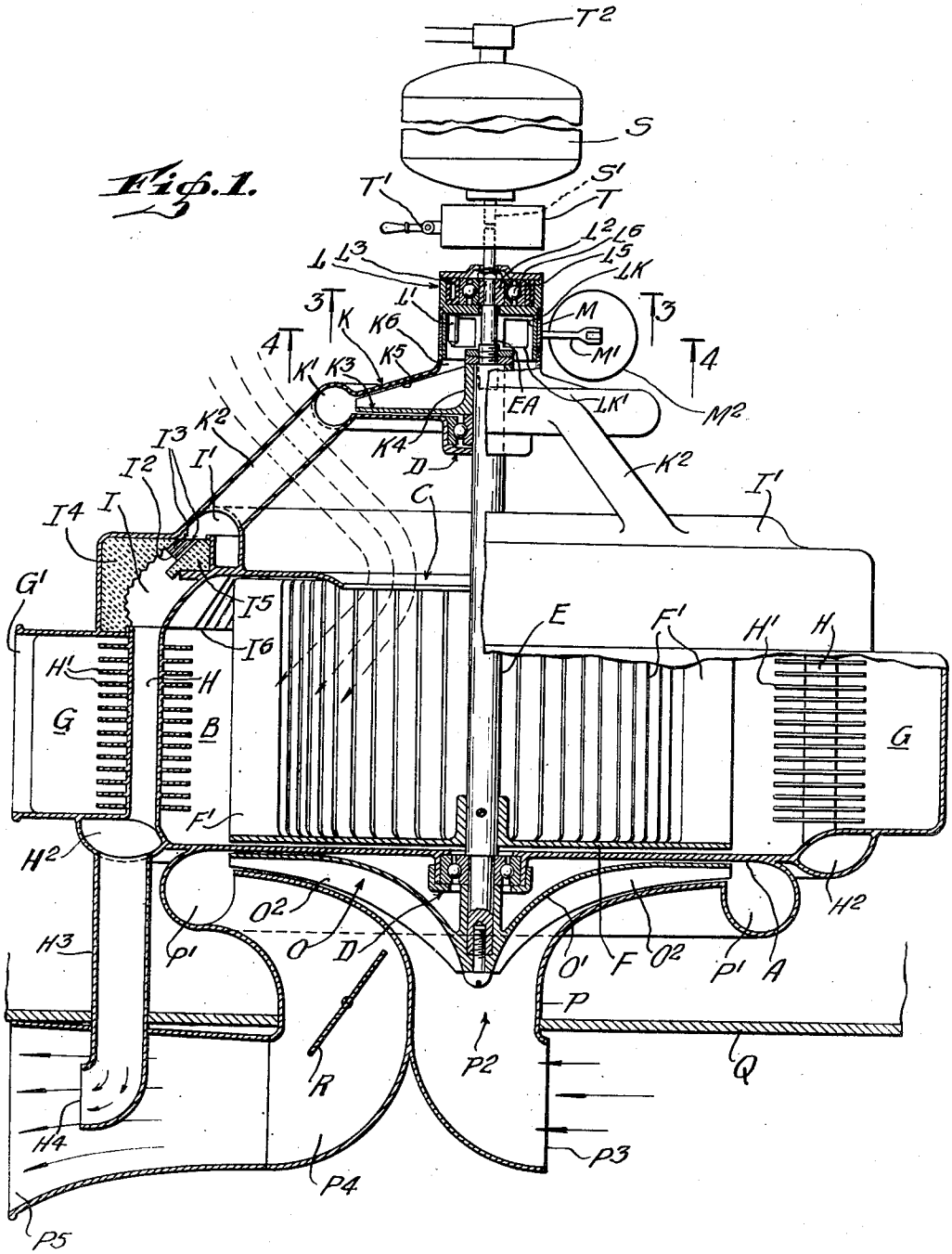
Aug. 28, 1945. F. O. HESS 2,383,650

AIRPLANE HEATER

Filed March 30, 1943 2 Sheets-Sheet 1

Fig. 1.



INVENTOR
FREDERIC O. HESS

BY John E. Ibbotson

ATTORNEY

Aug. 28, 1945. F. O. HESS 2,383,650

AIRPLANE HEATER

Filed March 30, 1943 2 Sheets-Sheet 2

Fig. 2.

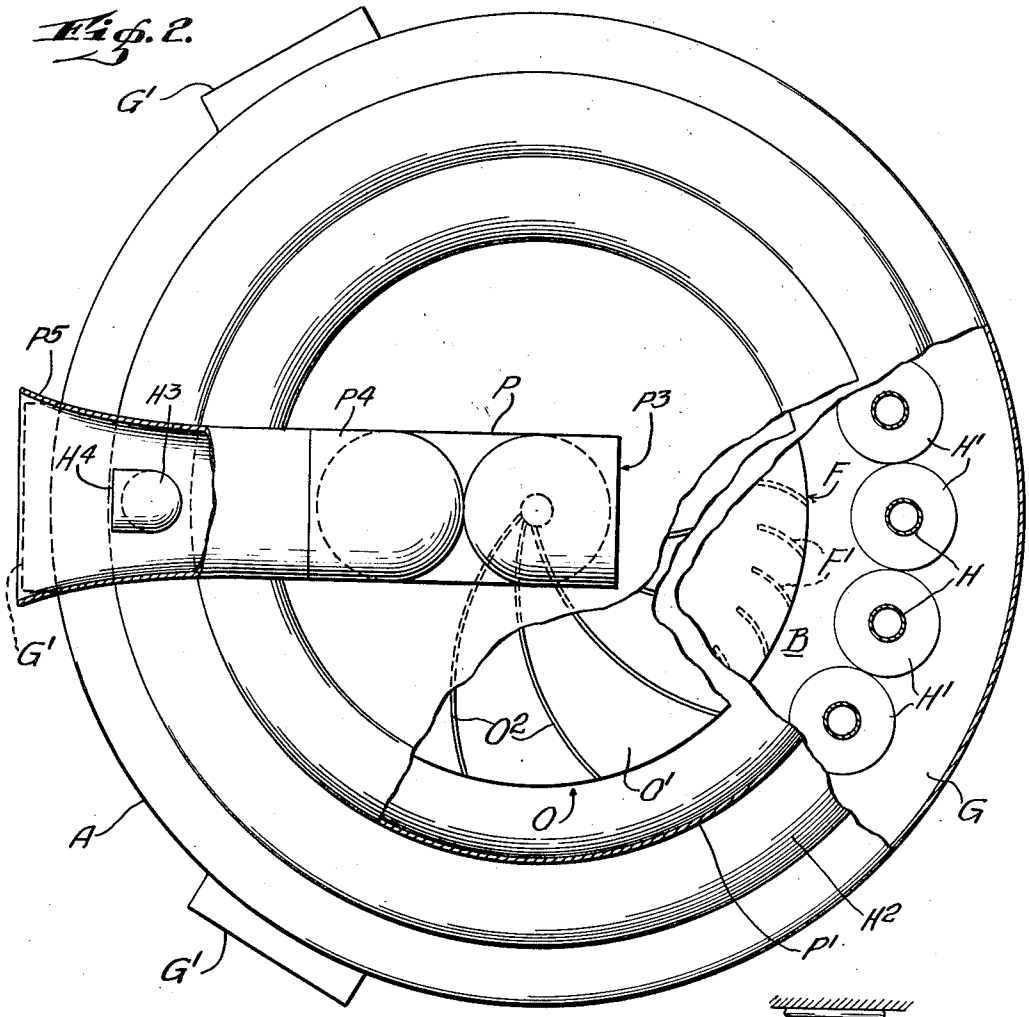


Fig. 3.

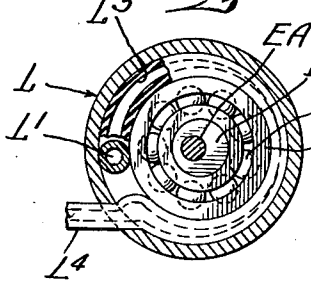


Fig. 4.

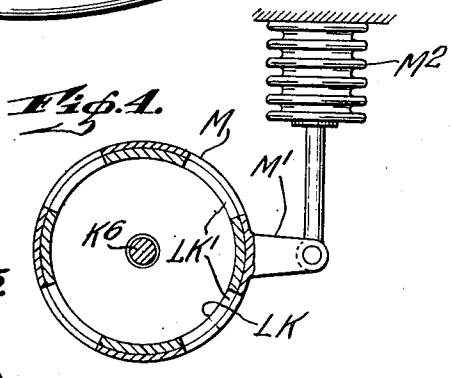
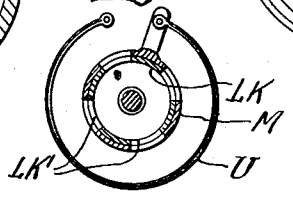


Fig. 5.



INVENTOR
FREDERIC O. HESS
BY John E. Hubbell
ATTORNEY

Patented Aug. 28, 1945 2,383,650

UNITED STATES PATENT OFFICE

2,383,650

AIRPLANE HEATER

Frederic O. Hess, Germantown, Pa., assignor to Selas Corporation of America, Philadelphia, Pa., a corporation of Pennsylvania

Application March 30, 1943, Serial No. 481,077

12 Claims. (Cl. 237—33)

The general object of the present invention is to provide an improved heater for use in airplanes, and is especially useful for heating cabin spaces of transport airplanes, war plane space provided for pilots, observers and gunners, and/or ammunition and in defrosting operations. More particularly, the present invention has for its major object to provide improvements in an airplane heater of a general type like that illustrated in Hess and Townsend Patent No. 2,314,089 granted March 16, 1943.

An airplane heater of the above mentioned type is a compact, light weight structure comprising a combustion chamber into which a combustible mixture of combustion air and atomized gasolene is passed and from which products of combustion are withdrawn in such manner as to maintain a pressure in the combustion chamber which is approximately equal to, but preferably is slightly less than the pressure of the atmosphere in the space in which the heater is located. Fan means for maintaining a suitable volume of flow of combustible mixture through the combustion chamber of the heater and for moving air through the air-heating space of the heater contribute to a relatively great heating capacity of the heater per unit of bulk and weight.

Specific objects of the present invention are to effect a further increase in the heating capacity of an airplane heater of given size and weight, to simplify the regulation and control of the heater, and to provide the heater with improved fan driving means. A still more specific object of the present invention, which contributes to the attainment of the previously mentioned objects, is to provide a heater of the above mentioned type with a fan driving air motor actuated by air flow along a path of flow extending from a scoop or ram inlet opening in the skin or shell of the airplane, and an outlet opening in the said skin or shell, with said inlet and outlet so relatively disposed that the air pressure in said inlet substantially exceeds that in said outlet in the normal operation of the airplane.

The air motor employed in the heater may take various forms. For example, it may be of a known type comprising a peripheral wheel with buckets or vanes against which the motor driving air is discharged in the form of a tangential jet. In the desirable form of the invention illustrated in the accompanying drawings, however, the air motor comprises a wheel formed with curved channels which extend outwardly from a central air-receiving portion of the wheel and discharge the air received at the periphery of the wheel. To permit effective heater operation when the airplane is grounded or the fan-driving motor is otherwise inoperative or ineffective, I may provide an auxiliary electric motor which can be appreciably smaller and lighter than it would need to be if it were the only fan driving motor for the heater.

In the ordinary practical use of such a heater the continuous maintenance of desirable operating conditions presents serious control problems as a result of the wide and rapidly occurring changes in pressure and temperature of the atmosphere enveloping the airplane in which the heater is used. At sea level the normal atmospheric air pressure is approximately 15 pounds and at 40,000 ft. above sea level, it is less than 3 pounds per square inch. When the atmospheric temperature at a sea level point on the earth's surface may be 100° F., for example, the temperature at a point 40,000 ft. above the first mentioned point will normally be of the order of 40 to 60 degrees F. below zero, but at times it may be as much as 140° F. below zero. A decrease in air temperature from plus 40° F. to 40° F. below zero, means an air density decrease of about 25%. Furthermore, variation in the speed of the airplane relative to the air in which it is moving may tend to create a substantial change in the pressure in the combustion space of the airplane heater. Thus, for example, it has been found in the use of a heater of the general type mentioned, that a sharp airplane turn may make a momentary change, equal to a nine inch head of water, in the pressure in the outlet opening at the skin of the airplane through which products of combustion are discharged from the airplane heater.

The various features of novelty which characterize my invention are pointed out in the claims annexed hereto and forming a part of this specification. For a better understanding of the invention however, its advantages and specific objects obtained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated a preferred embodiment of the invention;

Fig. 1 is a sectional elevation;

Fig. 2 is an inverted plan view;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Fig. 4 is a section on the line 4—4 of Fig. 1; and

Fig. 5 is a view taken similarly to Fig. 4 and illustrating a modification.

The embodiment of my invention illustrated somewhat diagrammatically in Figs. 1-4, com-

prises a heater shell or casing A formed of thin metal and enclosing a fan chamber B and having a central inlet opening C in one side wall of said chamber for the inflow of air to be heated from the airplane cabin or other space in which the heater is located. The casing A supports suitable bearings D for a main heater shaft E coaxial with inlet C and extending through chamber B. The shaft E supports an air circulating fan wheel F rotating in the chamber B and shown as comprising a disc at the side of the chamber B remote from the inlet C and peripheral blades or vanes F^1 each connected at one end to said disc and extending across the chamber B. The fan wheel F shown is of a well known type adapted to draw air into chamber B through its inlet C and to discharge the air into an annular air heating space B surrounding the fan wheel F.

In the construction shown the air discharged at its periphery by the fan wheel F, moves outward from the latter into an annular outlet chamber or space G which communicates with the chamber B through the spaces between air heating tubes or elements H parallel to and suitably spaced about the heater axis. Preferably and as shown, each tube H is formed of thin metal and is provided with external thin, circumferentially extending metal fins H' each extending radially away from the outer surface of each tube H for a suitable distance. That distance may be approximately equal to the tube diameter and in such case adjacent tubes H may have their adjacent sides displaced by a distance approximately equal to twice the tube diameter, as shown in Fig. 2. However, the particular spacing of the tubes H, and the form and dimensions of the fins H' are not essential characteristics of the heater. The heater is provided with one or more outlets G' from the space G through which the heated air is passed to the space or spaces to be heated.

The tubes H receive hot gases from the combustion chamber I of an annular burner and discharge into an annular collecting chamber H^2 having a tubular outlet pipe H^3. The burner comprises an inlet chamber I' separated from the combustion chamber I by an annular orifice wall I^2 through which a combustible mixture of air and atomized gasolene passes from the inlet chamber I' into the combustion chamber I, entering the latter in the form of a multiplicity of fine jets. Advantageously, the orifice wall is like that of the burner shown in said Patent No. 2,314,089 in that it is formed of ceramic plates having grooves at their sides which form the orifices I^3 of said wall. The orifice wall shown in Fig. 1 differs in form from the burner orifice wall of said prior patent, however, in that the orifice grooves I^3 are all similarly inclined to the axis of the heater so that the jets discharged into the combustion chamber I diverge from said axis. The outer wall of the annular combustion chamber I is formed of refractory material I^4, and is roughened or corrugated as shown, to retard the flow of the burning combustible adjacent said wall and thus contribute to the maintenance of combustion. A portion of the inner wall of the combustion chamber adjacent to the orifice wall is formed of refractory material I^5. The remaining portion of the inner wall of the combustion chamber is formed of metal and is provided with heat dissipating ribs or fins I^6 which extend into the outer portion of the fan chamber B.

The burner inlet chamber I' receives the combustible mixture through a plurality of tubular conduits K^2 extending from the annular chamber K' of a centrifugal fan K. The latter is coaxial with the shaft E and comprises a wheel or impeller element K^3. The latter includes a hub portion K^4 secured to the shaft E and a radial plate-like body extending away from the hub to the inner edge of the chamber K and provided at its side remote from the chamber B with radially extending blades or vanes K^5. The fan casing of fan K is formed with a central air inlet K^6 at its side remote from the chamber B through which combustion air enters the impeller chamber in which the blades K^5 move. A gasolene supply nozzle L' discharges a jet of gasolene against the inner portion of the impeller or wheel of fan K, which mechanically atomizes the gasolene jetted against it and mixes it with the combustion air which it draws through the inlet LK'. As shown, nozzle L' is parallel to and laterally displaced from the shaft E and forms the outlet from a small high speed gasolene pump L which is coaxial with the heater and comprises an actuating cam eccentric L^2 carried by the shaft E, or, as shown, by an axial extension EA of the tubular shaft E.

As shown most clearly in Fig. 3, the gasolene pump L is of a known type comprising a flattened tube L^3 of elastic material extending circularly about the pump axis and having one end connected to a gasolene supply pipe L^4 and having its other end connected to the discharge nozzle L'. In each rotation the eccentric L^2 moves a slug of gasolene through the tube L^3 and into the discharge nozzle L', as a result of the action of the high point of the eccentric L^2 in compressing and thereby closing the passage through the adjacent portion of the tube. As shown, the tube L^3 is directly engaged at its inner side by a floating thrust ring L^5 which surrounds the eccentric L^2, and a series of ball or roller elements L^6 are interposed between the eccentric and ring. The ring L^5 and balls L^6 reduce the frictional force tendency of the eccentric L^2 to give longitudinal movement to the tube L^3. The tube L^3 may be formed of neoprene or other elastic material adapted to withstand contact with gasolene and the mechanical stresses to which the tube L^3 is subjected.

As best shown in Figs. 1 and 4, the cylindrical casing of the gasolene pump L is mechanically connected to the adjacent side of the casing of the fan K through a cylindrical casing part LK. The latter is cut away to provide an air inlet LK' through which air passes to the fan casing inlet K^6 from the space in which the heater is located. The effective area of the inlet ports LK' may be regulated by the annular adjustment of a slotted cylindrical damper M, surrounding the casing parts LK, and provided with an arm M' through which the damper M may be annularly adjusted about the heater axis to variably throttle the supply of combustion air to the heater. In some cases the damper M may be adjusted manually, but ordinarily it is advantageous to adjust it automatically in response to variations in the pressure of the atmosphere or in automatic response both to variations in atmospheric pressure and in temperature variations. As shown in Figs. 1 and 4, the damper M is automatically adjusted to increase the volume of air flow through the port LK' as the pressure of the atmosphere enveloping the heater diminishes, by a bellows element M^2 which expands and contracts longitudinally as the surrounding atmospheric pressure decreases and increases. The bellows M^2 has one stationary end and its other end movable and connected to the arm M.

The portion of the shaft E projecting through and away from the side wall of the fan chamber B remote from the inlet C, carries the impeller wheel of an air motor O which rotates the fan wheels F and K^3 and the gasolene pump member L^2. As shown, the air motor impeller wheel comprises a thin metal body O' having a conical central portion and a radial outer portion and blades or vanes O^2 carried by said body O' at its front or outer side which extend from the central portion of the wheel to its periphery. The outer end of the vanes O^2 similarly diverge from the radial planes respectively in contact with the inner ends of the vanes, so that air moving outward through the passages between adjacent vanes subject the wheel O to a rotative torque.

A thin metal casing structure P, cooperates with the impeller body O' to form a wheel chamber through which the vanes O^2 sweep when the impeller is in rotation. The casing structure P is shaped to provide a discharge chamber P' surrounding the path of movement of the vanes O' and an inlet passage P^2 discharging an axial stream of air against the central portion of the air motor impeller. The air moving through the passage P^2 is received from a scoop or ram inlet P^3 external to the skin or shell Q of the airplane, and facing in the direction of airplane movement, so that the resistance of the air to the airplane movement increases the air pressure in the inlet P^3. The air motor casing is also shaped to provide a discharge passage P^4 receiving air from the delivery chamber P' and extending through the airplane shell Q and terminating externally of the latter in an open discharge end P^5, facing in a direction opposite to that in which the airplane is moving. The movement of the airplane relative to the enveloping atmosphere thus lowers the air pressure in the outlet P^5 and increases the air pressure in the inlet P^3.

The pipe H^3 discharging products of combustion passing through the tubes H and chamber H^2, has its discharge end H^4 extending into the portion of the passage P^4 external to the airplane shell Q, and so disposed that the air flow through the passage P^4 will produce an aspirating effect on the gases moving through pipe H^3. A butterfly damper R in the passage P^4 forms a means for regulating the volume of flow through the air motor O and thereby regulating the speed of rotation and available torque of the heater driving shaft E. The damper R may be subject to manual control, though in some cases it may be well to adjust the damper automatically so as to vary the speed of the shaft E in accordance with the variations in temperature which determine the desired heat output of the heater.

To permit the operation of the heater when the airplane is grounded or the heater air motor O is otherwise inoperative, I may make use of an electric motor S having its shaft S' adjacent and in line with the shaft EA, and adapted to be releasably connected to the latter by a clutch T. The clutch T includes a lever T' adjustable to operatively connect and disconnect the shafts S' and EA. The clutch T' may be operated manually or automatically as conditions require, and in particular it may well be manually actuated to connect the shafts S' and EA when the air motor is out of operation and be automatically operated to disconnect those shafts when the air motor O comes into operation and increases the speed of the shaft E. For its intended use, the motor S may be appreciably smaller, less powerful and less expensive than it would need to be if it were to be used as the sole driving means for the shaft E.

The form and dimensions of a heater constructed in accordance with the present invention may vary widely as conditions make desirable. By way of example and illustration, it is noted that for certain military, present day uses, a heater of the general form and relative proportions shown in Figs. 1 and 2, may have the diameter of the outer wall of the chamber G about 15 inches and the total weight of such a heater exclusive of the motor S, clutch T air motor passage portions P^2 and P^4 external to the skin of the airplane, may be approximately thirty pounds and in normal operation may liberate approximately 50,000 B. t. u.'s per hour in its combustion chamber.

To rotate the fan wheels F and K^3 and the pump L of such a heater at a suitable speed, which may be of the order of 4,000 revolutions per minute, about one-quarter horse power must be supplied by the air motor O, in low altitude operation. With the airplane moving at a speed of 300 miles per hour in an atmosphere having a pressure which is of the order of 14 pounds per square inch, the pressure in the ram inlet P^3 may exceed the pressure of the atmosphere by an amount corresponding to a water head of about twenty-two inches and the pressure in the outlet P^5 may be less than the atmospheric pressure by an amount corresponding to a water head of the order of twenty-two inches. Under such conditions a suitably designed air motor O of the proportions and dimensions suggested should be capable of developing about two horse power. That is ample for practical purposes, in which allowance must be made for unusually heavy frictional loads at times, and for the energy required for the delivery of an adequate amount of properly heated air under adverse conditions.

The power developed by the air motor will diminish as the airplane altitude increases, and there is a generally similar reduction in the energy required to move the air heated through the heater. In general, however, the frictional load will remain constant. However, the increasing relative importance of the frictional load as the altitude increase may be compensated for more or less, by reducing the throttling effect of the damper R, which normally will be adjusted into its maximum throttling position or low altitude operation. As will be understood, all of the dimensions and operational data mentioned above have been given by way of illustration and example, and not by way of limitation.

In general, as the airplane altitude increases, the damper M should be adjusted to diminish its throttling effect. Such adjustment will be automatically effected by the expansion of the bellows member M^2 of Figs. 1 and 4. When the temperature of the enveloping atmosphere diminishes materially, some throttling of the combustion air, without a corresponding reduction in the rate of gasolene supply, may be advantageous, as the resultant increase in the fuel richness of the combustible air and gas mixture delivered to the combustion chamber, facilitates ignition. Such an adjustment in response to temperature may be automatically effected by means of the character illustrated diagrammatically in Fig. 5, in which a bimetallic, thermostatic element U is employed to give opening and closing adjustment to the damper M as the tem-

perature of the element U increases and decreases.

As will be apparent, ordinarily the amount of combustion supporting air supplied by the fan K should vary in general accordance with the amount of air moved by the fan wheel F and with the amount of air moving through the air motor O, provided the atmospheric pressure in the space in which the heater is located varies with the pressure of the atmosphere enveloping the airplane. When the heater is located in a supercharged cabin however, it may sometime be advantageous to automatically adjust both of the dampers M and R in some cases by means responsive to the cabin temperature and operating in the general manner in which the above mentioned thermostat U operates.

The motor S may be dispensed with in some cases, but is advantageously employed in many cases for reasons already made apparent. When included in the heater it may well be provided in some cases with a coil and current delivery means T^2 for supplying energizing current to a spark igniter (not shown) for initiating combustion in the combustion chamber of the heater. After ignition is well established, the refractory material burner parts attain temperatures ample to maintain ignition.

To illustrate how the form of the heater may advantageously be varied as conditions make desirable, it is noted that when the heater is mounted on the floor or ceiling or alongside a side wall of an airplane cabin space, the heater may well be flattened or "pancaked," by reducing its dimensions in the direction of the length of the shaft E relative to its dimensions transverse to said shaft. Thus when the diameter of the inlet C is increased relative to the diameter of the fan K, the latter may approach the position in which it is in the same general plane as the burner of the heater without objectionably impeding the movement of air into the fan chamber B. As will be apparent, the motor S need not have its shaft in alignment with the shaft E but may be belt connected to the latter and in such case may occupy any convenient position relative to the heater body.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention, as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. The combination with an airplane, of a heater within said airplane and comprising structure providing a combustion chamber and an air heating space in heat exchange relation, fan means for moving combustion air into and products of combustion from the combustion chamber, fan means for moving air to be heated through said air heating space, an air motor for operating both of said fan means, and means for passing air through said motor to operate the latter comprising an inlet for air flow to said motor from the atmosphere through which the airplane is moving and an outlet for air flow from said motor to said atmosphere so relatively formed and disposed that the airplane movement creates a pressure in said inlet exceeding the pressure in said outlet.

2. The combination with an airplane, of a heater therein including structure providing an air heating space and a heating radiator including a combustion chamber, said radiator being in heat exchange relation with said space for transferring heat from heated products of combustion in said radiator to air in said space, fan means to provide a combustible mixture of air and fuel in said chamber and for discharging products of combustion from said radiator to the exterior of the airplane, fan means for moving through said space air to be heated, a translating device for operating both of said fan means, and conduit means through which air may pass from the exterior of the airplane to said device and from which air may be discharged to the exterior of the airplane, said device and conduit means being so constructed and arranged that flow of air therethrough, developed during flight of the airplane, will actuate said device to operate both of said fan means.

3. The combination with an airplane, of a heater therein including structure providing an air heating space and a heating radiator including a combustion chamber, said radiator being in heat exchange relation with said space for transferring heat from heated products of combustion in said radiator to air in said space, means including a fan and a fuel pump to provide a combustible mixture of air and fuel in said chamber and for discharging products of combustion from said radiator to the exterior of the airplane, means including a fan for moving through said space air to be heated, a translating device for operating said pump and both of said fans, and conduit means through which air may pass from the exterior of the airplane to said device and from which air may be discharged to the exterior of the airplane, said device and conduit means being so constructed and arranged that flow of air therethrough, developed during flight of the airplane, will actuate said device to operate said pump and both of said fans.

4. The combination set forth in claim 2, in which said radiator and air heating space are disposed about and envelop said translating device.

5. The combination set forth in claim 2, including an electric motor, and means for connecting and disconnecting said motor to and from said fan means.

6. The combination set forth in claim 3, including an electric motor, and means for connecting and disconnecting said motor to and from said fans and said pump.

7. The combination set forth in claim 2, including passage means through which products of combustion are discharged from said radiator, and in which said passage means is associated with said conduit means through which air is discharged from said translating device to the exterior of the airplane, so that air flowing through said conduit means from said translating device produces a suction effect in said passage means tending to reduce the pressure in said radiator.

8. The combination with an airplane, of a heater therein including structure providing a heating radiator and an air heating space, the radiator being in heat exchange relation with the space for transferring heat from a heating

medium in the radiator to air in the space, means to supply the heating medium for the radiator, fan means for moving air to be heated through the space, a translating device for operating the fan means, and conduit means through which air may pass from the exterior of the airplane to the device and from which air may be discharged to the exterior of the airplane, the device and conduit means being so constructed and arranged that flow of air therethrough, developed during flight of the airplane, will actuate the device to operate the fan means.

9. The combination set forth in claim 8 including an electric motor associated with the fan means and operable to drive the latter when the airplane is grounded.

10. The combination set forth in claim 8, in which the heating radiator and air heating space are disposed about and envelop the translating device.

11. The combination with an airplane, of a heater therein including structure providing a heating radiator and an air heating space, the radiator being in heat exchange relation with the space for transferring heat from heated products of combustion in the radiator to air in the space, means to supply heated products of combustion for the radiator, piping through which the products of combustion may pass from the radiator to the exterior of the airplane, fan means for moving air to be heated through the space, a translating device for operating the fan means, and conduit means through which air may pass from the exterior of the airplane to the device and from which air may be discharged to the exterior of the airplane, the device and conduit means being so constructed and arranged that flow of air therethrough, developed during flight of the airplane, will actuate the device to operate the fan means, and the discharge end of the piping terminating within the conduit means so that air discharged from the device to the exterior of the airplane may be utilized to aspirate products of combustion through the piping from the radiator.

12. The combination set forth in claim 11 including means to adjust the rate at which air flows through the conduit means and hence the aspirating effect produced for exhausting products of combustion through the piping from the radiator.

FREDERIC O. HESS.