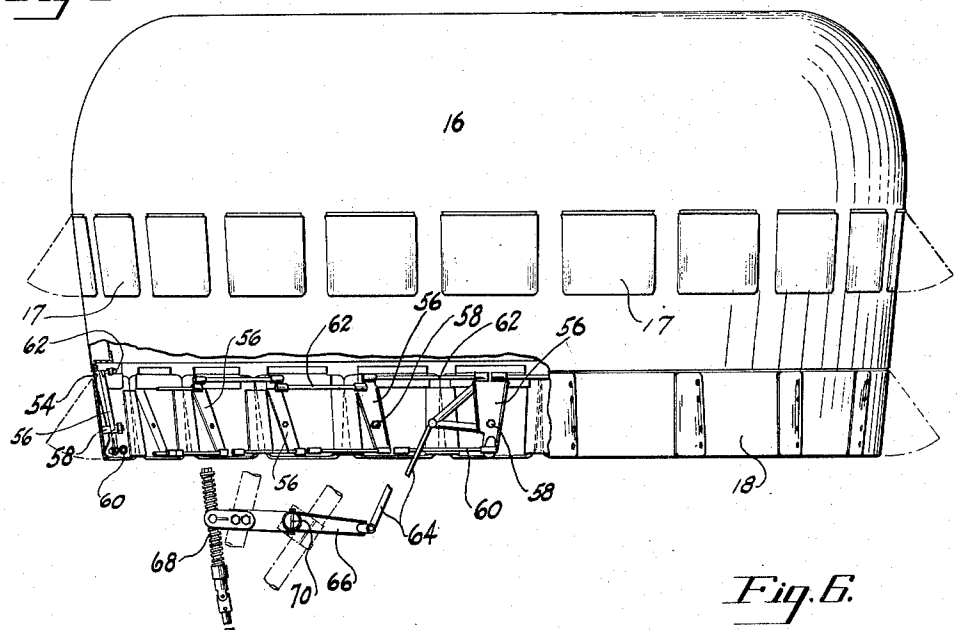


Fig. 5

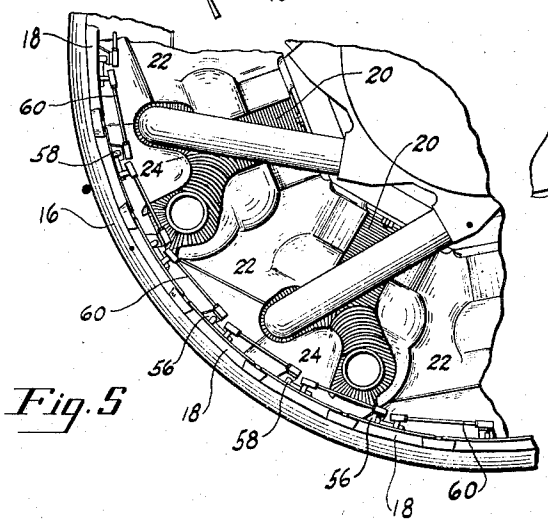
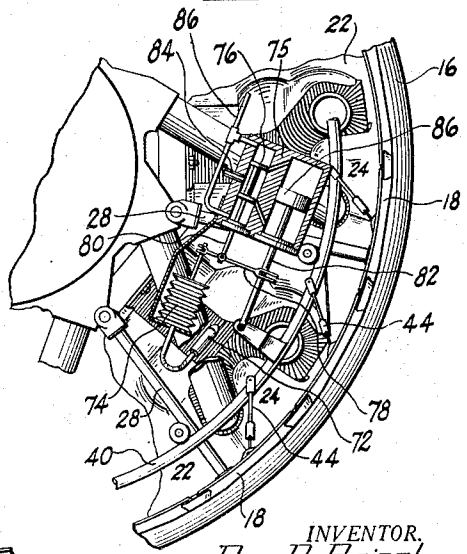


Fig. 6.



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UNITED STATES PATENT OFFICE

2,168,599

AIR REGULATING MEANS

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Application January 3, 1934, Serial No. 705,094

16 Claims. (Cl. 123—171)

This invention relates to air regulating means.

More specifically, this invention relates to cowlings and means for regulating the air flow therethrough.

Experience has shown that placing cowls around radial air-cooled motors such as are used in airplanes reduces the drag caused by that engine, but impairs the ability of that engine to properly cool. This inferior cooling is probably due to the reduced air flow over the heat radiating fins of the cylinders. Conversely, experience has shown that removing the cowl improves the cooling but increases the drag.

Many attempts have been made and many devices have been designed to properly cool a cowled engine so as to obtain the benefit of the reduction in drag. These devices often take the form of a fan or blower adapted to blow air on to the engine under the cowl, but obtain the increase in cooling at the expense of engine power and an increase of weight due to the fans or blowers and a loss of power due to the loss in converting mechanical force into moving air or air pressure.

In the mechanism employed by applicant, a device is used which comprises baffles substantially completely blocking the passage of air from the front to the rear of the cylinder under the cowl except in the space between the individual heat radiating fins of the engine. This device has been found to not only reduce the drag even beyond that of an ordinary cowled engine, but also actually improves the cooling over that obtainable without the cowl. When used with an ordinary cowl designed for normal conditions, it has been found that there are certain conditions under which the cooling provided thereby is not sufficient and certain other conditions under which the cooling is too great. This general type of baffle forms the subject matter of Patent Number 2,031,541 issued February 18, 1936, to Albert L. MacClain.

One of the objects, therefore, of our invention is to regulate the air flow under a cowl.

Another object of our invention is to improve the cooling of air-cooled engines.

Another object of our invention is to reduce the drag of an engine.

Other objects and advantages of our invention will be apparent from the accompanying specification and drawings which illustrate what is now considered the preferred embodiment.

Fig. 1 shows an airplane with the improved type of cowl mounted thereon.

Fig. 2 is an enlarged detailed view, partly in section, of flaps and their operating mechanism applied to a cowled engine having intercylinder and head baffles.

Fig. 3 is a partial rear view thereof with engine mounting ring omitted.

Fig. 4 is an enlarged detailed view, partly in section, of modified forms of flaps and operating mechanism.

Fig. 5 is a partial rear view of this modification.

Fig. 6 is a detail view, somewhat diagrammatic, showing a modified means for operating the device of Figs. 2 and 3.

This invention is shown as applied to an airplane having a fuselage 10, wings 12, propeller 14, and engine cowl 16. The cowl 16 is shown as applied to an engine having cylinders 20. Baffles 22 are fitted between adjacent cylinders and extend from the cowl to the engine crankcase, and substantially close all the passages between the front and rear of the engine under the cowl and between the adjacent cylinders except the space between the individual heat radiating fins of the engine. Additional baffles 24 are provided between the projections on the cylinder heads which house the valve operating mechanism. These baffles 24 substantially close the passage between the front and rear of the engine between the cowl and the cylinder heads except the space between the individual head radiating fins. By means of these baffles 22 and 24 and the cowl, the flow of air under the cowl from the front section to the rear section is limited to the air that can pass between the individual heat radiating fins. All other passages between these two sections under the cowl are closed as tightly as is practicable.

The cowl 16 is provided with flaps 18 adjacent its trailing edge. These flaps are hinged at their leading edges adjacent the trailing edge of the cowl 16 and are adapted to swing on their hinges so that the position of their trailing edges may be varied between a position adjacent the fuselage 10 or other body and a position removed therefrom. This movement of the flaps varies the size of the annular opening at the rear of the cowl and also varies the angle between the flaps and the relative wind.

The flaps may, if desired, when in the position adjacent the fuselage, entirely or substantially close the annular opening between the flaps and the fuselage or other body, thus allowing practically no air to pass under the cowl and over the cylinder fins and consequently greatly reducing the time required for warming up the

engine, especially in cold weather. When the flaps are in their extended or outwardly flared position, they provide an annular opening between the flaps and the fuselage or other body through which the air used to cool the engine may escape and in addition change the direction of flow of the air adjacent the trailing edge of the cowl. This change of direction of the air flow introduces a low pressure area under and to the rear of the flap which in turn introduces a low pressure area in the entire section between the fuselage and the rear of the engine and its baffles.

Blocking the space under the cowl and adjacent the engine, by means of baffles 22 and 24, so completely against air flow permits changing the air velocity head entering the forward portion of the cowl to a static pressure head adjacent and in front of the engine cylinders. The increased pressure in front of the baffles together with the reduced pressure back of the baffles causes a greatly increased flow of air over the engine heat radiating fins. Because of this construction air is also forced down into the bottom of the engine cooling fins permitting the efficient use of longer fins than is otherwise possible. Operation of the flaps 18 between their extended and contracted position varies the reduced pressure back of the engine and baffles, and, consequently, varies the quantity and velocity of cooling air flowing over the heat radiating fins.

In the modification shown in Figs. 2 and 3, the cowl 16 is supported adjacent the rear end thereof by a ring in the form of a channel member 26 which, in turn, is supported by radial members 28 extending between the ring 26 and the engine mounting ring 30. A tubular member 32 is bent into the form of a ring and secured adjacent the trailing edge of the cowl. This tubular member 32 is adapted to be placed in the recessed portion of the channel member 26 and held in place thereby. The forward portion of the cowl is secured by members 34 and 36 extending between the cowl and the engine rocker boxes. The cowl shown is of a well known two-piece type and after loosening the members 34 and 36 and other fastenings, the two parts may be separated to permit removal of the tubular ring 32 from the channel 26 and thus free the cowl from its supports so that it may be entirely removed from the engine in the usual manner. It should be understood, however, that any suitable type of cowl may be used. Secured to the rear portion of the channel member 26 are hinges 38 adapted to connect the flaps 18 with the ring 26 and thus support these flaps in position adjacent the trailing edge of the cowl.

In order to hold the flaps 18 in position and to move them about their hinges 38 between extended and contracted position, a ring 40 is supported by a plurality of rolls 42 substantially concentric with the flap and cowl supporting member 26. Links 44 are provided connecting the ring 40 with the individual flaps 18. A ball and socket or universal joint is used to connect the link with the ring 40 and two pivots at right angles to each other are provided in the connection between the link and the flap so that the link may be free to assume the various angles required of it in the opening and closing of the flaps. These links are arranged at such an angle with the ring 40 that movement of the ring 40 on its rolls 42 in one direction will tend to open or extend the flaps 18, and movement of the ring 40 in the other direction will close these flaps. This type of construction provides a very rigid connection between the flaps and the supporting ring, and practically eliminates any danger of fluttering of the flaps. Holding the ring 40 in any desired position will hold the flaps 18 quite rigidly in any desired position.

Any suitable means may be provided for moving the ring 40. In the embodiment shown in Figs. 1 and 2, a flexible shaft 46 is used to connect a crank 48 located in the pilot's compartment with a screw 50 rotatably supported on one of the channel supporting members 28. The screw 50 is threaded into a nut swiveled in a bracket 52 rigidly secured to the ring 40. A swivel joint is provided between the member supporting the screw 50 and the member 28 to compensate for the different angular positions of the screw 50. Rotation of the crank 48 will impart rotation to the screw 50 which, in turn, will cause rotation of the ring 40 and thus operate the flaps 18.

The operation of this device is as follows:

After take-off and during a climb, where maximum power is required of an engine and the relative air speed is materially less than cruising or maximum air speed, the flaps 18 are rotated about their hinges 38 so as to place them in their extended or flared position, as shown by the dotted lines in Fig. 2. This creates a low pressure area in the entire space under the rear section of the cowl, as this section is partitioned from the front section by a partition comprising the engine and baffles 22 and 24. As the opening between the front and rear section is restricted to the area between the individual heat radiating fins, it is impossible for sufficient air to pass this partition to materially destroy this reduced pressure, especially as the reduced pressure and the area adjacent the extended flaps are capable of handling a much larger quantity of air than passes the partition. This reduced pressure under the rear section of the cowl together with the pressure caused by the conversion of velocity head to static head under the forward section of the cowl so increases the air velocity over the fins that the cooling is materially increased during a climb.

When sufficient altitude has been attained and the airplane increases its speed as in level flight, then the difference in pressure between the front and the rear of the engine cylinders may be so great as to cause more cooling than is desirable. The crank 48 may then be operated to contract the flaps from their flared position and thus reduce the drag caused by the extended flaps and, in addition, reduce the pressure difference between the front and the rear of the engine cylinders which, in turn, will prevent undue cooling of the engine. When flying in a climb, level flight or otherwise, the engine temperature may be controlled by operation of the flaps, thus compensating for atmospheric temperature differences. For example, when flying in extremely cold weather, the flaps may be contracted to restrict the air flow, and thus permit the engine to operate at a temperature sufficiently high to ensure efficient operation and, conversely, in extremely warm weather the flaps may be opened and, due to the increased air flow over the engine fins, the engine temperature may be kept within the allowable limits for safe operation.

If desired, and in order to relieve the pilot of the task of, or assist him in, keeping the engine at the proper operating temperature, the flaps may be controlled by a thermostat actuated by

the engine temperature. The thermostat may actuate the flaps directly, or any suitable device may be used to thus control the flaps, and for purposes of illustration one form of such device is shown in Fig. 6.

In the device illustrated, a temperature responsive element 72 is placed in thermal communication with the engine, and serves to actuate a bellows 74 in the usual manner. In the form illustrated, a servo mechanism is interposed between the bellows and the ring 40 to assist the bellows in operating the flaps and to multiply the movement.

The servo mechanism may take any suitable form. In the embodiment shown, it comprises a valve controlled piston adapted to take a definite position for each position of the bellows. A link 78 is pivotally mounted intermediate its ends on the valve rod 80 and suitably connected at one end with the bellows 74 which is mounted on the housing 75, and at the other end with the piston rod 82. Fluid under pressure, such as oil from the engine lubricating system, is led to the valve 76 by means of a pipe 84 and pipes 86 lead to the drain or sump. This type of servo mechanism is well known, and further explanation is believed unnecessary. The piston rod 82 is connected by any suitable means with the flap actuating ring 40 and the entire servo mechanism is suitably secured to some stationary part of the airplane or engine structure such, for instance, as one of the radial arms 28. Relative movement of the piston rod 82 and the servo mechanism will therefore impart movement to the flap actuating ring 40.

The operation of this device is believed to be apparent from an inspection of the drawings and from the above description, but it will be briefly reviewed here.

Assume the entire device to be in operation under stable conditions with the flaps set in a position to give the desired engine temperature. If the conditions should change so that the engine temperature starts to rise, the bulb 72 will act to expand the bellows 74. This expansion will cause movement of the link 78 about its connections with the piston rod 82 as a center and, consequently, move the valve 76. Movement of the valve 76 will admit fluid under pressure to one side of the piston 86 and connect the other side with the drain, thus causing movement of the piston 86 and piston rod 82. This movement operates the link 78 about its connection with the bellows as a center, and moves the valve 76 back to its neutral position. Movement of the piston rod 82 causes, by means of its connection with the ring 40, movement of the flaps 18 which govern the flow of air over the engine and consequently its cooling. It will, therefore, be seen that an increase in engine temperature causes the flap to open and more air to be supplied to cool the engine. By properly proportioning the link 78, the engine temperature may be kept within any desired limits.

If desired, a manual control may be superimposed on the automatic control. This may take any of several forms. In the device illustrated, for instance, this may be accomplished by controlling the position of either the bellows 74 or the housing 75 from the pilot's cockpit. This could readily be accomplished by using a mechanism, as shown in Fig. 3, mounting either the bellows 74 or the housing 75 on the screw 50 after having disconnected that screw from the ring 40.

Figs. 4 and 5 show a modified form of flap and operating mechanism therefor. In this modified form the flaps 18 are secured directly to the cowl 16 by means of the hinges 54 so that the cowl and the flaps may be removed as a unit. A lever 56 is pivotally mounted by means of a pivot 58 on each flap 18, the pivot being located intermediate the ends of said lever with one end of the lever located adjacent the trailing edge of the flap and the other end located adjacent the hinge line. A link 60 is attached by means of a ball and socket or universal joint adjacent that end of the lever located near the trailing edge of the flap. The other end of the link 60 is secured by means of a ball and socket or universal joint to the next adjacent flap at a point near its trailing edge. Links 62 connect that end of each lever adjacent the hinge line with the same end of the lever on either side thereof. These links 62, therefore, connect all the levers together in such a manner that operation of one will cause operation of them all. A link 64 connects one of the levers 56 with one end of a two-armed lever 66 suitably pivotally supported at 70 in the airplane fuselage or other stationary support. The other end of said lever 66 pivotally supports a nut into which a screw 68 is threaded. One end of this screw is suitably supported on the fuselage frame members and suitable connections are brought from the screw to a crank 48 located in the pilot's cockpit. In the modification shown, this connection takes the form of rods and universal joints and is adapted to communicate rotation of the crank 48 to the screw 68 and through the various links and levers, turn the flaps 18 about their hinges. As in the previously described modification, the cowl shown here is a two-piece cowl adapted to be contracted on to its support in the usual manner, but it is obvious that the cowl need not take that particular form, as this invention is adapted to be used on various types of cowls such, for instance, as cowls built up of a number of segments, or on cowls made of only one piece, as well as both circular and non-circular cowls.

In the operation of this device, rotation of the crank 48 will cause rotation of the screw 68 and movement of the lever 66 on its pivot 70 which, in turn, will cause rotation of lever 56 about its pivot 58. Due to the inter-connection of all the levers by means of the links 62, all of the levers will thus be caused to move on their pivots 58. The movement of the lever 56 will cause movement of the link 60 which will tend to separate the trailing edges of the flaps 18. The hinged joints 54, however, will prevent any direct separation, but due to the fact that the hinges of adjacent flaps are at an angle to each other, this separation of the trailing edges of the flaps will cause rotation of the flaps about their hinges 54, and conversely, contraction or bringing together of the trailing edges of the flaps will cause rotation in an opposite direction about these hinges. The aerodynamic action of those flaps will, of course, be similar to that described for the modification illustrated in Figs. 2 and 3.

Under certain conditions, it may be found desirable to place additional flaps at some point other than the trailing edge of the cowl or it may be found desirable to fair the cowl into the fuselage or other body back of the cowl so that it has no trailing edge. Under these and other conditions, the cowl 16 may be provided with flaps 17. These flaps may be hinged to the cowl at their forward edges and operated by any suit-

able form of mechanism, any of the mechanisms shown or described in this application being suitable for that purpose. These flaps may, if desired, be connected to operate simultaneously with or independently of the flaps at the trailing edge of the cowl. These flaps have been shown as spaced from each other, and they may have plates subtended from each side thereof to strengthen the flap and guide the air, or they may be constructed similar to flaps 18 to form a continuous surface.

In any event the space under the flaps is connected either directly or by means of ducts with the space at the rear of the engine and baffles, and act in a manner similar to flaps 18 to reduce the pressure in that area.

Although we have described and shown what is now considered the preferred embodiment of our invention, it should be understood that the invention may be otherwise embodied and that the drawings are not to be construed as defining or limiting the scope of the invention, but as illustrative only.

It is, therefore, to be understood that the invention is not limited to the specific embodiments herein illustrated and described, but may be used in other ways without departure from its spirit, as defined by the following claims.

We claim:

1. Engine cooling means comprising, in combination, an engine having cooling fins and adapted to be moved relative to the surrounding air, a cowl around said engine open at the front and rear, baffles adjacent to said engine to form with said engine a partition in said cowl dividing the space within the cowl into a front portion and a rear portion and substantially preventing the passage of air from the front portion to the rear portion except through the spaces between individual engine cooling fins to provide a flight induced pressure different on opposite sides of said partition, hinged adjustable flaps adjacent the trailing edge of said cowl for regulating the air pressure under the rear portion of said cowl to vary the amount of engine cooling air passing through said cowl by inductively varying said pressure difference and means to adjust said flaps.

2. Engine cooling means comprising, in combination, an engine having cooling fins and adapted to be moved relative to the surrounding air, a cowl around said engine, an engine baffle system forming with said engine a partition in said cowl dividing the space under the cowl into a front portion and a rear portion and substantially preventing the passage of air from the front portion to the rear portion except through the spaces between individual engine cooling fins, means for regulating the pressure under the rear portion of said cowl comprising a series of hinged flaps associated together at the rear of said cowl operable to provide a continuous outward flare at the trailing edge of said cowl, and means for operating said flaps.

3. Engine cooling means comprising, in combination, an engine having cooling fins and adapted to be moved relative to the surrounding air, a cowling around said engine, a baffle system forming with said engine a partition in said cowling dividing the space under the cowl into a front portion and a rear portion and substantially preventing the passage of air from the front portion to the rear portion except through the space between individual engine cooling fins, means comprising a series of hinged flaps constituting an adjustable flare at the trailing edge of said cowl for regulating the flow of air through said engine by controlling the pressure in said rear portion of said cowl, and means responsive to the engine temperature for automatically operating said flaps.

4. In combination with an annular cowl, flaps hinged adjacent the trailing edge of said cowl, and means for operating said flaps, said means comprising a ring rotatably supported inside said cowl and individual links extending one between each flap and the ring connecting the flaps with the ring so that rotation of the ring will cause movement of the flaps on their hinges.

5. In combination with an annular cowl, flaps hinged adjacent the trailing edge of said cowl, and means for operating said flaps, comprising a lever pivotally supported intermediate its ends on each flap, links connecting one end of said lever to the next adjacent flap and means for moving said lever.

6. In an aircraft, means for reducing the drag and improving the cooling of an air cooled engine having a plurality of cylinders provided with heat radiating fins comprising, a stream lined cowl surrounding said engine, pressure baffles fitted to said cylinders to restrict the flow of air through said engine to the spaces between individual heat radiating fins, said baffles forming with said engine a partition dividing the space within said cowl into two sections disposed one on either side of said engine, for creating in one of said sections a flight induced air pressure above the pressure of the surrounding atmosphere, and in the other of said sections an air pressure lower than the air pressure in said one section, and means comprising a series of adjustable flaps hinged adjacent to the trailing edge of said cowl for varying the pressure difference between said sections to provide a pressure difference greater than the difference between the pressure in said one section and the pressure of the surrounding atmosphere under certain conditions of flight.

7. In combination with a radial air cooled engine having a plurality of finned cylinders of irregular contour, a stream lined cowl having open ends to provide for the flow of a stream of engine cooling air therethrough surrounding said engine and extending forwardly and rearwardly thereof, and a body adjacent to the rear portion of said cowl, means for controlling the cooling effect of said airstream comprising, a plurality of air pressure baffles shaped to conform to the contours of said cylinders substantially closing all spaces between said engine and said cowl except between individual engine cooling fins, and a plurality of adjustable flaps mounted adjacent to the trailing edge of said cowl and extending over the outer edge of said body to control the flight induced air pressure in the space within said cowl between said engine and said body to provide in said space a pressure less than the pressure of the surrounding atmosphere when the engine is operating under adverse cooling conditions.

8. In combination with a radial engine having heat radiating fins thereon, a stream lined cowl surrounding said engine and having an air exit opening of sufficient extent to provide adequate engine cooling at a predetermined condition of engine power output and cooling air temperature, and baffles extending from the interior of said cowl to the cooling surfaces of said engine to block the passage of air through said engine and provide a flight induced air pressure in the forward portion of said cowl substantially equal

to the pressure of the surrounding atmosphere plus the pressure of the converted kinetic energy of the air entering said cowl, means for reducing the drag of said cowl and improving the cooling of said engine comprising, a plurality of sequentially associated flaps hinged adjacent to the trailing edge of said cowl and movable from a position in which they constitute a drag reducing continuation of said cowl when the cooling requirements of said engine are below said predetermined condition to a position in which they constitute a flare at the trailing edge of said cowl to induce an air flow through said baffles greater than the flight induced air flow of said cowl alone by increasing the pressure difference on opposite sides of said baffles when the cooling requirements of said engine are above said predetermined condition.

9. In an aircraft, the combination with an air cooled engine, and a stream lined cowl surrounding said engine, of means for controlling the flow of engine cooling air through said cowl comprising, a series of flaps hinged adjacent to the trailing edge of said cowl, and means for adjusting the angular position of said flaps with respect to said cowl comprising, a manually rotatable member, a bodily movable member operatively associated with said flaps, and means for converting rotation of said rotatable member into movement of said bodily movable member.

10. In an aircraft, the combination with a radial air cooled engine and a stream lined ring cowl surrounding said engine and extending forwardly and rearwardly thereof, of means for controlling the flow of engine cooling air through said cowl comprising, a series of flaps hinged adjacent to the trailing edge of said cowl and disposed in angular relation with respect to each other, manually operable means for adjusting the angular relation of said flaps with respect to said cowl, and connecting means operatively associating individual flaps with each other and with said manual means for actuation of all of said flaps in unison upon operation of said manual means.

11. In combination with engine cooling means comprising a group of heat radiating surfaces, a cowl surrounding said heat radiating surfaces having an opening at one side of said group of heat radiating surfaces for the entrance of engine cooling air and an opening spaced from said air entrance opening for the exit of engine cooling air, means providing an air pressure drop through said group of heat radiating surfaces, means effective to control the cooling effect of said engine cooling air by varying the size of said air exit opening to regulate the air pressure drop through said group of heat radiating surfaces, and means responsive to the temperature of said engine for operating said control means to vary the size of said air exit opening.

12. In the combination of a streamlined cowl, a series of adjustable cowl trailing edge flaps and a flap operating mechanism, means supporting said flaps and said flap operating mechanism as one independent unit, and means supporting said cowl as a second independent unit removable from said combination without disturbing said flaps or said flap operating mechanism.

13. In the combination of a streamlined cowl for an aircraft engine and a series of adjustable flaps aerodynamically associated with the trailing edge of said cowl to control the flow of air therethrough and a flap operating mechanism, means supporting said flaps and said flap operating mechanism as an independent unit, means for supporting said cowl, and means for detachably connecting said cowl to said supporting means to render the same individually removable from said combination without disturbing said flaps and said flap operating mechanism.

14. In an aircraft a drag reducing and air flow regulating device for reducing the drag of and regulating the air flow past heat radiating surfaces comprising, in combination, a cowl surrounding said heat radiating surfaces, adjustable cowl flaps adjacent to but separate from said cowl, mechanism for moving said cowl flaps to inductively vary the air flow past said heat radiating surfaces, a support for said flaps and their operating mechanism, a support for said cowl, and means for attaching said cowl to its support constructed and arranged so that said cowl may be removed without disturbing said flaps or their operating mechanism.

15. In construction with engin cooling means comprising, a group of heat radiating surfaces, a cowl surrounding said heat radiating surfaces and subjected to a relative wind, said cowl having an air entrance opening in one end thereof at one side of said group of heat radiating surfaces and an air exit opening in the opposite end thereof at the opposite side of said group of heat radiating surfaces, means including said group of heat radiating surfaces dividing the interior of said cowl into separate chambers connected respectively with said air entrance opening and said air exit opening and providing an air pressure drop between said chambers through said group of heat radiating surfaces, a series of adjustable flaps hingedly mounted adjacent to the edge of said cowl at said air exit opening, and means for adjusting said flaps to change their inclination with respect to said cowl to inductively vary said air pressure drop and the consequent flow of cooling air through said cowl by changing the direction of the relative wind adjacent to said air exit opening.

16. Means adapted to be associated with an annular engine cowl to control the flow of engine cooling air therethrough comprising, a series of flaps hinged to an annular support adapted to be positioned adjacent to the trailing edge of said cowl, said flaps being disposed in angular relation with respect to each other, manually operable means for adjusting the angular relation of said flaps with respect to said cowl, and connecting means operatively associating individual flaps with each other and with said manual means for actuation of all of said flaps in unison upon operation of said manual means.

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