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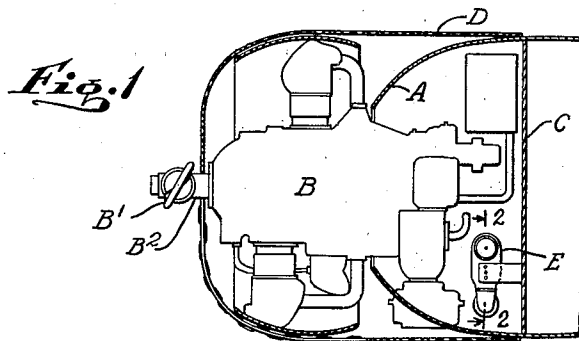
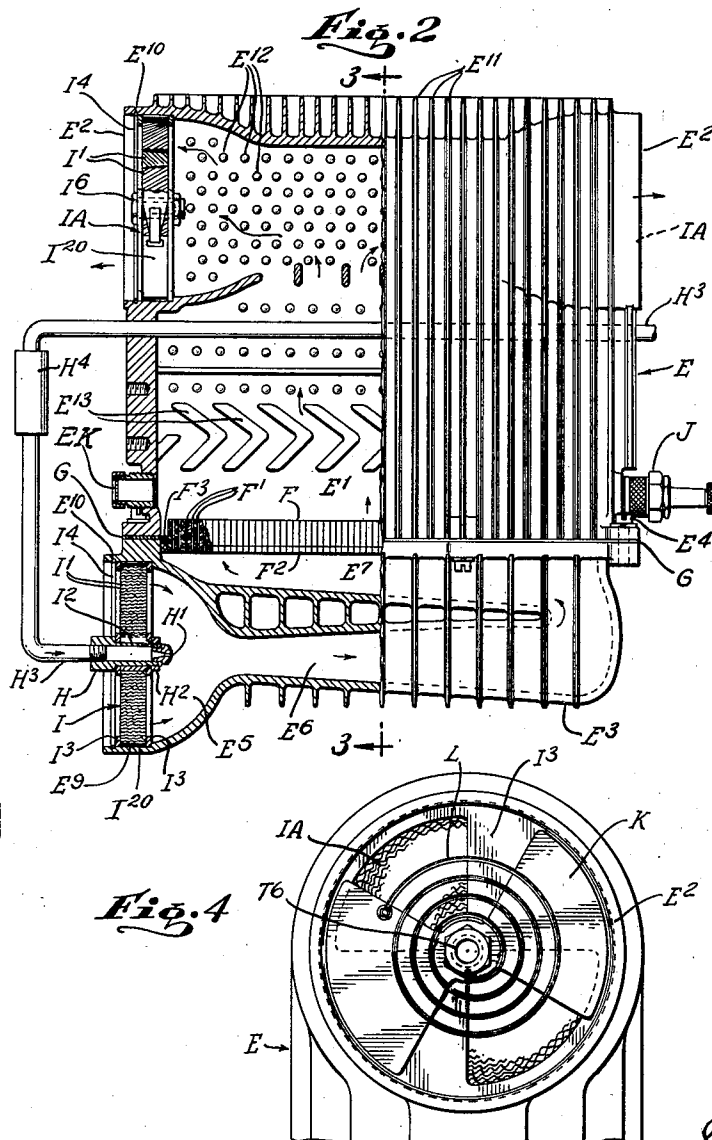
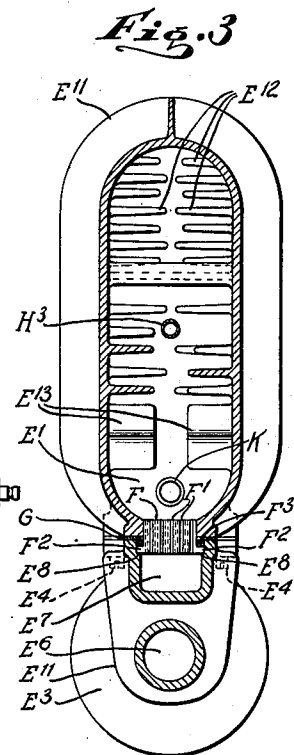
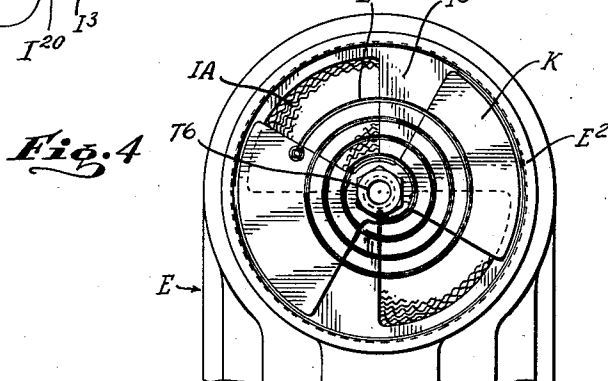
F. O. HESS

2,196,828

INTERNAL COMBUSTION ENGINE HEATER

Filed Jan. 22, 1936

2 Sheets-Sheet 1



INVENTOR
FREDERIC O. HESS
BY
J. E. Hubbell
ATTORNEY

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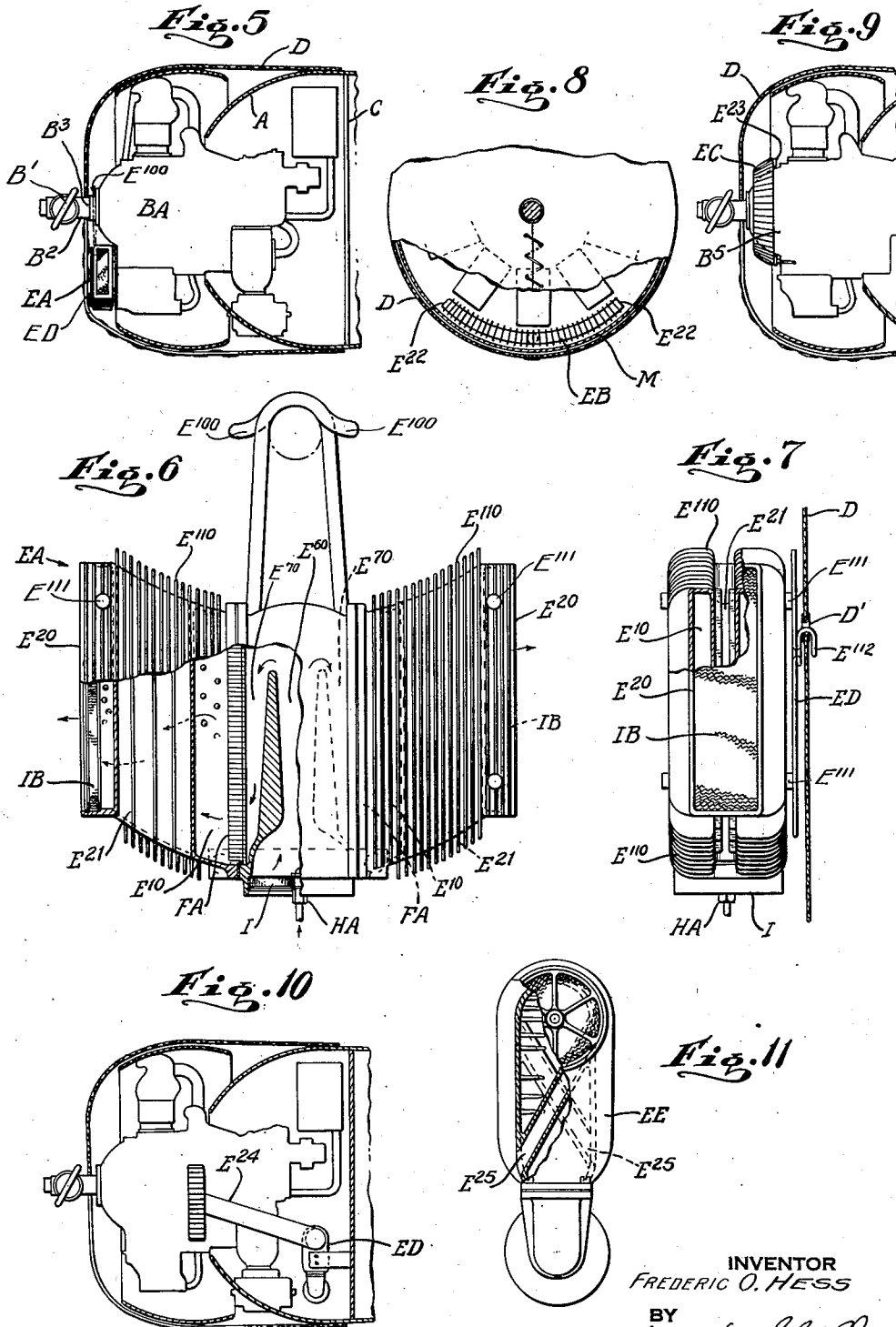
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2 Sheets-Sheet 2



INVENTOR
FREDERIC O. HESS

BY
J. E. Hubbell
ATTORNEY

UNITED STATES PATENT OFFICE

2,196,828

INTERNAL COMBUSTION ENGINE HEATER

Frederic O. Hess, Philadelphia, Pa., assignor to
The Selas Company, Philadelphia, Pa., a corporation of Pennsylvania

Application January 22, 1936, Serial No. 60,174

13 Claims. (Cl. 244—1)

The primary object of the present invention is to provide a simple and effective method of and apparatus for heating up an internal combustion engine, and particularly an aeroplane engine, preparatory to starting the engine into operation. When an aeroplane engine is driven by an internal combustion engine, the only type of engine now used for the purpose, it is practically impossible to start the aeroplane engine into operation without a preliminary heating up operation, when the aeroplane engine is as cold as it becomes when idle and exposed to low atmospheric temperatures. Effective aeroplane engine heating up provisions are obviously desirable for use with aeroplanes used for pleasure and commercial purposes, under conditions and in a locality in which the aeroplane engine becomes cold enough to make a preliminary heating up operation necessary and in which there is no available hangar in which the aeroplane can be warmed, but the present invention is of peculiar utility in connection with aeroplanes used for military purposes, and particularly with aeroplanes transported by and started from the deck of a war vessel. The invention is useful also in heating an internal combustion engine, and particularly an airplane engine, subjected to highly humid atmospheres of moderate temperatures, and particularly the high humidities experienced in tropical regions, to eliminate the objectionable effect of condensation on the carbureters and ignition system of the engine.

For the purposes of the present invention, I have devised an aeroplane engine heater which may take various forms and in all of its forms is characterized by principles of construction and operation peculiarly adapting it for use under such conditions as those existing in the case of a naval aeroplane carrier vessel. In particular, my improved heater is adapted for use within an enclosed engine heating space, such as may be formed in part by a cloth bag or cover which is placed about the aeroplane engine for use in the heating up operation. My improved heater may be permanently installed in the aeroplane in some cases, and in other cases may advantageously be detachably associated with the aeroplane, and in either event, it is practically essential that the heater should be relatively light in weight and small in bulk, and my improved heater may be made so light in weight that it can be attached to and supported by the associated cloth bag or cover part, so that the cover and heater form part of a single mechanical unit for transportation, storage and use, and in respect to

the putting of the unit into place on and its removal from the aeroplane with which it is used. My improved heater is especially adapted for its intended use in that the fuel burned in it may be propane or analogous material which can be conveniently packaged and transported in suitable quantities for engine heating purposes.

My improved heater discharges products of combustion into, and draws air for combustion from the engine heating space, the air being drawn into the heater by the aspirating effect of the heater fuel supply, and is characterized by provisions whereby fire risk in the engine heating operation is practically eliminated, notwithstanding the high temperatures necessarily attained within a compact lightweight heater of the required heating capacity and the entrance into the engine heating space, of combustible vapors and gases given off by the carburetor and fuel supply connections of the engine as the latter is heated up. In the operation of the improved heater, the combustion flame temperature may exceed 2500° F. The temperature of the ignition of combustible gases and vapors in the enclosed heating space is in the neighborhood of 700 or 800° F. The importance of this matter of fire risk will be realized when account is taken of the fact that a very considerable percentage of all aeroplanes in use in Arctic and sub-Arctic regions, which have been destroyed in recent years, have been destroyed as a result of fires started in the course of heating up the engines with the heating up methods and apparatus heretofore employed.

I substantially eliminate fire risk in accordance with the present invention by providing the heater body with internal heat absorbing projections and passage walls and with external heat dissipating fins or projections, so as to give the heater a relatively great heat absorbing and dissipating capacity, notwithstanding the small bulk and weight of the heater, and by providing each heater air inlet and combustion chamber outlet with a fire screen or check effective to prevent the outburst of flame either from the combustion chamber, or as a result of back-firing.

The discharge of products of combustion into, and intake of combustion air from the engine heating space, and the resultant circulation of the atmosphere in said space, contributes to an effective transfer of heat from the heater to the engine parts to be heated. The intake of combustion air to the heater from said space is of especial importance, moreover, in that it results

in the continuous combustion within the heater of combustible vapor and gas constituents in the enclosed space atmosphere, and thereby tends to prevent the accumulation of such vapors and gases in said space to an extent sufficient for the formation of an explosive mixture therein.

My improved heater is further characterized by its capacity for giving an audible indication of its operation. In general it is of much practical importance to have a reliable means for determining at any time whether or not the heater is in operation. There is always a possibility, of course, that, under the stress of emergency condition when haste in starting the airplane engine into operation is imperative, combustion in the heater combustion chamber may cease before the engine heating up operation is completed, as a result of a stoppage in the fuel line, or the exhaustion of the heater fuel supply or from some other cause. There is always a possibility also that through some failure in the heater ignition system, which ordinarily includes a spark plug, combustion may not start when intended to. I have found, however, that an effective and reliable indication of whether or not the heater is in operation, is given by a whistling heater noise obtainable when the draft flow through the heater is suitably throttled. For the maintenance of this whistling noise as the temperatures build up during the heating up operation and the volume of gas flow through the heater increases while the rate of fuel supply remains constant, the throttling of the draft must be diminished. Such reduced throttling of the draft flow is also essential to a desirable combustion efficiency, so that with a properly designed heater, the maintenance of the proper whistling noise not only indicates the continued operation of the heater, but also that it is operating with a desirable efficiency.

To diminish the draft flow throttling effect automatically as temperatures build up, I preferably employ a thermostatically controlled shutter or damper in connection with a heater air inlet or a discharge outlet. Even though there be a plurality of inlets or a plurality of outlets, it is ordinarily sufficient to provide one inlet or one outlet with a thermostatically controlled damper. The thermostatic damper operating means may be made to respond directly to the temperature of the heater metal or to the temperature in the enclosed heating up space, since either of those temperatures affords a suitable measure of the throttling effect required for the maintenance of the whistling noise. When the damper is provided at an outlet for the discharge of the products of combustion, the thermostatic operating means may be partly responsive to the heater metal temperature, and partly to the temperature at which the products of combustion are discharged.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred forms of apparatus and a preferred method of practicing the present invention.

Of the drawings:

Fig. 1 is a diagrammatic elevation of a portion of an aeroplane in which an engine heating

heater is permanently mounted at the rear of the engine;

Fig. 2 is an elevation of the heater taken at right angles to, and partly in section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 2;

Fig. 4 is an elevation of a portion of the heater taken similarly to Fig. 1 but on a larger scale;

Fig. 5 is a diagrammatic elevation of a portion of an aeroplane having a heater removably associated with the aeroplane engine;

Fig. 6 is a view taken at right angles to Fig. 5 and on a larger scale, showing the heater of Fig. 5 with parts thereof broken away and in section;

Fig. 7 is a view of the heater shown in Fig. 5, taken similarly to that figure, but on a larger scale; and

Figs. 8, 9, 10 and 11 are diagrammatic views generally similar to Fig. 1, and each showing a different heater form and disposition.

In the drawings, and referring first to the arrangement shown in Figs. 1—4, A represents a sheet metal hood or shell portion of the aeroplane structure at the front end of the latter, and surrounding the carburetor and fuel supply connections for the aeroplane engine B, the radial cylinders of which are in front of the shell A. Ordinarily, and as shown, in an aeroplane of the type illustrated, a fire wall C is located within the shell A between the space occupied by the operator and the space including the carburetor and fuel supply connection. In heating up the engine B, the latter is enclosed by a cover part D which is in effect a canvas bag having its otherwise open end fitting snugly about, and closed by the aeroplane shell portion A. In practice, the bag or cover extends between the engine B and propeller blades B' and is slit at one side to permit its passage over the engine propeller shaft B², the cover portions at the sides of the slit being detachably connected by lacing, or by other suitable provisions when the cover is in place.

In the arrangement shown in Figs. 1—4, an engine heater E is permanently mounted in the aeroplane structure in the space between the engine and the fire wall C, and adjacent the latter. The heater E in the particular form of construction shown in Figs. 1—4, comprises a one piece chambered body portion enclosing a vertically disposed combustion chamber E' with a burner F at the bottom of the latter, and having upper outlets E² for products of combustion at the opposite ends of the body portion, which, as shown, is generally rectangular in form. A chambered air and fuel gas mixing and distributing part E³ is detachably secured to the lower end of the heater body as by bolts E⁴.

The part E³ is formed at one end of the heater with a large air inlet chamber E⁵ circular in cross section, and communicating at its inner end with the small end of a horizontal passage E⁶ extending to the opposite end of the heater and increasing in cross section with the distance from the chamber E⁵. The large end of the passage E⁶ communicates with the corresponding end of a second horizontal passage E⁷ which extends back to the end of the heater at which the chamber E⁵ is located and diminishes in cross section as it approaches that end. The passage E⁷ forms the supply chamber for the burner F, which forms a pervious wall between the chamber E⁷ and the combustion chamber E'.

The burner F, advantageously, and as shown, consists of a multiplicity of thin vertically disposed plate-like bodies of ceramic material ex-

tending transversely to the length of the passage E⁷ and each formed with fine vertical grooves F' in its opposite sides. The grooves F' at two sides of each body may be staggered, or horizontally displaced, so that in the assembled burner, the grooves in each side of each plate-like body are closed by the portions of the adjacent side of a similar body, which portions lie between the grooves at that side of the last mentioned body.

In any event, along the joint between adjacent sides of adjacent burner bodies, there are a row of burner channels formed by the grooves F' in the said adjacent sides. The above described features of burner construction and arrangement, while novel with me, are not claimed herein, but are claimed in my prior application Serial No. 713,433, filed March 1, 1934. As shown, the burner plate bodies are formed with projections F² at their ends received in rabbets or recesses E⁸ formed in the upper portions of the side walls of the chamber or passage E⁷, which is open at its top. The burner plate bodies may be secured in place in the part E³ in any suitable manner as by the refractory cement F³ shown. Leakage through the joint between the heater body and the part E², is prevented, as shown, by a gasket G of asbestos or other suitable gasket material.

Air is drawn into the chamber E⁵ by the aspirating effect of a jet of fluid fuel supplied by a burner nozzle H having its discharge orifice H' within the chamber E⁵ and suitably adjacent to, and coaxial with the tapered nozzle passage E⁶ which serves, in effect, as an injector mixing nozzle. In the preferred construction shown, the fuel nozzle H is mounted axially in a fire check or screen element I, which forms a pervious outer wall for the chamber E⁵, and through which air is drawn into the latter. The fire check or screen element E is of such character that if, on the development of some abnormal condition, a combustible mixture should move outward from the chamber E⁵ through the element I, the latter will cool the mixture to a temperature below its ignition temperature, in its passage through the element I.

Advantageously, and as shown, the fire check element I consists mainly of thin corrugated metal I' wound spirally about a hollow core or thimble I², the circular body thus formed being surrounded by a peripheral band member I²⁰, which holds the spiral convolutions snugly in contact with one another. As shown, the metal I is corrugated and arranged in accordance with the principles of the LeBoutillier and Hess Patent 1,910,020, granted April 18, 1933, so that the corrugations of each convolution extending between the sides of the latter and are inclined thereto in a direction opposite to that in which the corrugations of each adjacent convolution are inclined to its side edges.

As shown, the thimble and spirally wound strip metal structure I are held between two end members or spiders I³ of spoked wheel form. The peripheral edges of the members I³ preferably extend radially outward beyond the band I² for snug engagement with a cylindrical wall portion E⁹ of a rabbeted seat for the element, with which the member E³ is provided. As shown, the thimble I² and surrounding metal I¹ are clamped between the end members I³ by the burner nozzle member H which passes through the thimble I² and is enlarged at its outer end to bear against the hub portion of the adjacent end member, and is threaded at its inner end to receive a clamping nut H² bearing against the

hub portion of the inner member I³. The fire screen unit may be detachably secured in place in any suitable manner as by means of a piece of spring wire I⁴ bent into circular form and removably received in a circular groove E¹⁰ formed in the inner wall of the flange E⁹. The strips I¹, thimble I², band I²⁰, and end members I³, and also the heater main body portion and part E³, may advantageously be formed of aluminum, where economy in weight is desirable, as it is in aeroplane equipment.

The burner nozzle H may receive fluid fuel through a supply pipe H³ from any suitable source (not shown), which may be located in the aeroplane or may be exterior of the aeroplane and cover D, and in the latter case, the pipe H³ advantageously may include a copper or other flexible tube section, and the tank or connecting pipe ordinarily includes a valve for suitably regulating the pressure at which the fuel is delivered to the nozzle H. The source of fuel may be a tank of propane gas or other fuel gas, or may be a tank containing a liquid fuel such as liquid propane or gasoline. When liquid fuel is employed, it is preferably vaporized prior to its delivery to the burner nozzle as by passing a vaporizing section of the pipe H³ in sufficiently good heat transfer relation with the heater E to insure proper vaporization of the fuel. In Fig. 2 the vaporizing section of the pipe H³ passes through the combustion chamber of the heater, and H⁴ represents a strainer in the pipe H³ adjacent the nozzle H. Such a strainer which may comprise a mass of steel wool in the strainer receptacle is especially desirable when the liquid fuel used is leaded (ethyl) gasoline, since in such case, lead separates out of the fuel in metallic and oxidized powder form during the vaporizing process, and if not arrested in the strainer H⁴, may clog the burner nozzle orifice H'.

Across each of the outlets E² from the combustion chamber E', there is provided a fire screen or check element IA, which may be analogous in construction and mounting with the element I previously described, except that in lieu of the clamping connection of the element formed by the burner nozzle H, a clamping bolt I⁶ is employed in each of the elements IA. The products of combustion escape from the combustion chamber E' through the pervious walls formed by the elements IA, which must cool the combustion gases prior to their discharge into the atmosphere below the temperature of 700° or 800° F., at which combustible gases and vapors coming from the engine carbureter and fuel supply connections into the enclosed space in which the heater E is located will ignite. Since the flame temperature in the combustion chamber adjacent the burner F may be of the order of 2500°, the temperature of the gases at the inlet sides of the elements IA will be substantially in excess of said ignition temperature notwithstanding the special provisions shortly to be described, through which the heater body absorbs from the combustion chamber and dissipates much of the heat liberated in the combustion chamber.

The heat dissipating capacity of the heater E is made desirably great by forming the latter with thin walls of metal of good heat conductivity and by providing the heater body and the part E³ with a multiplicity of integral thin heat dissipating ribs or fins E¹¹. To increase the transfer of heat from the combustion chamber to the wall of that chamber, the combustion chamber is shaped to provide suitably tortuous passages for the gas

flow therethrough, and a multiplicity of heat absorbing projections from the wall of the combustion chamber extend into the latter. The form and disposition of those projections may obviously be varied. As shown, the combustion chamber proper is narrowed at its upper end where it communicates with the inner ends of funnel shaped passages leading to the outlets E². Extending into those funnel shaped passages and the space connecting their inner ends, are a multiplicity of small conical projections E¹². In the combustion chamber proper, ribs E¹³ extending into the combustion chamber from the opposite side walls of the latter, separate a considerable portion of the space adjacent each side wall into a multiplicity of vertically disposed serpentine passages.

In the preferred contemplated mode of use of the apparatus shown in Fig. 1, a vigorous circulation within the enclosed space in which the heater is arranged, is set up as a result of the air flow into the heater through the screen I, due to the aspirating or injector action of the fuel discharged through the burner nozzle member H, and of the discharge of the products of combustion through the outlets E², and due to the convection circulation in said space due to the difference between the temperatures in different portions thereof. The engine heating effect is due partly to the radiation of heat from the outer surface of the heater, partly to the heat in the products of combustion discharged, and partly to the convection heating and circulation of the atmosphere within the enclosed space, which comes into contact with, and absorbs heat from the heater and from other parts including, notably the metal shell A, which are more directly heated by the heater E.

While the cover member D is ordinarily and preferably not provided with definite openings for the out-flow of heated air and gas, or for the inflow of cold air, there is enough flow through the member to prevent any appreciable or significant increase in gas pressure above atmospheric pressure in the enclosed space, and for the supply of oxygen to the latter, as required for the maintenance of efficient combustion during the period in which the heater is normally in operation.

With the operation described, combustible gases or vapors which are in the atmosphere of the enclosed space, are drawn into the heater with the air passing to the inlet chamber E¹, and are burned in the combustion chamber E' of the heater. This practically eliminates all possibility of a sufficient accumulation of combustible gases and vapor in the atmosphere of the enclosed space to make that atmosphere an explosive mixture, notwithstanding the fact that a considerable quantity of combustible gases and vapors may be given off to said atmosphere from the engine carbureter and supply connections as they are heated up.

In general, it is practically important to have some reliable means for determining at any time whether or not the heater is in operation. There is always a possibility, of course, that under the stress of emergency conditions, when haste in starting the aeroplane engines into operation is of extreme importance, that through a stoppage in the fuel line, or the exhaustion of the heater fuel supply, or from some other cause, that combustion in the combustion chamber E' will cease, or may not start through some failure of the ignition device, ordinarily a spark plug J, as shown.

While the heater is ordinarily and preferably provided with a window EK, through which the flow of combustion may be observed when an observer is in position to look through the window in normal operation, such visual inspection is rendered difficult or impossible by the cover D.

A thermostatic arrangement responsive to the heater temperature for indicating whether the heater is or is not in operation would be of doubtful reliability, and would involve complications which are desirably avoided. I have found, however, that when the flow through the heater is suitably throttled, the operation of the heater will produce a whistling noise of such volume and character that it can be detected by one standing close to the enclosing cover D, even though the engines of other aeroplanes in the immediate vicinity are in operation and are producing the loud roars characteristic of the operation of such engine. For the maintenance of such a whistling noise of desirable volume, it is practically essential that the throttling of the flow through the heater should be decreased as the heater temperature rises. Such throttling action may be automatically effected by a throttling damper adjusted by thermostatic means responsive to the heater temperature and variably throttling an air inlet or an exhaust outlet of the heater.

The heater E is shown as provided with such an adjustable damper K, for one only of its two outlets. As shown in Fig. 4, the damper K is mounted on one of the outlet fire screens IA, and is in the form of a disc-like element rotatively mounted on the clamping bolt T⁶ of the corresponding element IA, and comprises tapered sector or spoke parts which overlap the spoke portions of the adjacent fire screen end member I³. The thermostatic means shown for angularly adjusting the damper K, comprises a strip of bi-metallic thermostatic metal L wound into spiral form and having its inner end anchored to the adjacent element IA, and having its outer end connected to the damper element K at some distance from the axis thereof. In the arrangement shown, the thermostatic strip L is heated partly by conduction through the fire screen metal, but mainly by the exhaust gases which, notwithstanding the cooling action of the fire screen, have a delivery temperature which increases through a considerable range as the heater heats up.

The damper control provisions serve not only to maintain the proper whistling indication, but also contributes to improved combustion conditions, since, as the temperature within the heater and the expansion of the combustion gases are increased, the throttling effect should be diminished to avoid draft pressure loss which would prevent the proper amount of combustion supporting air from being drawn into the heater by the aspirating effect of the fuel jet.

The general principles and advantages of the form of the invention shown in Figs. 1-4, may be obtained with heaters differing in construction and disposition from that of the heater E shown in Figs. 1-4, and in particular, those principles may be utilized with especial advantage in a heater which is detachably associated with the engine for the heating up operation, and is removed along with the cover D when the aeroplane is to be started in operation. Owing to the light weight of the heater, it may well be physically attached to, and supported by the cover member, since each is normally used only in association with the other. With a detachable

heater, the latter may be located in better position for transferring heat to the engine cylinders, than is the case with the heater E shown in Figs. 1-4. In particular, the heater may be located in front of and immediately adjacent the engine, as in the arrangement shown in Figs. 5 and 6, wherein the heater EA, when in use, is directly supported by a suspension strap or hooks E¹⁰⁰ engaging the propeller shaft B², or preferably, an immediately adjacent portion B³ of the engine BA.

The heater EA shown in Figs. 5, 6, and 7, is similar in its general principles of construction and operation, to the heater E, but differs considerably therefrom in form, and notably in that the heater EA is relatively flatter and longer than the heater E, and has a combustion chamber E¹⁰ and burner FA between each end of the heater and the central portion of the latter, which is provided with a single fuel burner nozzle HA at its bottom. The combustion air is drawn into the heater through a fire screen element I, as in the construction shown in Figs. 1-4. In the construction of Figs. 5-7, the air and fuel are mixed in an expanding nozzle passage E⁶⁰ similar to the passage E⁵ of the construction first described. At its upper end, the passage E⁶⁰ communicates with two passages E⁷⁰ at the opposite sides of the passage E⁶⁰, and serves as the fuel supply and distribution chambers for the two burners FA. Each of the latter may be identical in construction with the burner F previously described, but is vertically disposed. At the outlet E²⁰ from each combustion chamber E¹⁰, is provided a fire screen IB similar in general type and purpose to the previously described screens IA, but shown as differing therefrom in form. Each element IB is rectangular in outline, and comprises corrugated strip or strips bent to form straight side by side portions instead of being wound into spiral form.

The heater EA is formed with external heat dissipating ribs or fins E¹¹⁰, corresponding in purpose to the fins E¹¹ previously described. Each combustion chamber E¹⁰ may be provided with internal heat absorbing projections corresponding in purpose to the previously described projections E¹² and E¹³. The heater EA is preferably formed, also, with open ended vertical tubular passages E²¹ extending through the combustion chamber, and each providing a chimney action, or effect, which increases the convection current circulation of the enclosed space. The general circulation in that space is enhanced, also, by the relatively wide separation of the outlet ports and the fact that they discharge products of combustion upwardly and away from the vertical plane which includes the propeller shaft axis.

The circulation thus provided extends to all portions of a space immediately in front of the engine and which in vertical section transverse to the axis of the propeller shaft, is substantially coextensive with the space occupied by the engine, and the gases circulated also move through spaces between the engine cylinders and at the rear of the latter. The heat transfer to the engine is thus more direct and effective than in the arrangement first described. The direct heat transfer is of especial importance in the case of an engine having two side by side sets of combustion chambers, as shown in Fig. 1, so that the engine dimensions in the direction of the propeller shaft are correspondingly large. When the heater is in close proximity to the cover,

the latter may be protected against over heating by a radiation screen ED of material having low heat conductivity. As shown, the screen ED is carried at the ends of projections E¹¹ from the corresponding side of the body of the heater EA.

As will be apparent, my improved heater, whether permanently or removably mounted in the aeroplane, may be located in various positions different from those shown in Figs. 1-5, as conditions make desirable, and may be specially shaped to adapt it to any particular desired location in the aeroplane. Thus, as shown in Fig. 8, the heater EB is located directly beneath the engine and between the lowermost cylinders thereof, and an annular shroud or shield member M surrounding the engine. For that location, the heater EB may advantageously be in the form of an arc curved about the axis of the engine with an exhaust outlet E²² at each end of the arc. In the arrangement shown in Fig. 9, the heater EC is of annular form and surrounds the nose portion B⁵ of the engine in front of the engine cylinders, and the exhaust outlet opening or openings E²³ may be formed in the edge of the annular heater adjacent the engine cylinders.

In the arrangement shown in Fig. 10, the heater ED is located generally as shown in Fig. 1, but is provided with a lateral exhaust outlet conduit extension E²⁴ leading to the adjacent side of the engine, so that the exhausted products of combustion are discharged directly against the engine structure.

The heater EE shown in Fig. 11 may be generally like the heater shown in Figs. 1-5, but differs therefrom in that inclined open ended passages E²⁵ extend through the combustion chamber of the heater to augment the circulation in the enclosed space by a chimney action, analogous to that obtained with the passages E²¹ of the heater EA.

As previously stated, the heater may be attached to, and supported by the flexible cover member D so that the heater may be put in place, removed, and transported with the cover member. In such case, the heater may be attached to the cover member in any suitable manner. For example, as shown in Fig. 7, the heater shield member ED may be formed with one or more hook extensions E¹¹², each received in a corresponding eyelet or opening D' in the cover member D.

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. A light weight compact heater adapted for use in, and to heat a surrounding atmosphere containing air and combustible vapors, comprising a chambered metallic structure having a fuel and air receiving chamber, and a combustion chamber, and having an inlet to said receiving chamber and an outlet from said combustion chamber and formed externally with projections

giving a large external heat dissipating surface relative to the bulk of said body, and with integral projections extending into each combustion chamber and providing a large heat absorbing surface relative to the volume of said chamber, a pervious burner wall separating said combustion chamber from the first mentioned chamber, pervious metallic walls extending across said inlet and across said outlet and each serving as a fire check screen, and means for supplying fluid fuel to said receiving chamber in a stream adapted by its aspirating action to draw air for the combustion of the fuel into said receiving chamber through the said pervious wall extending across said inlet.

2. A light weight compact heater adapted for use in and to heat an atmosphere containing air and combustible vapors, comprising a chambered metallic structure including a fuel and air receiving chamber and two combustion chambers located at opposite sides of said receiving chamber, and having an inlet to said receiving chamber, and an outlet from each combustion chamber at the side of the latter remote from said receiving chamber, and formed externally with projections giving a large external heat dissipating surface relative to the bulk of said body, and with integral projections extending into each combustion chamber and providing a large heat absorbing surface relative to the volume of said chamber, a pervious burner wall between each chamber and said receiving chamber and constituting a fuel burner, pervious metallic walls, one extending across said inlet and one across each of said outlets, and each serving as a fire check screen, and means for supplying fluid fuel to said receiving chamber in a stream adapted by its aspirating action to draw air for combustion into said receiving chamber through the said screen for said inlet.

3. A heater as specified in claim 1, in which said receiving chamber comprises an initial air admission portion, an expanding nozzle portion, and a burner supply portion, and in which said admission portion is immediately adjacent the inlet opening fire screen and said nozzle portion leads away from said air admission portion and has its throat or inlet end substantially smaller in cross section than said air admission portion, and said burner supply portion lies alongside of said nozzle portion and between it and the burner wall and is connected to said nozzle at the end of the latter remote from said admission space, and in which the fuel stream is discharged axially into said nozzle portion through the said throat thereof.

4. A heater as specified in claim 1, in which said receiving chamber comprises an initial air admission portion, an expanding nozzle portion, and a burner supply portion, and in which said admission portion is immediately adjacent the inlet opening fire screen and said nozzle portion leads away from said air admission portion and has its throat or inlet end substantially smaller in cross section than said air admission portion, and said burner portion lies alongside of said nozzle portion and between it and said burner wall and is connected to said nozzle at the end of the latter remote from said admission portion and contracts in cross section from its end connected to said nozzle to its end adjacent said admission portion, and in which the fuel stream is discharged axially into said nozzle portion through the throat thereof.

5. A heater as specified in claim 1, in which

the inlet to the receiving chamber is circular, and the fire check screen extending across it comprises a hub portion and corrugated metal strip material wound spirally about said hub, and in which said hub is formed with an axial passage through which the fuel stream is passed into said receiving chamber.

6. A heater as specified in claim 1, comprising thermostatic means for subjecting the gas flow through the heater to a throttling effect diminishing as the heater temperature increases.

7. A heater as specified in claim 1, having an exhaust outlet fire screen circular in cross section, and comprising a central hub portion, a damper mounted on said hub portion for angular movement and adapted to variably throttle flow through said fire screen according to the angular position of the damper, and thermostatic means connecting said damper and fire screen element and angularly adjusting the damper in accordance with variations in the temperature of the gases passing through the fire screen.

8. A heater as specified in claim 1, in which the heater structure is formed with vertically disposed tubular portions extending through the combustion chamber and providing open-ended chimney passages for augmenting convection current circulation of the atmosphere surrounding the heater.

9. A heater as specified in claim 1, in which the heater structure comprises a part including a combustion chamber and a separable part including the receiving chamber, and in which the burner wall between said chambers is formed of plate-like bodies of refractory material formed with burner orifice grooves in their sides and mounted side by side in one of said members.

10. Aeroplane engine heating means, comprising a flexible cover member adapted for detachable mounting on the aeroplane to enclose a space including said engine, and a heater adapted to be put in place in said space and removed therefrom as the cover member is put in place and removed and comprising a combustion chamber adapted to receive air for combustion from said space and to discharge products of combustion into said space, and means for supplying fluid fuel to said combustion chamber in a stream having sufficient velocity to aspirate air for combustion into said chamber from said space and to discharge products of combustion into said space with sufficient velocity to create a vigorous circulation therein.

11. Aeroplane engine heating means, comprising a flexible cover member adapted for detachable mounting on the aeroplane to enclose a space including said engine, and a heater adapted to be put in place in said space and removed therefrom as the cover member is put in place and removed, and comprising a combustion chamber adapted to receive air for combustion from said space and to discharge products of combustion into said space, means for supplying fluid fuel to said combustion chamber in a stream having sufficient velocity to aspirate air for combustion into said chamber from said space and to discharge products of combustion into said space with sufficient velocity to create a vigorous circulation therein, and a heat screen attached to one side and spaced away from the heater to permit air flow therebetween, said screen being adjacent said cover.

12. A heater as specified in claim 1, in which said receiving chamber comprises an air admission space immediately adjacent the inlet fire

check screen and of relatively large cross sectioned area, an expanding nozzle portion leading away from, and having its throat or inlet end substantially smaller in cross section than said space, and means for discharging the fuel stream axially into said nozzle at the inlet end of the latter.

13. A heater, as specified in claim 1, in which

the means for supplying fluid fuel to the receiving chamber of the heater comprises a fuel supply pipe which receives vaporizable liquid fuel and including a section absorbing heat from the heater to vaporize the liquid fuel prior to its delivery to said receiving chamber.

FREDERIC O. HESS.