

April 24, 1945.

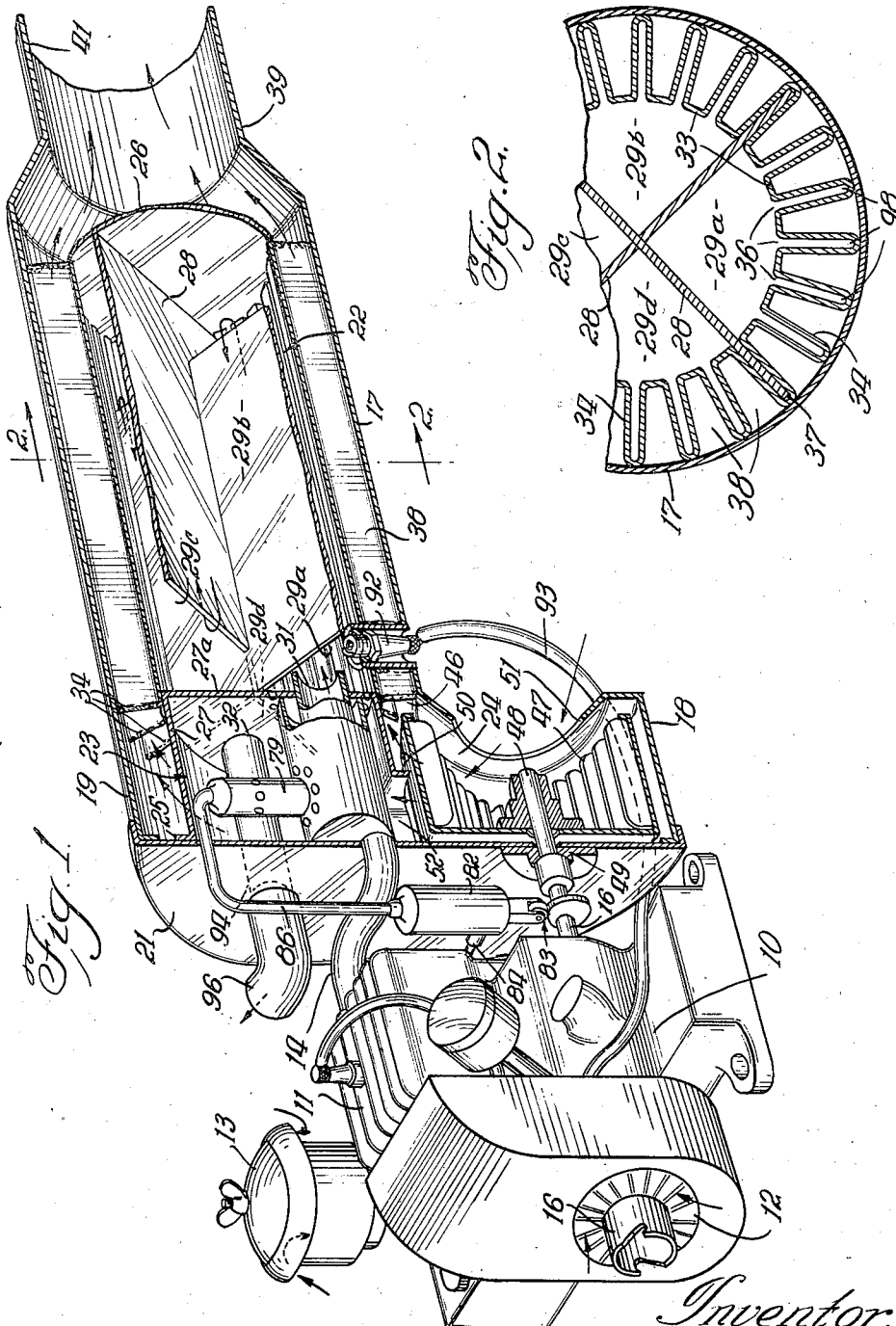
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2,374,203

HEATER

Filed Aug. 30, 1941

3 Sheets-Sheet 1



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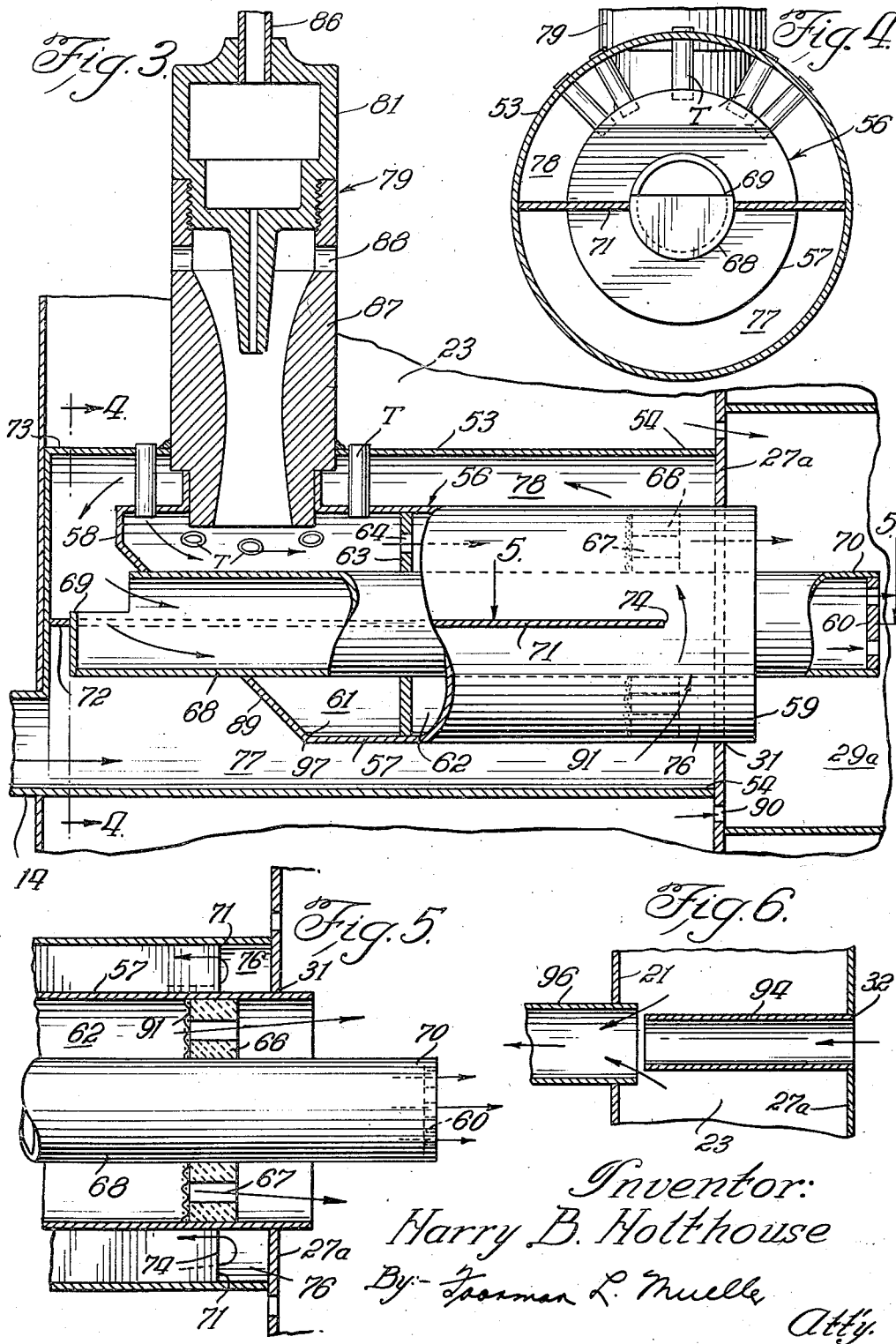
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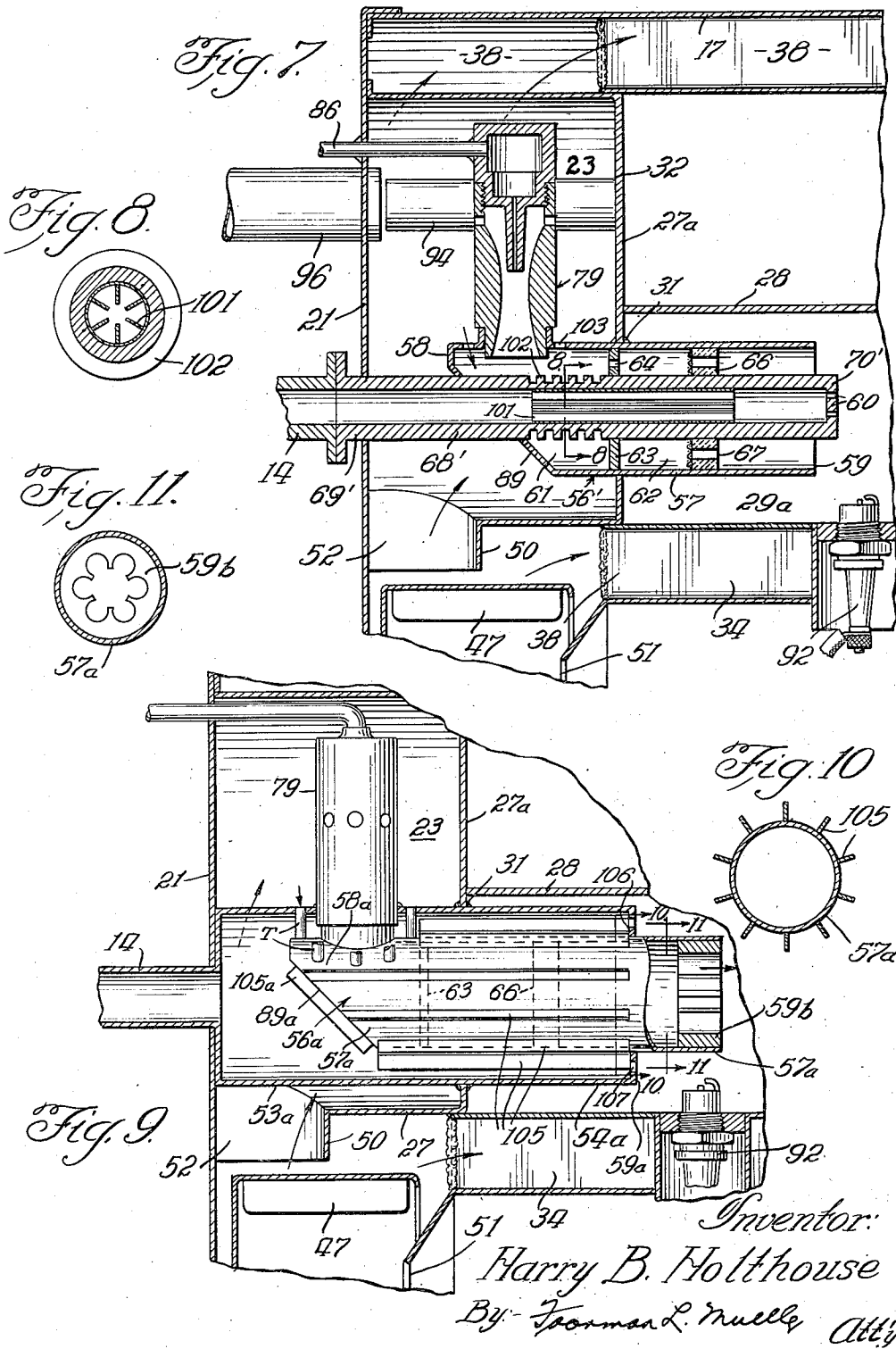
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UNITED STATES PATENT OFFICE

2,374,203

HEATER

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Application August 30, 1941, Serial No. 408,984

12 Claims. (Cl. 126—110)

This invention relates generally to heating systems and in particular to a heating system of internal combustion type operated in conjunction with an internal combustion engine.

It is an object of this invention to provide an improved heating system.

Another object of this invention is to provide an air heater of internal combustion type assembled as a portable unit with an internal combustion engine and utilizing such engine as the sole source of power supply.

A further object of this invention is to provide a heater of internal combustion type operated on liquid fuel and in conjunction with an internal combustion engine, in which the fuel is substantially completely vaporized for burning in the heater by utilization of the engine waste heat.

Yet another object of this invention is to provide a heater of internal combustion type operated on liquid fuel, in which the fuel is introduced with air into a conditioning portion having heat projected thereon to heat the same to a fuel vaporizing temperature to provide for a thorough mixing of the air and fuel therein.

A still further object of this invention is to provide a portable air heating system comprised of a heater of internal combustion type operatively assembled with an internal combustion engine as a source of power, which is compact and simple in design, rugged in construction, light in weight, and capable of producing heat quickly and efficiently.

A particular feature of this invention is found in the provision of a heater of internal combustion type using liquid fuel and adapted for operation by an internal combustion engine, in which the heat in the engine exhaust gases is used to vaporize the liquid fuel to condition it for mixing together with the air for combustion.

Another feature of this invention is found in the provision of a heater of internal combustion type operated by an internal combustion engine, in which the burner fuel is initially vaporized by the heat of the engine exhaust gases for mixing together with air, with the air and fuel mixture then being mingled with the exhaust gases for burning together.

Further objects, features, and advantages of this invention will become apparent from the following description when taken in connection with the accompanying drawings in which:

Fig. 1 is a view in perspective of a complete assembly of one form of this invention with parts thereof removed and other parts shown in section for the purpose of clarity;

Fig. 2 is a fragmentary transverse sectional view of the heater combustion chamber as seen along the line 2—2 in Fig. 1;

Fig. 3 is a fragmentary sectional view showing the assembly of the heater fuel conditioning unit with the exhaust conduit of the internal combustion engine;

Fig. 4 is a sectional view taken along the line 4—4 in Fig. 3;

Fig. 5 is a sectional plan view as seen along line 5—5 in Fig. 3;

Fig. 6 is a fragmentary sectional view showing the tail pipe assembly at the outlet of the heater combustion chamber.

Fig. 7 is a fragmentary sectional view of a modified form of the invention;

Fig. 8 is a sectional view along line 8—8 in Fig. 7;

Fig. 9 is a fragmentary sectional view of yet another modification of the invention;

Fig. 10 is a sectional view taken along the line 10—10 in Fig. 9; and

Fig. 11 is a sectional view as seen on line 11—11 in Fig. 9.

In practicing this invention there is provided as a portable unit, an air heater of internal combustion type and an internal combustion engine which produces all of the power for operating the heater. Liquid fuel for burning in the heater is introduced with air into a fuel conditioning unit or mixing device, the heat from the engine exhaust gases being utilized to heat the conditioning unit and vaporize the fuel for mixing together with the air. This vaporous mixture is admitted into a combustion chamber where it is mingled with the exhaust gases for burning therewith. The air to be heated is circulated in a heat-transfer relation about the combustion chamber, the entire unit being capable of mounting on skids or a carriage so as to be easily transportable from place to place to deliver heated air whenever it is desired.

Referring to the drawings, there is shown in Fig. 1 one form of the invention which includes an internal combustion engine having an engine block 10, an air-cooled cylinder 11 cooled by a fan 12, an intake manifold 13, an exhaust conduit 14, and a crank shaft 15. The engine operates an air heater or burner and is assembled therewith as a complete operating unit which may be mounted on a carriage or the like (not shown) so as to be easily moved about to furnish heated air wherever it is necessary, as for example to heat airplane engines to facilitate their

starting, or to heat tents, barracks, cabins, or the like.

The heater includes a housing comprising a longitudinally extending cylindrical portion 17 and an integrally formed L-shaped radially extending portion 18 at one end 19 thereof, the end 19 being closed by a cover plate 21. The cylindrical portion 17 of the heater housing encloses a cylindrical combustion chamber 22 and an air chamber 23, while a fan compartment 24 is enclosed by the housing portion 18 and cover plate 21. The combustion chamber 22 is closed at one end by a plate 26 and at its opposite end by the base or closed portion 27a of a cup-shaped member 27, the open end of the member 27 being integrally formed with an annular flange 25 for assembly with the housing cover plate 21, the air chamber 23 being formed within the member 27.

A partition member 28 of substantially cross-shape (Figs. 1 and 2) is positioned within and axially of the chamber 22 and is of a construction to divide the chamber into four axially extending but connected passages 29a-29d. The member 27 is formed in the bottom portion 27a thereof with openings in communication with the passages 29a and 29d to provide an inlet 31 and an outlet 32 for the connected passages and hence for the combustion chamber. The wall of the combustion chamber 22 is integrally constructed with alternately arranged peripheral portions 33 and radially extending fins 34 (Fig. 2). The fins 34 are bent double with their inner ends 36 opening into the combustion passages 29a-29d. The partition member 28 is positioned within the open inner ends 36 of certain of the fins 34 and is retained in a fixed relative position within the combustion chamber 22 as by welding. The housing portion 17 fits about the outer ends 37 of the fins 34 to form an annular passage 38 about the combustion chamber 22, the end 39 of the housing portion 17 extending outwardly of the combustion chamber 22 and being of funnel shape to provide a discharge or outlet opening 41 for the passage 38.

As is evident from Fig. 1, the fins 34 are coextensive in length with the combustion chamber 22, with the air passage 38 being extended to the housing cover plate 21 by the cup-shaped member 27. The air passage 38 is in communication with the fan compartment 24 through a passage 46, the fan 47 located in the compartment 24 being mounted on the end 48 of the engine crank shaft 16 which extends through and is rotatably supported by a bearing 49 in the housing cover plate 21. The bearing 49 is of a construction to seal the opening in the end plate 21 for the crank shaft 16. An air inlet 51 for the fan 47 is formed in the housing portion 18. The air to be heated is thus drawn by the fan 47 through the inlet 51, passed through the passage 38 in heat exchange relation with the fins 34 and discharged from the heater through the outlet 41.

The air chamber 23 within the member 27 is connected with the fan compartment 24 by a passage 52 which is separated from the air circulating passage 46 by a baffle 50 integrally formed with the member 27 and extending to the periphery of the fan 47. The baffle 50 divides the air delivered by the fan 47 for discharge into the passage 38 and the air chamber 23. The air in the chamber 23 is utilized for combustion so that the fan 47 operates to supply both the air for combustion and the air to be heated. It is understood, of course, that the chamber 23 is sealed

from the combustion chamber 22 and the air passage 38 and is in communication with the fan compartment only through the passage 52.

As shown in Figs. 1 and 3 a portion 53 of enlarged section of the engine exhaust conduit 14 is located within the air chamber 23 in a position axially of the combustion chamber 22 and concentrically of the combustion chamber inlet 31. The conduit portion 53 is of greater diameter than the inlet 31 so that the end 54 thereof is radially spaced about the combustion chamber inlet 31 and in sealed engagement with the base portion 27a of the member 27. Supported by the conduit portion 53 is a fuel conditioning unit designated generally as 56, for preparing fuel for burning in the combustion chamber 22 with the exhaust gases from the engine.

Referring to Figs. 3, 4 and 5 the fuel conditioning unit 56 is seen to include a substantially tubular housing 57 having a closed end 58 and an open end 59. The housing 57 is positioned within and axially of the exhaust conduit portion 53 and is radially spaced therefrom so as to be completely exposed to the exhaust gases passing therethrough. The open end 59 of the housing 57 is positioned within the combustion chamber inlet 31 and seals such opening against any passage therethrough of exhaust gases from the exhaust conduit portion 53. An air and fuel mixing chamber 61 is located at the closed end 58 of the housing 57 and is separated from an equalizing chamber 62 therein by a partition plate 63 which extends transversely completely across the housing 57, the chambers 61 and 62 being in communication through perforations 64 formed in the upper portion of the plate 63. The housing 57 and partition plate 63 are composed of a heat conducting material such as copper or the like and are connected together in thermal relation. The equalizing chamber 62 is in turn separated from the passage 29a of the combustion chamber 22 by a heat insulating plate 66 which extends completely across the open end 59 of the housing 57 and is spaced inwardly thereof, the equalizing chamber 62 and the passage 29a being in communication through openings 67 positioned peripherally about the plate 66. Admission of the exhaust gases from the engine and specifically from the conduit portion 53 into the combustion chamber 22 is accomplished by means including a heating element or conduit portion 68 composed of copper or like material and extending axially through the housing 57 and outwardly therefrom at both ends, the element 68 being supported in the closed housing end 58, and partition plates 63 and 66. The end 69 of the heating element 68 which projects from the closed end 58 of the housing 57 is open to the exhaust conduit portion 53 so as to receive exhaust gases therefrom, these gases being discharged into the combustion chamber from the element end 70. The inlet end 69 is located to one side of a partition plate 71 extending longitudinally of the conduit portion 53 and about the projecting end 69 of the heating element 68 and housing 57. The end 72 of the partition member 71 is in sealed engagement with the end 73 of the conduit portion 53, while its other end 74 is spaced from the base portion 27a of the member 27 to form a connecting passage 76 between the compartments 77 and 78 of the conduit 53 on opposite sides of the partition member. The exhaust gases, as indicated by the arrows in Fig. 3, thus flow from the exhaust conduit 14 into the compartment 77 through passage 76 into

the compartment 78 and then into the open end 69 of the conduit 68 for discharge therethrough into the passage 29a of the combustion chamber 22 where they are burned. Since the housing 51, partition plate 63 and heating unit 68 are composed of a high heat conducting material, the heat from the exhaust gases is readily transferred to these parts so that during the normal operation of the heater they are at a temperature substantially equal to the temperature of the exhaust gases in the conduit portion 53.

The air and fuel which is to be burned in the combustion chamber 22 with the engine exhaust gases is introduced into the mixing chamber 61 through an air and fuel receiver or nozzle 79 inserted through the wall of the conduit portion 53 and mounted on the housing 57 so that the end 81 thereof is located in the air chamber 23. Fuel is delivered to the receiver 79 by a pump 82 illustrated as being of reciprocating type and operated from the engine crank shaft 16 through cam means 83. Connection of the pump with the engine fuel tank (not shown) but generally located in the base of the engine block 10 is made through pipe 84, the fuel from the pump being delivered through pipe 86 to the nozzle 79 (Fig. 1).

As is shown in Fig. 3 the nozzle 79 includes a Venturi portion 87 having peripherally extending air ports or openings 88 near one end thereof which are in communication with the air chamber 23. The air entering the ports 88 and the fuel from the fuel line 86 are introduced together in the Venturi portion 87 for discharge therefrom into the mixing chamber 61 of the conditioning unit 56. Since the air in the chamber 23 is maintained under pressure by the fan 47 it is evident that an initial velocity is imparted to the air entering the Venturi portion 87 through the ports 88, so that the body of fuel entering the Venturi portion 87 is partially broken up by the air prior to its passage into the mixing chamber 61.

In the operation of the invention the air and fuel from the venturi 87 are directed against an inclined wall 89 of the mixing chamber 61, integral with the housing 57 at the end 58 thereof and against that portion of the heating element 68 within the mixing chamber, for deflection against the partition plate 63. As previously mentioned the housing 57, heating unit 68 and plate 63 are heated by the engine exhaust gases in the exhaust conduit portion 53, this heat being such that these parts are heated to a temperature which is capable of vaporizing the fuel coming in contact therewith. The heating of these parts is facilitated by a perforated plug 60 in the end 70 of the conduit 68, the plug acting to impede the flow of the exhaust gases and thus prolong their contact with the conditioning unit 56. The fuel thus vaporized in the mixing chamber mixes together with the air introduced into the mixing chamber through the venturi 87 and through the tubes T connecting the mixing chamber 61 and air chamber 23, this vaporous mixture passing through the apertures 64 in the plate 63 into the equalizing chamber 62. The fuel is retained in a vaporous state within the equalizing chamber 62 by virtue of such chamber being heated exteriorly by the gases in the exhaust conduit portion 53 and interiorly by the heating unit 68. The equalizing chamber 62 functions to practically eliminate the turbulent character of the mixture in the mixing chamber 61 and provides for the vaporous mixture being distributed substantially uniformly over the entire cross section

of the housing 57 at the outlet end 59. This uniform distribution of the fuel mixture is further aided by a copper screen or the like 91 placed within the equalizing chamber 62 and across the openings 67 in the heat insulating plate 66. The mixture passing through the perforations 67 into the passage 29a of the combustion chamber is thus of substantially uniform quality on entering the combustion chamber 22. This mixture is intermingled with the exhaust gases discharged from the outlet 70 of the heating or conduit element 68 for burning therewith in the combustion chamber 22, ignition being initiated by a spark plug 92 arranged in the passage 29a at the combustion chamber inlet 31, the plug 92 being electrically connected by a cable 93 to a coil (not shown) mounted on the engine and energized by the magneto (not shown) associated therewith. Additional air for supporting combustion in the combustion chamber 22 is admitted into the passage 29a through openings 90 formed in the base portion 27a concentrically about the combustion chamber inlet 31 and connecting the passage 29a with the air chamber 23. Combustion proceeds through the passages 29a—29d, with the products of combustion being exhausted from the combustion chamber 22 through the outlet 32, the flow of the gases through the passages in the combustion chamber being indicated by the arrows in Fig. 1.

As shown in Figs. 1 and 6 the outlet 32 is provided with a tail pipe 94 which projects outwardly therefrom into the air chamber 23. A second tail pipe 96 of larger diameter than the tail pipe 94 is inserted through the heater housing cover plate 24 into the air chamber 23, concentric with the tail pipe 94 but spaced therefrom. The adjacent ends of the tail pipes 94 and 96 are thus both open to the air chamber 23. However, since the air chamber 23 is retained under pressure by the fan 47, air therefrom flows outwardly through the tail pipe 96 to provide an ejector action on the exhaust gases flowing in the tail pipe 94. This ejector action serves to reduce the back pressures in the combustion passages 29a—29d and facilitates the passage of the gases therethrough, the gases being discharged from the heater through the tail pipe 96.

On starting of the heater, or at times during its operation it may happen that all of the fuel entering the mixing chamber 61 is not completely vaporized therein. In such instances the unvaporized or raw fuel collects in a cavity or fuel carrying portion 97 at the bottom of the mixing chamber formed between the unperforated portion of the plate 63 and the inclined wall 89. By virtue of the heat in the walls of the cavity 97 any fuel collected therein is heated and vaporized for mixing together with the air passing through the mixing chamber, this mixture entering the equalizing chamber in a vaporous form. In the event any raw fuel should form or find its way into the combustion chamber 22, it collects in the cavities 98 (Fig. 2) in the fins 34 through the openings 36 therein, the heat in the fins vaporizing this fuel for later burning. All of the fuel supplied to the heater is thus substantially completely vaporized so that burning thereof proceeds efficiently and uniformly at all times of heater operation. Since the fan 47 supplies both the air for combustion and circulates the air to be heated, air is circulated through the passage 38 simultaneously with the starting of heater operation, it being understood that opera-

tion of the heater starts concurrently with the starting of the engine.

The modified forms of the invention shown in Figs. 7 and 9 are similar in all respects to the embodiment of Fig. 1 except for the relational assembly of the conditioning unit 56, the exhaust conduit portion 53 and the combustion chamber 22. Similar numerals of reference shall be used, therefore, to designate similar parts throughout the various views.

In Fig. 7 the exhaust conduit portion 53 is eliminated and the conditioning unit 56' is located within the air chamber 23 with the open end 59 thereof positioned through the combustion chamber inlet 31 in communication with the passage 29a. The heating element 68' at the end 69' thereof is connected directly with the engine exhaust conduit 14 so that the exhaust gases are passed in a heat transfer relation therewith and discharged directly into the combustion chamber from its outlet end 70'. To facilitate the heating of the unit 68' radially extending fins 101 (Fig. 8) are provided therein over the portion thereof extending across the mixing chamber 61 and equalizing chamber 62. A transfer of heat from the exhaust gases in the element 68' to that portion thereof within the mixing chamber 61 is further aided by peripherally extending fins 102. It is understood of course, that the heat from the heating element 68' is transferred to the housing 57 through its thermal connection with the heating element by the inclined wall 89 and partition plate 63 so that the entire conditioning unit 56' is heated to substantially the temperature of the engine exhaust gases passing through the heating unit 68'. Since the housing 57 at its closed end 58 is within the air chamber 23 air is introduced from the air chamber directly into the mixing chamber 61 through ports 103 formed in the housing about the nozzle 79. This air and the air introduced into the mixing chamber with the fuel from the nozzle 79 is thoroughly mixed with the fuel in the mixing chamber due to its vaporization in the manner above fully described in connection with Fig. 1.

In the modification of Fig. 9, the exhaust conduit portion of 53a has its end 54a positioned within the combustion chamber inlet 31 so that the exhaust gases from the engine are discharged therefrom directly into the combustion chamber. The housing 57a of the conditioning unit 56a is located within the conduit portion 53a in spaced relation therewith. This form of the invention eliminates the heating element 68 of Fig. 1 so that the transfer of heat to the conditioning unit 56a from the exhaust gases in the conduit portion 53a is accomplished entirely by the passage of such gases about the housing 57a. The transfer of heat from these exhaust gases is aided by fins 105 (Fig. 10) annularly spaced about the housing 57a and extending longitudinally thereof, and fins 105a extending in an up and down direction, as viewed in Fig. 9, formed at the closed end 58a of the housing 57a. The flow of exhaust gases through the conduit portion 53a is impeded by the provision of an annular apertured flange 106 at the end 54a thereof, the flange being in sealed engagement with the outlet 59a of the conditioning unit 56a so that the apertures 107 in the flange 106 are positioned between the housing 57a and the wall of the conduit 53a. The outlet 59a of the conditioning unit 56a is provided with an annular projecting nose or extension 59b of heavier construction than the walls of the housing 57a and of a scalloped or fin contour on the inner

periphery thereof. The nose 59b acts to collect and transfer heat from the mixture burning at the outlet 59a back to the housing 57a to aid the heating function of the exhaust gases in the conduit 53a. The air and fuel introduced into the mixing chamber 61 is additionally mixed with air entering the chamber 61 from the air chamber 23 through the tubes T, the fuel being vaporized for mixing together with this air by its contact with the housing end wall 89a and deflection against the partition plate 63. The vaporous mixture leaving the conditioning unit at the outlet thereof is intermingled with the exhaust gases from the apertures 107 and together are burned in the combustion chamber 22.

From a consideration of the drawings and above description it is seen that the invention provides for a unit air heater of portable type which is operated in conjunction with an internal combustion engine, and which utilizes the power from such engine as the sole source of power supply. The exhaust heat from the engine is used in the operation of the heater to prepare a vaporous air and fuel mixture which is intermingled with the exhaust gases for burning therewith in the heater combustion chamber. The substantially complete vaporization of the fuel for the heater assures a complete burning thereof with a maximum production of heat and a practical elimination of noxious odors and visible exhaust. The engine and heater are assembled together in a compact unit which may be readily moved about to provide heated air wherever it is needed. The unit is thus readily applicable for use in an airport to heat airplane engines for starting purposes, in cabins, small workshops, and the like. The entire unit is simple in design and of a rugged construction to withstand any rough handling thereof during its movement from place to place, without impairing its efficient operation.

Although the invention has been described with specific reference to several preferred forms thereof it is to be understood that changes therein can be made which are within the full intended scope of the invention as defined by the appended claims.

I claim:

1. A heating system including a burner and an internal combustion engine having an exhaust conduit, a combustion chamber means for said burner having an inlet at one end, an air chamber means at said one end separated from said combustion chamber means, said exhaust conduit having a portion thereof positioned in said air chamber means, a passage means about said combustion chamber means for air to be heated, air moving means in fluid connection with said air chamber means and passage means to supply air thereto, air and fuel mixing means at said combustion chamber means inlet arranged in heat transfer relation with the exhaust gases in said conduit portion, means admitting air from said air chamber means into said air and fuel mixing means, and means for supplying fuel to said mixing means, with said fuel being heated in said mixing means and vaporized for mixing together with the air therein, said vaporous mixture being passed through said combustion chamber inlet for burning therein.

2. A heater of internal combustion type utilizing an internal combustion engine as a source of power supply, a combustion chamber means for said heater having an inlet, a fuel conditioning unit arranged with the outlet thereof in fluid communication with the inlet of said combustion

chamber means, means supplying air and fuel to said conditioning unit, an exhaust conduit for said engine having an end portion thereof positioned within said conditioning unit and arranged to discharge the engine exhaust gases into said inlet, with the fuel in said unit being vaporized for mixing together with said supply air by the heat from the exhaust gases in said conduit portion, said air supply means acting to move said vaporous mixture into said combustion chamber means for burning therein with the gases from said conduit portion.

3. A heater of internal combustion type adapted to be operated in conjunction with an internal combustion engine having an exhaust conduit, a combustion chamber means for said heater having an inlet, air and fuel mixing means having an outlet in communication with the inlet of said combustion chamber means, said exhaust conduit having an end portion thereof arranged to discharge the engine exhaust gases into said inlet, with said air and fuel mixing means being positioned in said end portion to be heated by said exhaust gases, means for supplying air and fuel adjacent each other into said mixing means, with the heat from said exhaust gases acting to heat said air and fuel and to vaporize the fuel for mixing together with said air, with said air supply means providing for the movement of said vaporous mixture into said combustion chamber means for burning therein with said exhaust gases.

4. In a burner operated in conjunction with an internal combustion engine, a combustion chamber means for said burner having an inlet, fuel conditioning means having an outlet in communication with the inlet of said combustion chamber means, an exhaust conduit for said engine having a portion thereof positioned about said conditioning means, and a second portion extending through said conditioning means, with said second portion being arranged to discharge the exhaust gases from said engine through said inlet, means connecting together said two conduit portions, with said conditioning means being heated by the exhaust gases passing through said two conduit portions, and means introducing air and fuel into said conditioning means, with the fuel in said conditioning means being vaporized by the heat therein and mixed together with said air, with said vaporous mixture and exhaust gases being intermingled at said inlet for burning together in said combustion chamber means.

5. In a burner of internal combustion type utilizing an internal combustion engine as the sole source of power supply, a combustion chamber means for said burner having an inlet, an exhaust conduit for said engine having one portion thereof adjacent said inlet but separated therefrom, a fuel conditioning unit in said one portion of the exhaust conduit having an outlet in communication with the inlet of said combustion chamber means, means extending longitudinally through said fuel conditioning unit fluid connecting said exhaust conduit portion with said inlet, and means supplying air and fuel to said conditioning unit, with the heat from the gases in said longitudinally extending means and one conduit portion heating said conditioning unit to vaporize the fuel therein for mixing together with said air, said air supply means acting to move said vaporous mixture into said combustion chamber means for burning therein with said exhaust gases.

6. In a burner operated in conjunction with an

internal combustion engine, a combustion chamber means for said burner having an inlet, a fuel conditioning unit having an outlet in communication with the inlet of said combustion chamber means, an exhaust conduit for the exhaust gases from said engine having an end portion thereof positioned longitudinally through said fuel conditioning unit with the discharge opening thereof arranged at said outlet, means supplying air and fuel to said conditioning unit, with the heat from the engine exhaust gases in said exhaust conduit portion heating the air and fuel in said unit and vaporizing said fuel for mixing together with said air, said vaporous mixture being burned in said combustion chamber means with said exhaust gases.

7. In a system having an engine with heated exhaust gases issuing therefrom and passage means therefor and having a heater with a fuel combustion chamber; the means for conditioning fuel for burning in the combustion chamber which comprises fuel and air mixing and mixture conveying means opening into the combustion chamber, and conduit means enclosing at least a portion of said mixing and mixture conveying means and opening into said combustion chamber, with said conduit means being connected with said passage means and receiving heated exhaust gases therefrom and discharging said heated exhaust gases into the combustion chamber.

8. In a system having an engine with heated exhaust gases issuing therefrom and passage means therefor and having a heater with a fuel combustion chamber; the means for conditioning fuel for burning in the combustion chamber which comprises fuel and air mixing and mixture conveying means opening into the combustion chamber, first conduit means enclosing at least a portion of said mixing and mixture conveying means and fluid connected with said passage means to receive heated exhaust gases therefrom, and second conduit means extending within said portion of said mixing and mixture conveying means open at one end to receive heated exhaust gases from said first conduit means and open at the other end to discharge said heated exhaust gases into the combustion chamber.

9. In an internal combustion heating system which includes an engine provided with an exhaust and a heater provided with means defining a combustion chamber, a fuel conditioning unit comprising a pair of tubular members disposed one within the other to provide two spaces which are separated by the walls of the inner member, perforated partition walls dividing one of said spaces into an air and fuel mixing chamber and an equalizing chamber through which a mixture of fuel and air may be delivered to said combustion chamber from said mixing chamber, means for supplying fuel and air to said mixing chamber, and means for transmitting heated exhaust gases from said engine exhaust through the other of said spaces for the purpose of vaporizing the fuel supplied to said mixing chamber and transmitted through said equalizing chamber to said combustion chamber.

10. In an internal combustion heating system which includes an engine provided with an exhaust and a heater provided with means defining a combustion chamber, a fuel conditioning unit comprising a plurality of tubular members disposed one within the other to provide three concentrically arranged spaces, perforated partition walls dividing the middle one of said spaces into an air and fuel mixing chamber and a pressure

equalizing chamber through which a mixture of fuel and air may be delivered to said combustion chamber from said mixing chamber, means defining an air pressure chamber which surrounds at least a part of said unit and communicates with said mixing chamber, air moving means for supplying air under pressure to said air pressure chamber, means for supplying fuel to said mixing chamber for mixing with the air therein and for transmission with the air through said equalizing chamber to said combustion chamber, and means for transmitting heated exhaust gases from said engine exhaust to said combustion chamber over a path which includes the outer one of said spaces and the inner one of said spaces, thereby to vaporize the fuel supplied to said mixing chamber and transmitted with the air through said equalizing chamber to said combustion chamber.

11. In an internal combustion heating system which includes an engine provided with an exhaust and a heater provided with means defining a combustion chamber having an inlet at one end, means defining an air chamber at said one end of said combustion chamber, air moving means for delivering air to said air chamber, air and fuel mixing means at least partially disposed in said air chamber and provided at said combustion chamber inlet to discharge a mixture of fuel and air into said combustion chamber, means for delivering fuel to said mixing means, said air and fuel mixing means having at least one

air admission opening through which air from said air chamber may be received therewithin for mixing with the fuel, and means communicating with said engine exhaust and disposed within said air chamber for utilizing the heat from the engine exhaust gases to heat the fuel during its mixture with the air in said mixing means and prior to admission of the mixture into said combustion chamber.

12. In an internal combustion heating system which includes an engine provided with an exhaust and a heater provided with means defining a combustion chamber having an inlet at one end, means defining an air chamber at said one end of said combustion chamber, air moving means for delivering air to said air chamber, air and fuel mixing means at least partially disposed in said air chamber and provided at said combustion chamber inlet, said mixing means having an air and fuel mixing space therein which communicates with said air chamber to receive air therefrom and also communicates with said combustion chamber, means for delivering fuel to said mixing chamber, and conduit means communicating with said engine exhaust and having a portion disposed within said mixing space for utilizing the heat from the engine exhaust gases to heat the fuel during its mixture with the air in said mixing means and prior to admission of the mixture into said combustion chamber.

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