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HEATING SYSTEM

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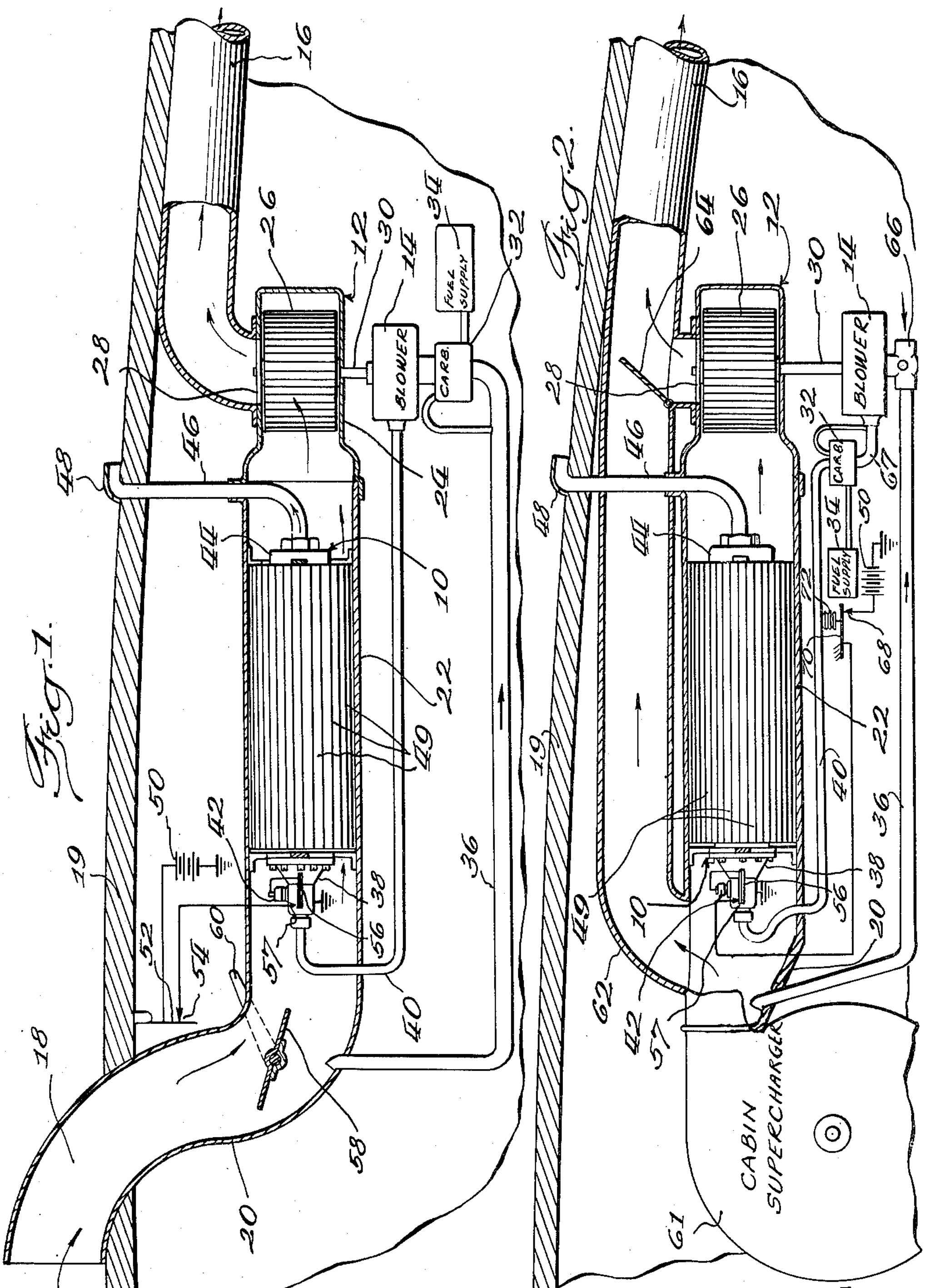

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2,364,458

HEATING SYSTEM

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21 Claims. (Cl. 237—12.3)

My invention relates generally to heating systems, and more particularly to an internal combustion heating system for use in heating airplanes and the like.

It is an object of my invention to provide an internal combustion heating system which has a large heating output, which is self-contained and light in weight, and which occupies a minimum of space.

It is another object of my invention to provide an internal combustion heating system which is operated by power derived from the flow of a current of air through the heating unit.

It is another object to provide an internal combustion heating system which will discontinue the supply of fuel to the heating system should the current of air flowing past the heating unit be interrupted, so that there is no danger of overheating a part of the system.

It is a further object to provide a heating system for airplanes which will be conditioned for operation incidental to opening a valve to permit air to flow through the heating system to the airplane cabin.

It is a further object to provide an internal combustion heating system which is simple and rugged in construction and reliable in operation.

It is a further object to provide an internal combustion heating system which will not become overheated at low rates of flow of air to be heated.

It is a further object to provide an internal combustion heating system, for use in heating airplanes and the like, which presents no appreciable fire hazard.

Other objects will appear from the following description, reference being had to the accompanying drawing in which:

Fig. 1 is a diagrammatic cross-sectional view of a heating system illustrating one embodiment of my invention; and

Fig. 2 is a diagrammatical cross-sectional view, similar to Fig. 1, showing a second embodiment of my invention.

The embodiment of my improved heating system shown in Fig. 1 is designed and constructed to be used in heating an airplane which does not have a supercharged cabin. The heating system may be installed in the fuselage or in the engine nacelle of the airplane. Air from a suitable source of air under pressure flows past the heating unit 10, through an air turbine 12 which operates a positive displacement blower 14 to supply combustible mixture to the heating unit 10, and through an outlet conduit 16 to the cabin passenger compartment of the airplane. The conduit 16 may be branched so that part of the heated air may be used to heat other compartments of the airplane, such as the gunner's compartment when the heating system is used to heat a bomber.

The source of air under pressure is illustrated as being a ram 18 positioned adjacent the outer surface of the airplane wall 19, opening into the slip stream of the airplane or the slip stream of the airplane propeller, whichever is more effective to produce a positive pressure in the ram 18. An air supply conduit 20 conveys the air under pressure to the inlet of the casing 22 which encloses the heating unit 10, which may be of the construction disclosed and claimed in my co-pending application Serial No. 378,262, filed February 10, 1941. The outlet of the casing 22 is connected to a turbine housing 24 which encloses a suitable air turbine rotor 26. The rotor 26 may be a "Sirocco" type fan rotor having its blades shaped to render it effective as an air turbine. Heated air from the outlet 28 of the turbine casing 24 passes to the airplane cabin through a conduit 16.

The positive displacement blower 14, which may be of the "Roots" or cycloidal type, is mounted upon the same shaft 30 as the air turbine rotor 26. The blower 14 draws combustible mixture from a suitable carburetor 32, illustrated as a balanced carburetor, and forces it to the heating unit 10, where it is ignited and burned.

The carburetor 32 receives liquid fuel from a fuel supply 34 and mixes it with air to form a combustible mixture. While the carburetor 32 may receive air from any suitable source, it is shown as receiving air through a duct 36 having its inlet opening positioned in the air supply conduit 20 of the heating system. This arrangement of the carburetor air supply causes the carburetor to operate at above atmospheric pressure, thereby reducing the load upon the positive displacement blower 14 and increasing the efficiency of the system. Also, the location of the carburetor air inlet in the heating system air supply conduit 20 substantially removes the fire hazard of the system, in that it prevents combustible mixture and/or liquid fuel from escaping from the carburetor air inlet and accumulating in the compartment in which the heating system is located.

The heating unit 10, which is described and claimed in my aforesaid co-pending application Serial No. 378,262, filed February 10, 1941, comprises a suitable combustion chamber housing 38 which is supplied with combustible mixture through a duct 40 connected with the outlet of the blower 14. The combustible mixture within the combustion chamber is ignited by a suitable electrical igniter 42 and burned. The hot gases of combustion therefrom pass into a heat exchanger shell 44, and through the heat exchanger shell to an exhaust pipe 46 which discharges them overboard at a point adjacent the outer surface of the plane. A hood 48 may be placed over the discharge end of the exhaust pipe and positioned so that it faces away from the direction of flight of the airplane so that the motion of the airplane creates a partial vacuum which aids in causing combustible mixture to flow from the carburetor through the heating system. A plurality of radially spaced longitudinal fins 49 are secured to the outside of the shell 44 to conduct heat to the air flowing through the system.

The electric igniter 42 may suitably be of the resistance type and may comprise a coil of nichrome wire heated to incandescence by the passage of current therethrough. It is supplied with electric current from any convenient source, such as a grounded battery 50.

When the igniter 42 is energized, current flows from the hot side of the battery 50, through a control switch 52, 54, which may be opened and closed incidental to stopping and starting the operation of the system, through a thermal switch 56, 57 which is located to be responsive to the temperature of the heating unit 10 and which is open when hot and closed when cold, to the igniter 42 and from there to the ground. The thermal switch may comprise a bimetal 56 which warps away from a stationary contact 57 upon the the occurrence of combustion. In order to avoid arcing between the bimetal 56 and the contact 57, it is preferable that the bimetal 56 have a snap action.

The flow of air past the heating unit 10 may be controlled by a valve or a damper 58 which may be operated manually or operated by a suitable thermostatic control responsive to the temperature of the cabin of the airplane. While the valve 58 is illustrated as being in the heating system air supply conduit 20, it may be located at any other suitable point, such as in the heated air outlet conduit 16.

The control switch 52, 54 may comprise a resilient switch arm 52 and a stationary contact 54. In order to operate the switch 54 so that current may flow to the igniter 42 when and only when the system is operating, a lever arm 60 is mounted upon the same shaft as the valve 58 and is angularly positioned to engage the lower end of the resilient switch arm 52 when the valve 58 is in a position to prevent the flow of air through the heating system, thereby opening the switch 52, 54 and preventing the energization of the igniter 42. When the valve 58 is opened sufficiently to permit air to flow through the heating system and cause it to operate, the arm 60 is withdrawn from the switch arm 52 so that the igniter 42 may be energized.

Assuming that the airplane is in motion, opening of the valve 58 will permit the heating system to operate. Air will then flow from the ram 18, past the heating unit 10, through the air turbine 12, through the conduit 16, to the space to be heated. The moving air rotates the rotor 26 of the air turbine 12 and actuates the positive displacement blower 14, which draws a combustible mixture of fuel and air from the carburetor 32 and forces it through the conduit 40 to the heating unit 10. Opening of the valve 58 closes the control switch 52, 54 and electric current from the grounded battery 50 passes through the switches 52, 54, and 56, 57 to the igniter 42. The combustible mixture is ignited by the igniter 42 and the hot gases of combustion therefrom pass through the heat exchanger shell 44 and through the exhaust pipe 46 to the outside of the airplane. The heat of combustion heats the bimetal 56 and causes it to warp away from the contact 57 and deenergize the igniter. The heat of combustion also heats the longitudinally disposed fins 49 which transfer heat to the air passing to the cabin.

The rate of flow of air through the heating system may be controlled by adjusting the valve 58, resulting in the control of the amount of heated air supplied to the airplane cabin. As the valve 58 is closed to reduce the rate of flow of air through the heating system, the rate of flow of air through the air turbine 12 is also reduced. The turbine rotor 26 then revolves more slowly and the amount of combustible mixture supplied by the blower 14 to the heating unit 10 is reduced. The operation of the heating system is thus very stable and the heating unit 10 cannot become overheated when the system is operated at a fraction of its capacity. When it is desired to discontinue the operation of the heating system the valve 58 may be closed, stopping the flow of air through the heating system and thereby discontinuing the supply of combustible mixture to the heating system 10. Closing of the valve 58 also causes the lever 60 to engage the lower end of the resilient switch arm 52 and open the ignition circuit 52, 54 to prevent current from flowing through the igniter.

Fig. 2 shows an embodiment of my improved heating system which may be used to heat an airplane having a supercharged cabin and which will not interfere with the normal operation of the cabin supercharger. Parts which are similar to parts shown in Fig. 1 and which have been described in connection therewith are similarly numbered.

The cabin supercharger 61 is used as a source of air under pressure for operating the heating system. The air inlet conduit 20 of the heating system leads from the outlet of the cabin supercharger to the inlet of the casing 22 which encloses the heating unit 10.

A by-pass conduit 62 is provided to conduct air directly from the outlet of the supercharger 61 to the conduit 16, so that air passing to the cabin need not pass through the casing 22 and air turbine 12.

A valve 64 is provided to control the operation of the heating system. This valve 64 may be positioned to close either the air turbine outlet 28 or the by-pass conduit 62, or it may be placed in an intermediate position. When the outlet 28 of the air turbine is closed, the heating system is inoperative and all of the air passing from the supercharger 61 to the airplane cabin passes through the by-pass 62. When the by-pass 62 is closed, all of the air passing to the airplane cabin is used to operate the heating system and is heated thereby, so that the heating system operates at its maximum heat output. When the valve 64 is in an intermediate position, part of the air from the cabin supercharger 61 passes through the by-pass and is not heated, and the rest of the air operates the heating system at a fraction of its capacity and becomes heated.

The valve 64 may be controlled manually or may be controlled by a suitable thermostatic control responsive to the cabin temperature. The valve and conduit arrangement shown may be replaced by any other suitable arrangement for controlling the relative amounts of heated and unheated air passing from the cabin supercharger 61 to the cabin.

The flow of air through the air turbine 12 rotates the rotor 26 which drives the positive displacement blower 14. The operation of the blower 14 causes combustible mixture from a balanced carburetor 32 to flow to the heating system. The carburetor 32 may have its outlet connected with the inlet of the blower 14, as shown in Fig. 1, or it may have its air inlet connected with the outlet of the blower 14 by a duct 67, so that the blower 14 supplies air under pressure to the inlet of the carburetor, as shown in Fig. 2. The balanced carburetor 32 receives liquid fuel from a suitable fuel supply 34. This fuel supply 34 must deliver fuel to the carburetor 32 at a positive pressure in excess of the highest pressure which will be created in the duct 67 by the blower 14 during the operation of the heating system.

Air may be supplied to the inlet of the blower 14 from a three-way valve 66. The three-way valve 66 may be positioned either to supply air directly from the atmosphere to the inlet of the blower 14, or to supply air under pressure from the outlet of the supercharger 61, through the duct 36, to the inlet of the blower 14.

An electrical igniter 42, which may be of the type described in connection with Fig. 1, is provided with an electrical circuit which receives electric current from a suitable source, illustrated as a grounded battery 50. In series with the igniter 42 and the battery 50 is a pressure responsive switch assembly 68, 70, 72, which is responsive to the pressure created by the operation of the blower 14 and which is closed when and only when the pressure created by the blower 14 is sufficiently high to cause enough combustible mixture to flow to the heating unit 10 to support combustion. The switch 68, 70, 72 is illustrated as comprising a stationary contact 68 and a resilient switch arm 70 biased away from the contact 68. The interior of a pressure responsive expanding bellows 72 is in communication with the fluid flowing from the blower 14 to the heating unit 10. The bellows 72 is illustrated as having one end secured to the heating unit combustible mixture supply duct 40 and having its interior in communication with the interior of the duct 40. The unsecured end of the bellows 72 is connected with the resilient switch arm 70 so that, when the operation of the blower 14 creates a sufficient positive pressure to operate the heating system, the bellows 72 elongates and closes the switch 68, 70 to energize the igniter 42.

A thermal switch 56, 57, in series with the igniter 42, is provided as shown and described in coonnection with Fig. 1.

When the valve 64 is in the position shown, and the cabin supercharger 61 is initially operated, a strong current of air will pass from the supercharger 61 and will flow through the casing 22, to the heating unit 10, through the air turbine 12 and through the conduit 16 to the cabin. This current of air will revolve the rotor 26 of the air turbine and thereby operate the blower 14, creating a positive pressure at the outlet of the blower 14 and thereby causing combustible mixture to flow to the heating unit 10.

The rise in pressure at the outlet of the blower will cause the pressure within the bellows 72, in communication therewith, to rise and the bellows 72 will expand and will move the resilient switch arm 70 into engagement with the contact 68 to close the igniter circuit. Current then flows from the grounded battery 50, through the thermal switch 57, 56 and through the igniter 42 to the ground. This flow of current will heat the igniter 42 sufficiently to ignite the combustible mixture within the combustion chamber housing 38 and will thereby establish combustion. The heat of combustion will cause the temperature of the bi-metal 56 to rise, so that the bi-metal 56 snaps away from the contact 58 and thereby opens the ignition circuit and deenergizes the igniter 42. The hot gases of combustion from the combustion chamber housing 38 pass through the heat exchanger shell 44 and through an exhaust pipe 46, which discharges the products of combustion overboard. Heat conducted from the heat exchange shell 44 heats the longitudinal fins 49 which, in turn, heat the air flowing through the casing 22.

When the cabin supercharger 61 is operating, the operation of the heating system may be controlled solely by means of the valve 64. The valve 64 may be positioned so that all the air passing to the airplane cabin passes through the by-pass 62 and, therefore, the heating system is not operated, or that none of the air passing to the cabin passes through the by-pass 62 and the heating system is operated at its maximum capacity, or it may be placed in any desired intermediate position so that the heating system operates at the desired fraction of its capacity and the air passing to the cabin is heated to the desired temperature. It is to be noted that the amount of combustible mixture burned in the heating system is controlled by the amount of air flowing past the heating unit 10, so that the system cannot become overheated, and that the energization of the igniter 42 is controlled by the operation of the heating system, so that the igniter 42 is energized only when necessary to ignite the fuel flowing to the heating unit and there is no wastage of electric current.

While I have described my invention in connection with preferred embodiments thereof, it will be apparent to those skilled in the art that my invention may take various other forms without departing from its underlying principles. I therefore wish to include within the scope of the following claims all constructions by which substantially the results of my invention may be obtained by substantially the same or similar means.

I claim:

1. In a heating system for heating airplanes and the like, the combination of an internal combustion heating unit for burning a combustible mixture of fuel and air, an air turbine, conduit means for conducting air past said heating unit and through said turbine to a space to be heated so that the current of air past said heating unit operates said turbine, a carbureting device for mixing fuel and air to form a combustible mixture, and means including a blower driven by said air turbine for supplying combustible mixture from said carbureting device to said heating unit.

2. In a heating system for heating airplanes and the like, in combination, an internal combustion heating unit comprising a combustion chamber for burning a combustible mixture of fuel and air and a heat exchanger receiving the

gases of combustion therefrom, a casing enclosing said heating unit, conduit means for conducting air from said casing to a space to be heated, a source of air under pressure for forcing air through said casing past said heat exchanger to the space to be heated, an air current operated motor positioned in the path of flow of air from said source through said casing to the space to be heated and adapted to be actuated by the flow of air therethrough, a carburetor for mixing fuel and air to form a combustible mixture, duct means for supplying combustible mixture from said carburetor to said combustion chamber, a blower connected to said air motor for operation thereby to cause combustible mixture to flow through said duct means to said combustion chamber, and means for discharging the products of combustion from said heating unit.

3. In a heating system for heating airplanes and the like, in combination, an internal combustion heating unit comprising a combustion chamber for burning a combustible mixture of fuel and air, and a heat exchanger receiving the gases of combustion therefrom; a casing enclosing said heat exchanger, means for supplying air under pressure to said casing, conduit means for supplying air from said casing to a space to be heated, an air turbine located in the path of flow of air passing through said casing and adapted to be operated by said flow of air, a carbureting device for supplying combustible mixture to said combustion chamber, a blower for causing combustible mixture to flow from said carbureting device to said combustion chamber, a mechanical connection for operating said blower by said air turbine, and an air flow controlling valve located in the path of flow of the air passing through said casing.

4. In an internal combustion heating system for heating airplanes and the like, in combination, an internal combustion heating unit comprising a combustion chamber for burning a combustible mixture of fuel and air, and a heat exchanger receiving the gases of combustion therefrom; an electrical igniter for igniting the combustible mixture in said combustion chamber, a source of electrical energy, a switch in series with the source of electric current and the igniter, means actuated by the current of air flowing past said heating unit for supplying combustible mixture under pressure to said combustion chamber, and an element responsive to the pressure of the combustible mixture passing to said combustion chamber for closing said switch when said pressure is at a value high enough to cause combustible mixture to flow to the heating unit at a sufficient rate to maintain combustion.

5. In a heating system for heating airplanes and the like, in combination, an internal combustion heating unit, a source of air under pressure, conduit means for conducting air from said source past said heating unit to a space to be heated, a valve positioned in said conduit means for controlling the flow of air therethrough, a carbureting device for supplying a combustible mixture of fuel and air to said heating unit, means responsive to the flow of air through said conduit means to supply combustible mixture to said heating unit when and only when air flows through said conduit means, an electrically operated igniter for igniting the combustible mixture in said heating unit, a source of electric current for said igniter, a circuit for supplying current from said source to said igniter, a switch in said circuit, and means for closing said switch incidental to the opening of said valve and opening said switch incidental to the closing of said valve

6. In a heating system for heating an airplane having a cabin supercharger and a supercharged cabin, in combination, an internal combustion heating unit for burning a combustible mixture of fuel and air, a first conduit for supplying air under pressure from the outlet of said cabin supercharger to said heating unit, a second conduit for conducting air from said heating unit to the cabin of the airplane, an air turbine positioned in the path of the flow of air through said heating unit and adapted to be actuated by said flow of air, a carbureting device for mixing fuel and air to form a combustible mixture, a duct for conducting combustible mixture to said heating unit, a blower operated by said air turbine for causing combustible mixture to flow through said duct to said heating unit, means by-passing said heating unit for conducting air directly from the cabin supercharger to the cabin, and means for controlling the relative amounts of air flowing past said heating unit and through said bypass means.

7. In a heating system for heating airplanes and the like, in combination, an internal combustion heating unit for burning a combustible mixture of fuel and air, a casing surrounding said heating unit, a source of air under pressure, a first conduit for conducting air from said source to said casing, a second conduit for conducting air from said casing to a space to be heated an air turbine located in the path of flow of air from said source through said casing to the space to be heated, a positive displacement blower operated by said air turbine and having an inlet and an outlet, a carbureting device for mixing fuel and air to form a combustible mixture, a duct for supplying air from said first conduit to the said carburetor, a conduit for supplying combustible mixture from said carburetor to the inlet of said blower, and a duct for supplying combustible mixture from the outlet of said blower to said heating unit.

8. In an internal combustion heating system for use in heating the cabin of an airplane having a cabin supercharger, in combination, an internal combustion heating unit for burning a combustible mixture of fuel and air, a casing enclosing said heating unit, first conduit means for supplying air from the outlet of the cabin supercharger to the inlet of said casing, second conduit means for conducting air from the outlet of said casing to the cabin of the airplane, an air turbine located in the path of flow of air flowing through said casing and adapted to be rotated thereby, a carbureting device for mixing fuel and air to form a combustible mixture means including a positive displacement blower operated by said air turbine for supplying combustible mixture from said carbureting device to said heating unit, a by-pass conduit for by-passing said heating unit and said air turbine for supplying air directly from the cabin supercharger to the airplane cabin, and valve means to control the relative amounts of air flowing through said by-pass conduit and through said casing.

9. In a system for heating the cabin of an airplane, having a cabin supercharger, and a conduit for conveying air from said supercharger to the cabin, a heater of the internal combustion type having a heat exchanger located in a section of said conduit for heating the air passing

therethrough, means forming a passageway by-passing said conduit section, damper means to determine the relative proportions of the air discharged by said supercharger and flowing through said passageway and conduit section, and means responsive to the air flow through said conduit section for controlling the rate of production of heat by said heater.

10. In a heating system for aircraft having a cabin supercharger, a conduit for conveying air from said supercharger to the cabin, said conduit including a heater section, a heater of the internal combustion type having a heat exchanger located in said conduit section to heat the air flowing therethrough, means forming a passageway by-passing said conduit section, a turbine operated by the air flow through said conduit section, means responsive to the speed of operation of said air turbine to determine the rate of heat production by said heater, and means for controlling the relative rates of air flow through said passageway and through said conduit section.

11. The combination set forth in claim 10, in which said means for determining the rate of production of heat by said heater includes a fuel supply apparatus for said heater driven by said turbine.

12. In a heating system for aircraft, the combination of a conduit, an air ram for supplying air under pressure to said conduit, manually adjustable damper means controlling the rate of air flow through said conduit, an enclosed heater unit located in said conduit, an air turbine located in the path of flow of air flowing through said conduit and adapted to be rotated thereby, and means operated by said turbine to supply fuel to said heater.

13. The combination set forth in claim 12 in which said fuel supply means includes a positive displacement pump driven by said turbine and supplying a combustible mixture of fuel and air to said heater unit.

14. In an aircraft heating system, the combination of an internal combustion type heater having heat producing means and a heat exchanger, means for conveying air to be heated past said heat exchanger, pressure differential producing means for causing a flow of air through said conveying means, motor means operated by the air flowing through said conveying means, and means driven by said motor for supplying a combustible mixture to said heater.

15. In an aircraft heating system, the combination of a ram receiving atmospheric air under the dynamic pressure due to the motion of the aircraft through the atmosphere, a duct receiving air from said ram and for conveying air to a space in the aircraft to be supplied with heated air, a heater of the internal combustion type having a combustion chamber and having a heat exchanger located in said duct, and means responsive to the rate of flow of air through said duct for supplying a combustible mixture to the combustion chamber of said heater at a rate which varies with said rate of air flow.

16. In an aircraft heating system, the combination of a ram receiving atmospheric air under the dynamic pressure due to the motion of the aircraft through the atmosphere, a duct receiving air from said ram and for conveying air to a space in the aircraft to be supplied with heated air, a heater of the internal combustion type having a combustion chamber and having a heat exchanger located in said duct, and means for supplying fuel to the combustion chamber at a rate varying with the rate of flow of air through said duct.

17. In an aircraft heating system, the combination of an internal combustion type heater having a heat exchanger, means for conveying air to be heated past said heat exchanger, motor means operated by air flowing past said heat exchanger, means driven by said motor means for supplying a combustible mixture to said heater, and means to regulate the flow of combustible mixture to said heater by controlling the rate of flow of air past said heat exchanger.

18. In an aircraft heating system, the combination of an internal combustion type heater having a heat exchanger, means for conveying air to be heated past said heat exchanger, motor means operated by air flowing past said heat exchanger, means driven by said motor means for supplying a combustible mixture to said heater, an electric igniter, an energizing circuit therefor, and common means for controlling said energizing circuit and the flow of air past said heat exchanger.

19. In an aircraft heating system, the combination of an internal combustion type heater having a heat exchanger, means for conveying air to be heated past said heat exchanger, motor means operated by air flowing past said heat exchanger, means driven by said motor means for supplying a combustible mixture to said heater, means providing a passageway for by-passing air around said heat exchanger, and means for regulating the relative rates of air flow through said by-pass passageway and past said heat exchanger.

20. In an aircraft heating system, the combination of an internal combustion type heater having a heat exchanger, means for conveying air to be heated past said heat exchanger, motor means operated by air flowing past said heat exchanger, means driven by said motor means for supplying a combustible mixture to said heater, and means to prevent effective operation of said heater when said means for supplying the combustible mixture to said heater is delivering such mixture at less than a predetermined pressure.

21. In an aircraft heating system, the combination of an internal combustion type heater having a heat exchanger, means for conveying air to be heated past said heat exchanger, motor means operated by air flowing past said heat exchanger, and means driven by said motor means for supplying a combustible mixture to said heater, said last named means including a carburetor and a positive displacement air pump driven by said motor means for supplying air to said carburetor.

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