Aug. 8, 1944. C. D. OTTO ET AL 2,355,103

APPARATUS FOR REDUCING FIRE HAZARDS OF ENGINE COMPARTMENTS

Filed Nov. 27, 1943 2 Sheets-Sheet 1

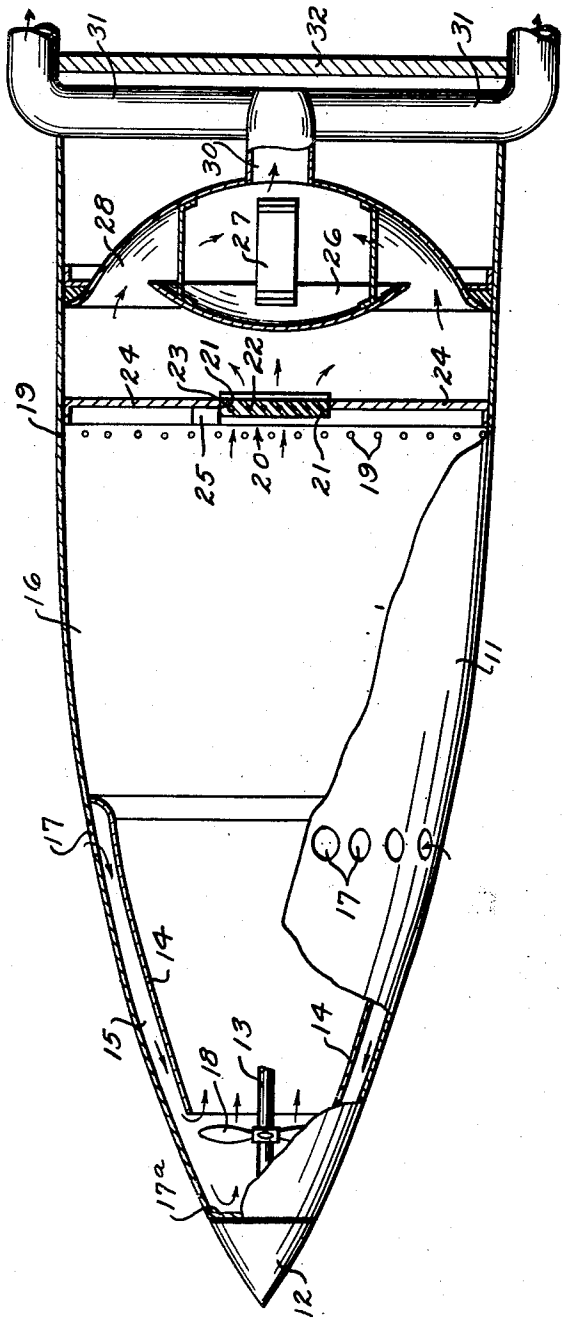



FIG. 1.

INVENTORS
CHARLES D. OTTO
JAMES A. MCDONNELL
BY Joseph B. Hazell and Clyde Roop
ATTORNEYS

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Filed Nov. 27, 1943 2 Sheets-Sheet 2

FIG. 2.

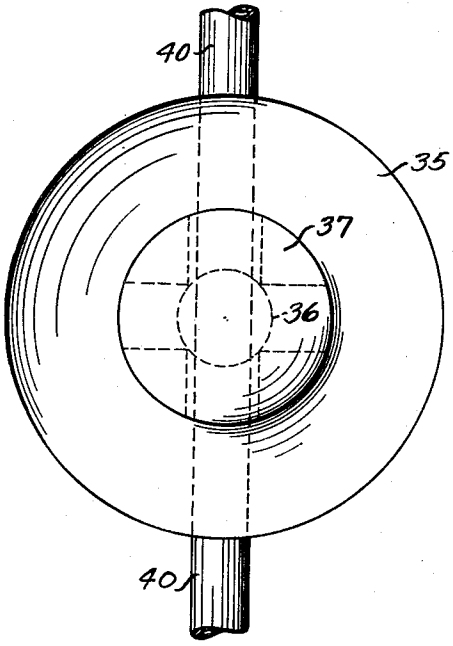



FIG. 3.

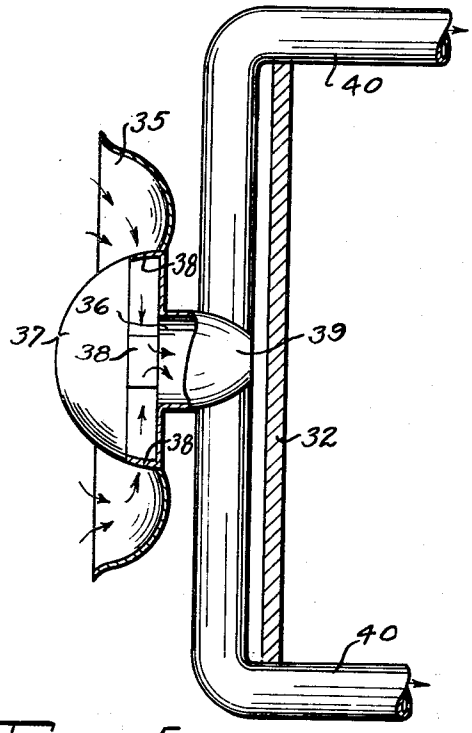



FIG. 4.

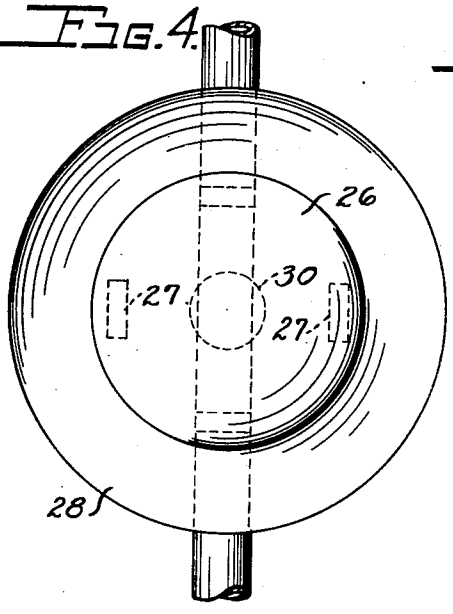
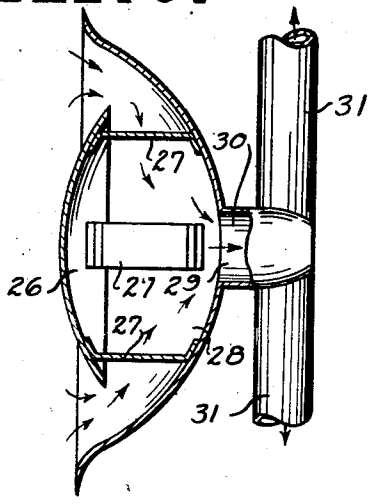



FIG. 5.




INVENTORS
CHARLES D. OTTO
JAMES A. McDONNELL
By Joseph W. Hazell and Blake Crouch
ATTORNEYS

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# UNITED STATES PATENT OFFICE

2,355,103

## APPARATUS FOR REDUCING FIRE HAZARD OF ENGINE COMPARTMENTS

Charles D. Otto and James A. McDonnell,
New York, N. Y.

Application November 27, 1943, Serial No. 511,926

5 Claims. (Cl. 180—54)

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

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

This invention relates to the ventilation and pressurization of engine compartments, and its principal object is to provide a combination firewall and flame venting construction which may be employed on airplanes, motor vehicles, motorboats, etc., to protect lives by minimizing the possibility of a fire spreading from an engine to other parts of the vehicle. Another object is to provide a pressurized engine compartment having means responsive to temperature variations for venting or discharging the air and other gases in the compartment. Another object is to provide means in an engine compartment for constantly discharging gasified air, while permitting the maintenance of pressure within the compartment. Further objects and advantages will appear during the following description of two embodiments of the invention and of a practical application thereof to aircraft.

According to the Kane Patent No. 609,278, it is old to ventilate burning buildings by means of flues running to the roof and connected with each room, the flue connections being opened automatically by a rise in the temperature of the room. J. B. Strauss in Patent No. 1,925,415 proposed the cooling of an automobile engine of the radial type by placing the engine outside of the hood and in the mouth of a draft tube extending the entire length of the automobile and open at the rear end, the motion of the automobile being depended upon to cause a sufficient draft through the tube to cool the engine without employing a conventional cooling system. One of the early arrangements for cooling airplane motors is shown in Guyot Patent No. 1,386,493 dated August 2, 1921, wherein a cooling air duct extends longitudinally from a point directly back of the propeller to the rear of the engine, thence outwardly through lateral apertures to the exterior of the fuselage. Numerous modifications show various arrangements with pusher propellers and radiators, and in some instances a small fan is employed to increase the air circulation. In the Morse Patent No. 2,077,708, the air cooling of radial motors is shown, together with a directing of the heated air to a discharge conduit which is so shaped as to gain a jet propulsion effect. In Patent No. 2,112,727, John Lloyd suggests cooling aircraft motors by transmitting the cooling air through a wing which has at least one outlet, which may be controllable in size. J. P. Rogers in Patent No. 2,164,545 shows an airplane engine nacelle with an intake or scoop at the forward end and a pilot-controlled exit-flap at the rear end. And D. B. Cox in Patent No. 2,302,298 shows a cooling system for an in-line airplane engine wherein two scoops, one on either side of the forward end of the engine, lead to an engine compartment in which substantial air pressure is built up because of the smaller size of the outlets for the cooling air. It is stated that the static pressure in the engine compartment provides a fire seal so that "flash-back into the fuselage is precluded."

Our invention differs from these and other prior art disclosures by providing a pressurized engine compartment, a flame-arresting device back of the compartment, and flame venting means leading from the flame-arresting device to any safe point to the rear of the airplane. The engine compartment may, or may not, have power-driven means to build up the pressure, and may, or may not, have automatic shutters which open responsive to temperature to discharge some of the gases. Additionally, means may be provided to vent continuously to the atmosphere gassified air such as might otherwise collect in the engine compartment and create a fire hazard.

In the accompanying drawings:

Figure 1 is a diagrammatic sectional elevation through the nacelle or nose end of an airplane employing the invention;

Figure 2 is an elevation of one form of flame-arresting device and flame vent;

Figure 3 is a sectional elevation of the parts shown in Figure 2;

Figure 4 is an elevation of the flame-arresting device and flame vent shown in Figure 1; and

Figure 5 is a sectional elevation of the form of Figure 4.

Referring particularly to the drawings, a nacelle or nose 11 of an airplane is shown with a propeller spinner 12 and a propeller shaft 13 which is coupled with the crankshaft of the engine (not shown). Supported within the nacelle or nose 11 and spaced from the inner wall thereof is a baffle 14 which will be generally frusto-conical if the nacelle is circular in cross section, since the baffle is provided to form an air duct or passageway 15 partially surrounding but separated from the engine compartment 16. In other words, the shape of the baffle depends upon that of the nacelle, the important

consideration being to guide atmospheric air inducted through ports 17 to an area or zone in front of the engine. As shown, ports 17 are arranged in a circular series, although the arrangement may be varied considerably. A deflector plate 17a forms a seal between the spinner and the intake end of compartment 16, and directs air from the passageway 15 to said intake end, as indicated by the arrows. Instead of a single annular or other passageway 15, we may use a plurality of pipes, each joined at one end to one of the ports, and discharging air at any point forward of the engine compartment. Because of the additional cost and weight, the plural pipe construction is undesirable and hence is not shown, but is mentioned to illustrate the point made above, namely, that the air intake or passageway may assume various forms.

While it is intended that the intake ports 17 shall be located at such points that positive pressure will force a large amount of air into the engine compartment, in the event experiment shows that the ports are subject to negative pressure on the particular nacelle on which the invention is to be used, we intend to employ air scoops (not shown, but well known in the art), which will force air through the several ports into the air duct 15. In lieu of air scoops we may employ a small blower 18 driven by the propeller shaft and so located as to suck air through intake ports 17 and blow it into the engine compartment, whenever the propeller shaft is rotated. If preferable, we may drive the blower by means of a power take-off from the engine (not shown), and in either case the capacity of the blower will be such as to build up positive pressure within the engine compartment, which is one of the aims of this invention.

The air drawn into the engine compartment by the induced draft flows all around the engine and uniformly cools it, also takes up any vapors such as fuel vapors. As vaporized fuel may form a highly explosive mixture with air, it is preferred that the gasified air be permitted to escape continuously during operation of the airplane. To this end we have shown a series of small weep holes 19, which are so located in the walls of the engine compartment that there will be a constant outflow to the atmosphere of any gasified air through them, under the pressure built up as described. If necessary small tubular vents (not shown) may increase the flow through these weep holes, in case there is a positive pressure (during flight) at the points where the weep holes discharge. The total area of the weep holes, or their discharge capacity, will be but a small fraction of the area or capacity of the automatically controlled shutter 20 which vents the engine compartment responsive to temperature. This shutter comprises a plurality of vanes 21 pivoted as at 22 so as to open or close an aperture 23 preferably in the center of a partition 24 secured at the rear of the engine compartment and closing the latter. Partition 24 may be of metal and may serve as a partial barrier to flames. Vanes 21 open and close responsive to a thermostat 25 and levers (not shown), as is known in the automobile radiator art. Until the temperature in the engine compartment reaches a certain figure, the vanes will stay closed, but above that point they will open and as the temperature increases, the opening will be widened. Thus the automatic shutter tends to hold the engine compartment within a certain range of temperatures, and also prevents free circulation of air through the engine compartment, while permitting sufficient air to escape to hold the temperature and pressure within a certain range. This result in itself is desirable and worth while, though incidental to the principal features of the invention.

Directly back of the partition 24 but spaced therefrom is a flame-arresting or venting device comprising a shield or baffle 26 supported by tie plates 27 upon a dished metal partition 28 whose edges are secured to the nacelle on the inside. Centrally of the dished partition is an aperture 29 to which a short pipe 30 is connected. Pipe 30 leads to two or more symmetrically disposed pipes 31 which extend to a rear point of the airplane. It will be observed that aperture 29 is directly back of the center of the shield or baffle 26, which in turn is directly back of the shutter formed by vanes 21. Thus any flames which are passed by the open shutter will strike the shield or baffle 26 and will curl around the shield and pass behind it into pipe 30 and through pipes 31 to points to the rear of the airplane. Pipes 31 are indicated as being outside the airplane, and this is preferred; however, with some all metal airplanes where high performance is critical, the pipes may extend on the inside (with the proper insulating wrappings or coatings) to points in the rear where the gases and flame may be discharged safely. When disposed on the outside, pipes 31 may be of a flattened tubular form to reduce drag, as will be understood without illustration. A conventional firewall 32, such as is provided on all tractor type airplanes, is shown directly back of the point where pipes 31 branch off from pipe 30; however, with the extraordinary fire protection provided by walls 28 and 24, firewall 32 will usually be dispensed with as unnecessary.

The dished partition 28 and shield 26 are shown apart from an airplane in Figures 4 and 5. The device of Figures 4 and 5 may be considered per se as a flame arrester and venting device which, if properly shaped and supported, may be placed at various locations on the airplane, automotive vehicle, motorboat or other vehicle. All installations of internal combustion engines employing gasoline or the like as a fuel are subject to fire hazards and many lives have been lost because of this fact. Our invention is primarily useful because it will minimize if not entirely eliminate such hazards by first confining the flames to the engine compartment, and second, venting them to a point or points to the rear of the vehicle, without the possibility of setting fire to the vehicle. A pressurized engine compartment obviously will facilitate venting of the flames; however, the expansion of air when heated by flames will also create a blast which will carry off the flames and gases.

Another form of the flame arrester is shown in Figures 2 and 3, wherein a dished plate 35 has a central aperture 36, with a rounded shield or baffle 37 supported by means of legs 38 directly in front of but spaced from the central aperture. A pipe coupling 39 joins a pair of branching pipes 40 with the central aperture, pipes 40 extending to rear points of the airplane or other vehicle. The operation of this form of the invention is precisely the same as that of the embodiment shown in Figures 4 and 5, and it may be used in various places on vehicles of many different types.

One of the advantages of the construction and arrangement of Figure 1 is the fact that an air pressure may be built up which will give the effect of a one-stage supercharger, thus boosting the performance of the airplane at certain alti-

tudes. The described construction may be light in weight, and need not increase the weight of the airplane, since certain conventional parts may be eliminated, notably the intake throat or air scoop for the engine, and the usual firewall. Furthermore, as uniform cooling of the engine is obtained by pressurizing the engine compartment, a slight increase in engine efficiency may result, since overheating always lowers the performance of an engine. Another advantage is the fact that the engine itself, and all parts attached thereto, including the exhaust manifold, etc., are in no way modified or rearranged. A further advantage is that the nacelle or compartment is closed on the outside except for the relatively small intake ports and the still smaller weep holes, hence may be readily made of armor plate or may be armored on the inside wherever desired. Furthermore the invention is adaptable to all types of engines and facilitates starting in cold weather. Streamlining of the nacelle or engine hood is made easier because of the elimination of the usual air scoop, and thus the speed of an airplane employing the invention may be increased. The flame venting device of Figs. 2 and 3 or of Figs. 4 and 5 may be used in present airplanes ahead of the conventional firewall or in lieu thereof without resorting to a pressurized engine compartment. Also the automatic shutter may be replaced by a manually controlled shutter, or a manual control system may be employed to permit the pilot to regulate the draft through the shutter in the event the thermostatic control 25 fails to operate. Other advantages and modifications will be apparent to those skilled in the various arts to which the improvements may be applicable.

Obviously, the invention may be embodied in various forms neither described nor shown.

What we claim is:

1. In combination with a vehicle having a body and an engine for propelling the body, a plurality of air intake ports; means to guide the air passing through the ports to an area in front of the engine; the body having a compartment which surrounds the engine and is completely closed except for the air intake area at one end of the compartment and an air exit at the other end; a fire-arresting device at the air exit end of the compartment; and venting means joined to the fire-arresting device and discharging air, gases and flames directed against the fire-arresting device at a safe point to the rear of the vehicle.

2. The invention according to claim 1, wherein the engine compartment has an additional partition directly in front of the fire-arresting device, said partition having an opening which is opened or closed by a thermostatically controlled shutter.

3. The invention according to claim 1, wherein the engine compartment is partly closed by a partition having a central opening, and the fire-arresting device has a central opening with a flame shield supported in front of the central opening, to deflect flames passing through the fire-arresting device to the venting means.

4. The invention according to claim 1, wherein the engine compartment has a plurality of small weep holes so located as to discharge continuously any gasified air which may be in the compartment; the total area of the weep holes being considerably less than the area of the intake apertures so that air pressure is constantly maintained in the compartment.

5. A fire-arresting device for airplanes and other vehicles comprising a partition having a central opening, a shield or baffle directly in front of said opening but spaced therefrom, and a conduit or pipe connected to the partition at the rear of said opening, said conduit or pipe being adapted to discharge flames, etc. at a safe point to the rear of the vehicle.

CHARLES D. OTTO.
JAMES A. McDONNELL.