Feb. 24, 1942. R. J. WOODS 2,274,442

HEAT EXCHANGE DEVICE

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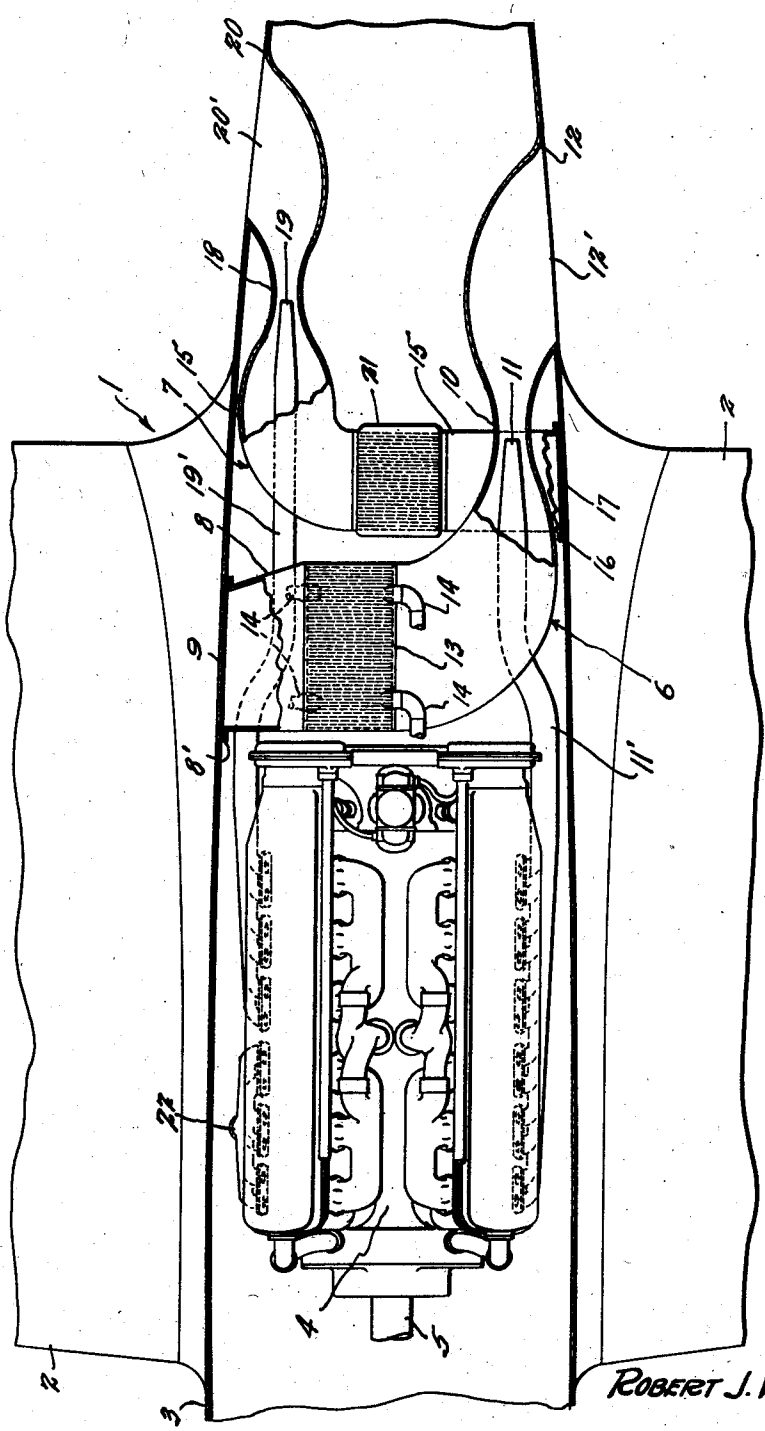


Fig. 1.

Inventor

ROBERT J. WOODS

By Semmes, Keegin & Semmes

Attorneys

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FIG. 2.

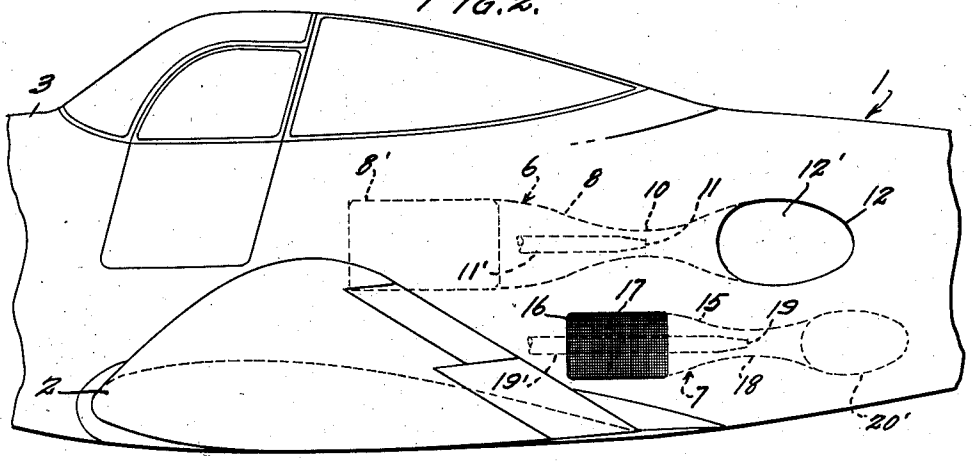
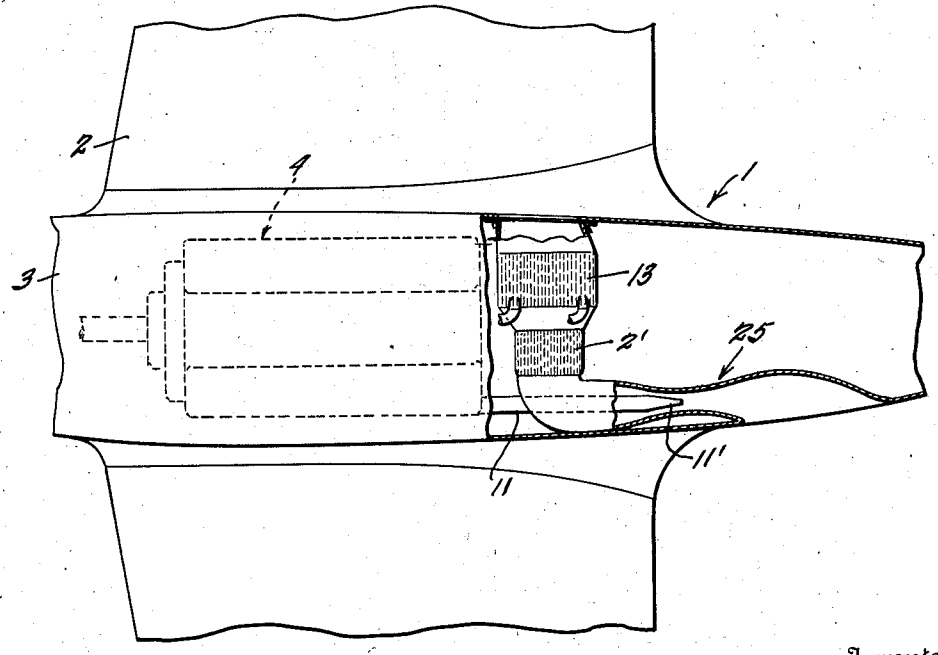


FIG. 3.



Inventor

ROBERT J. WOODS

By Semmes, Keegin & Semmes

Attorneys

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2,274,442

HEAT EXCHANGE DEVICE

Robert J. Woods, Grand Island, N. Y., assignor to Bell Aircraft Corporation, Buffalo, N. Y., a corporation of New York

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4 Claims. (Cl. 123—174)

This invention relates generally to a means for increasing the flow of gases through a conduit having a Venturi section by utilizing the energy of exhaust gases of an engine, and more especially to the utilization of this idea for purposes of heat exchange by positioning a heat exchange device in a conduit of this construction. While this invention contemplates the use of any desired type of gas in the conduit at any desired temperature and in combination with any suitable heat exchange device, this application is directed to the idea of positioning the radiator or oil cooler of a combustion engine in the conduit and inducing an increased flow of atmospheric air to pass through the conduit in a manner which is to be subsequently described.

Hitherto, difficulty has been encountered in cooling combustion engines by the use of radiators, and this is especially true when the machine is at rest or moving slowly. This difficulty is present under all conditions in vehicle constructions in which the radiator does not have a frontal area as is the case with rear end drive buses and cars. My invention will also increase the efficiency of the cooling systems of tanks, armored cars and Diesel locomotives.

Many types of airplanes also employ radiators and other heat exchange devices, such as lubricating oil coolers, which are positioned so as not to have an opening normal to the direction of flight. In order to obtain adequate cooling in airplanes of this type, air scoops are employed to induce increased air flow for purposes of cooling, or the radiators and oil coolers are placed partly outside the contour of the airplane to obtain adequate air flow. Either of these structures materially increases the drag upon the airplane.

Moreover, in all present types of airplane construction, including those having radiators with openings normal to the direction of flight, the volume of cooling air depends to a large extent upon the speed of flight. For this reason, when the engine is driven at high speeds with the airplane at rest, the present method of cooling is inadequate. Moreover, when power off glides are employed, the engine oil is chilled and the cylinder jacket temperature is decreased, thereby requiring the pilot to frequently gun the engine to keep it warm.

One of the objects of my invention is to overcome the above-mentioned disadvantages of the prior art.

Another object of my invention is to provide a conduit having a Venturi section in which is positioned the nozzle of an exhaust pipe of an internal combustion engine.

Still another object of my invention is to increase the air flow through a conduit of the type just described by creating a suction effect by discharging the exhaust gases from the engine into the Venturi section.

Yet another object of my invention is to provide a cooling unit for an internal combustion engine which consists of a conduit in which is positioned a heat exchange device, such as a radiator, for reducing the temperature of the cooling medium or the lubricating oil of the engine, said conduit being provided with a Venturi section in which is positioned the nozzle of an exhaust pipe from the internal combustion engine.

A further object of my invention is to provide a cooling unit of the type described in which the conduit does not have a frontal opening normal to the direction of motion, thereby enabling the volume of the flow of air through the conduit to be principally controlled by the engine speed rather than the velocity at which the vehicle is moving.

With these and other objects in view, my invention embraces broadly the concept of providing a conduit through which a gas may freely circulate, which is provided with a reduced portion in which the nozzle of the exhaust pipe of an internal combustion engine may be positioned in such a manner that the exhaust gases may be discharged at high velocity into this restricted portion of the conduit, thereby creating a suction effect which will increase the flow of gases through the conduit. The variety and the temperature of the gas employed will depend on the type of heat exchange device which is positioned within the conduit.

The present application embraces the idea of inducing an increased flow of atmospheric air to pass through a conduit, in which are positioned radiators connected to the cooling or lubricating system of an internal combustion engine. Such construction can be used in connection with either stationary engines or engines used to propel vehicles, and is especially suitable for use in buses and cars having rear end drives, and in airplane construction to lessen drag. The use of this invention will also overcome the difficulties which have been encountered in cooling the power units of certain special types of vehicles, such as armored cars, tanks, and Diesel locomotives.

Figure 1 of the drawings discloses a fragment in longitudinal section of an airplane in which

is positioned two of the cooling units which form the basis of this invention.

Figure 2 of the drawings discloses a fragment in side elevation of the fuselage of an airplane. Figure 3 discloses a fragmental plan view partly in section of a modification of the invention.

For purposes of illustration I have shown in the drawings the manner in which my invention is applied to cooling an internal combustion engine which forms the power unit of an airplane, which is generally designated by the numeral 1. In the design shown in the drawings, the airplane 1 is provided with a main airfoil 2 and a fuselage 3 in which is mounted a twelve cylinder combustion engine 4 having a drive shaft 5.

Mounted directly behind the engine 4 are a pair of superposed cooling units 6 and 7. The cooling unit 6 consists of an air duct 8, one end of which is substantially rectangular in cross section and is mounted on the right side of the fuselage as shown at 8' at a point directly above the airfoil 2. The skin of the fuselage 3 at this point is provided with an aperture through which the duct 8 communicates with the atmosphere. A grill 9 is positioned in the aperture to filter the incoming air.

The cylindrical portion of the air duct 8 extends transversely across the fuselage 3 until it is in close proximity with the left wall of the fuselage and then turns rearwardly and is narrowed to form a Venturi section 10 in the narrowest part of which is positioned a nozzle 11 of an exhaust pipe 11' in a manner which will be subsequently described. The rearward extremity of the duct 8 is flared and is mounted on the left side of the fuselage 3 at a position rearward of the trailing edge of the airfoil 2 as shown at 12. An aperture 12' is provided through the skin of the fuselage at this point so that the air duct 8 forms a continuous conduit from one side of the fuselage 3 to the other.

The exhaust pipe 11' is mounted on the left block of the engine 4 and exhausts the burnt vapors from the six cylinders which form this block. This exhaust pipe extends rearwardly, through a close fitting aperture in the air duct 8 and discharges the exhaust gases into the Venturi section 10, as has previously been described.

A liquid radiator 13 is rigidly mounted in the large section of the air duct 8 between the grill 9 and the Venturi section 10. This radiator 13 is connected to the cylinder jackets of the engine 4 by means of the pipes 14.

In operation the air passes through the grill 9, through the radiator 13, and the remainder of the air duct to the left side of the fuselage 3 where it is discharged through the opening 12'. The force required to induce this air flow through the air duct 8 and across the fuselage 3 is obtained by the suction effect created by the discharge of exhaust gases from the nozzle 11 of the exhaust pipe 11' into the Venturi section 10.

The cooling unit 7 consists of an air duct 15 which is similar in construction to that of the air duct 8. The intake end of the air duct 15 is mounted, however, on the left side of the fuselage 3, as indicated at 16, above the airfoil 2 and is provided with a grill 17 which is positioned in an aperture through the fuselage skin. The cylindrical portion of the air duct 15 extends transversely across the fuselage to a point adjacent the right side of the fuselage and then extends rearwardly and narrows to form a Venturi section 18 in the narrowest part of which is positioned the nozzle 19 of an exhaust pipe 19'. The air duct 15 is provided with a flared end which is mounted on the right side of the fuselage 3 as shown at 20 and surrounds an aperture 20' which is provided in the skin of the fuselage at this point. An oil cooler 21 is positioned in the cylindrical portion of the air duct 15 and is connected to the lubricating system of the engine 4 by any suitable means.

The exhaust pipe 19 is connected to the exhaust ports of three of the cylinders which form the right block of the engine 4 and extends rearwardly into the air duct 15 in a manner similar to that described in connection with the exhaust pipe 11'. The burnt gases from the remainder of the cylinders which compose the right block of the engine 4 are exhausted through the exhaust pipe indicated at 22.

In operation the air passes through the strainer grill 17, the oil cooler 21 and the remainder of the air duct 15 to the exhaust aperture 20'. The force required to induce this air flow is obtained by the suction effect created by discharging the gases into the narrowest part of the Venturi section 18 at high velocity.

By employing this suction effect, a large volume of air can be drawn through the air ducts 8 and 15 without employing air scoops or the use of grills having a frontal area normal to the line of flight. Moreover, the radiator or oil cooler need not be positioned in such a manner that they extend out into the air flow. By eliminating these constructions, the engine may be efficiently cooled without obstructing the air flow surface of the airplane.

Another important feature resides in the fact that the amount of air flowing over the heat exchange devices is proportional to the engine speed and is not dependent upon the velocity of the airplane. For this reason, during power off dives when the engine speed is cut to a minimum, the suction created by the exhaust gases in the Venturi sections of the air ducts is instantly reduced with a corresponding reduction of the volume of air which is drawn through the ducts. This prevents the lubricating oil and cooling medium from being chilled during the dive, and removes the necessity of gunning the engine.

Moreover, when the engine is being driven with an open throttle with the airplane at rest upon the ground, the increased velocity and volume of the exhaust gases being discharged into the Venturi sections draws a large volume of air through the ducts, thereby increasing the heat exchange capacity of the radiator and cooler and increasing the general efficiency of the engine.

While for purposes of illustration I have shown the exhaust pipe 11 connected to six cylinders of the engine 4 and the exhaust pipe 19 connected to three cylinders of the engine 4, it is to be understood that my invention is not to be limited by this disclosure, nor to the use of a twelve cylinder engine. Any type of gasoline or Diesel engine may be used, and actual tests on airplanes of different designs may disclose that all the cylinders are necessary to induce the proper air flow through one or more cooling units, and, on the other hand, it is possible that one or two cylinders may be sufficient. Obviously, the amount of suction produced by a specified engine and engine speed will depend upon the size and length of the air duct, and also

the size of the Venturi section. It is contemplated that these factors will be varied to apply my invention to different types and designs of machines in order to secure the desired results.

Moreover, it is possible to construct a single air duct 25 in which to accommodate both the radiator 13 and the oil cooler 21 as shown in Figure 3 of the drawings, and my disclosure is therefore not limited to the use of two ducts. These ducts may communicate with the atmosphere and exhaust through any portion of the fuselage or nacelles which would be convenient or advantageous in airplanes of different designs. In order to reduce the number of claims necessary to protect the invention, the term "conditioning system" as used in the claims is intended to mean both the cooling system and lubricating system of an engine.

In addition, it is believed obvious from this description that a cooling device of the character described may be readily adapted for use in buses, cars, armored cars, tanks, Diesel locomotives, or in connection with stationary engines. It is especially effective for use in vehicles which present a difficult cooling problem, such as rear end drive buses, armored cars, and Diesel locomotives, and stationary engines, or where air drag must be reduced to the minimum as in the case of airplanes. In adapting the invention, the air duct is mounted in any suitable manner at a point adjacent the engine to be cooled.

I therefore wish it understood that, although I have described only one form of my invention for purposes of illustration, I do not intend that the invention be limited to any particular type of airplane construction or to any particular type of vehicle. On the contrary, I desire the invention to be only limited by the prior art and the scope of the appended claims.

I claim:

1. A conditioning system for a vehicle having opposed walls and provided with an engine having an exhaust port and an oiling system, comprising an opening in each of said opposed walls, said openings being positioned perpendicular to the said air flow, a duct mounted within the vehicle, the extremities of said duct operatively communicating with said openings, one of said openings serving as an outlet and the other as an inlet to the duct, a Venturi section in the duct adjacent the outlet opening, a heat exchange device mounted in the duct at a point intermediate the inlet opening and the Venturi section, and an exhaust pipe extending through the wall of the duct and terminating in the Venturi section, said exhaust pipe and heat exchange device being operatively connected to the exhaust side of the engine and the oiling system, respectively.

2. A conditioning system for a vehicle having opposed walls and provided with an engine having exhaust ports, a liquid cooling system and an oiling system, comprising a pair of openings in each of the said opposed walls, said openings being positioned perpendicular to the said air flow, a pair of ducts mounted within the vehicle, said ducts extending transversely across the vehicle and operatively communicating with the openings in the opposed walls, a Venturi section in each of the ducts adjacent the outlet openings, a heat exchange device mounted in each of the ducts at points intermediate of the inlet opening and the Venturi section, and an exhaust pipe extending through the wall of each of the ducts and terminating in the Venturi section, said exhaust pipes and heat exchange device being operatively connected to the exhaust side of the motor and the cooling and oiling systems, respectively.

3. A conditioning system for a vehicle having opposed walls and provided with an engine having exhaust ports, a liquid cooling system and an oiling system, comprising a pair of openings in each of the said opposed walls, said openings being positioned perpendicular to the said air flow, a pair of ducts mounted within the vehicle, said ducts extending transversely across the vehicle and operatively communicating with the openings in the opposed walls, a Venturi section in each of the ducts adjacent the outlet openings, a heat exchange device mounted in each of the ducts at points intermediate of the inlet opening and the Venturi section, and an exhaust pipe extending through the wall of each of the ducts, each of said exhaust pipes terminating in the narrowest part of said Venturi section and each of said exhaust pipes being parallel to the longitudinal axis of the Venturi section in which it is positioned, said exhaust pipe and heat exchange device being operatively connected to the exhaust side of the engine and the cooling and oiling systems, respectively.

4. A conditioning system for a vehicle having opposed walls and provided with an engine having an exhaust pipe and liquid cooling and oiling systems comprising an opening in each of the said opposed walls, said openings being positioned perpendicular to the said air flow, a duct mounted within the vehicle, the extremities of said duct operatively communicating with the said openings, one of the said openings serving as an outlet and the other as an inlet for the duct, a Venturi section in the duct adjacent the said outlet opening, a pair of heat exchange devices mounted in the duct at a point intermediate the inlet opening and the Venturi section, and an exhaust pipe extending through the wall of the duct and terminating in the Venturi section, said exhaust pipe being connected to the exhaust side of the engine, and one of the heat exchange devices being connected to the liquid cooling system and the remaining heat exchange device being connected to the oiling system.

ROBERT J. WOODS.