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3,092,095

FUEL BURNING HOT AIR HEATER

Filed Oct. 29, 1959

3 Sheets-Sheet 1

Fig. 1

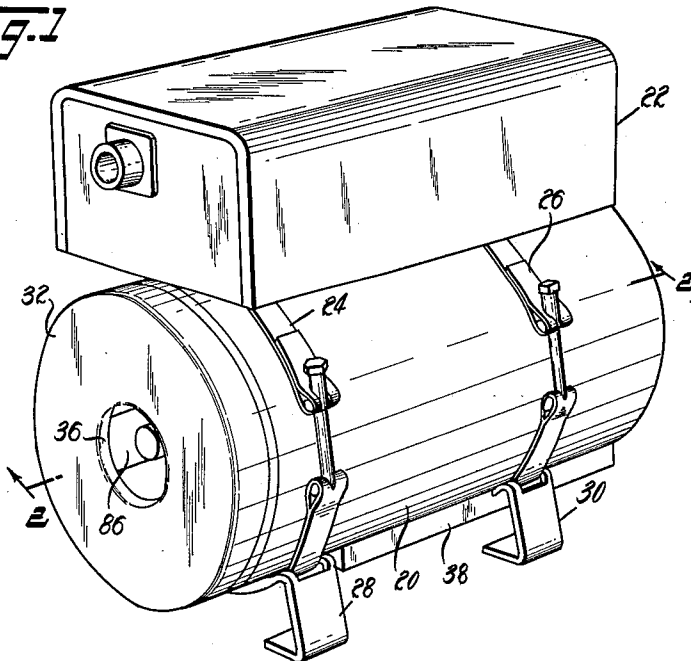
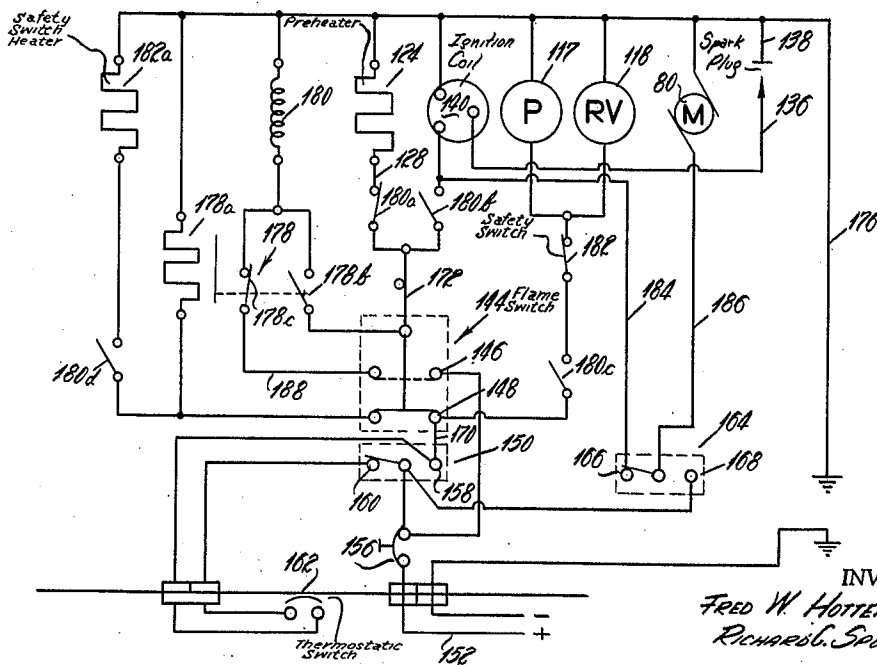


Fig. 5

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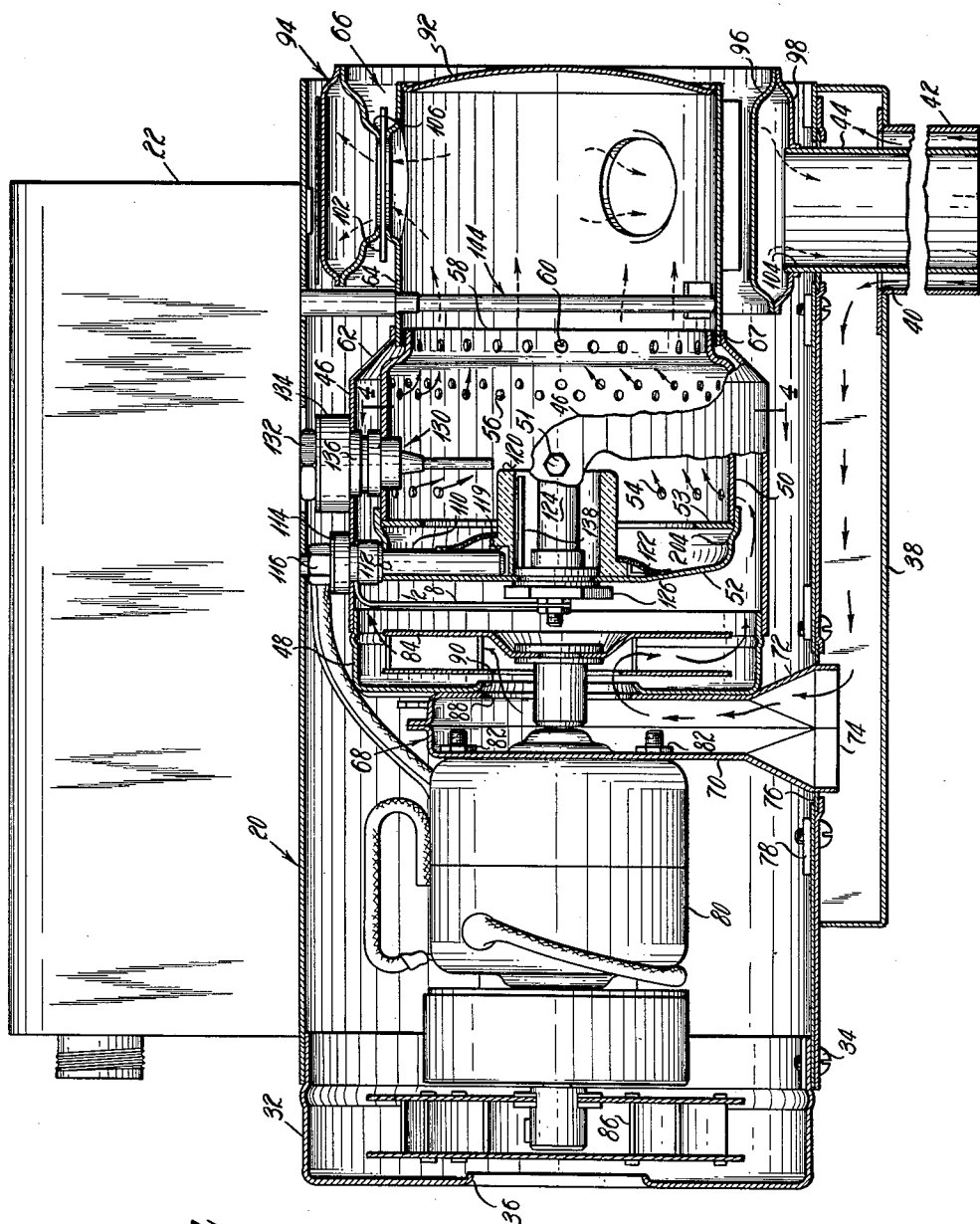


Fig. 2

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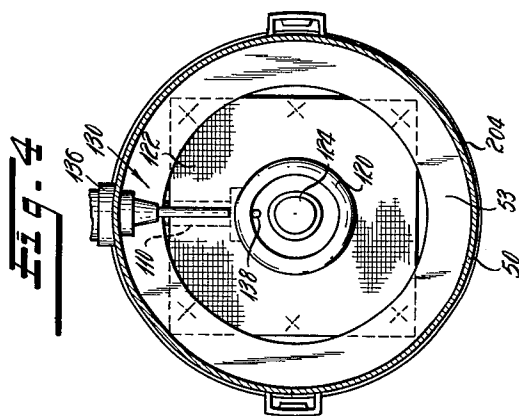
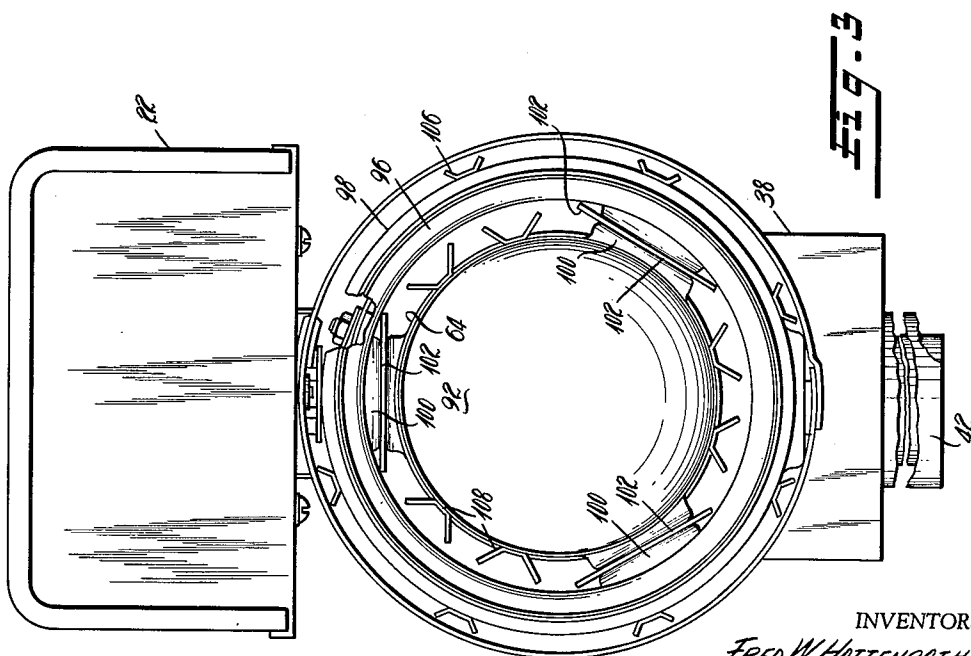
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3 Sheets-Sheet 3



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FUEL BURNING HOT AIR HEATER

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6 Claims. (Cl. 126-110)

This invention relates to heating apparatus and more particularly to forced draft liquid fuel burners which produce heated fresh air.

The heaters of the present invention are usable wherever portability or compactness are important, for example to provide heat for tents, trailers, temporary military shelters or to provide heated air for warming vehicles or aircraft engines prior to starting under conditions of extreme cold or to provide heated air for the interior of automotive vehicles.

Operation in extremely cold weather presents a problem which has been at best only partially solved in the past. In prior units starting the burner under such conditions has been effected only by the use of particularly volatile fuels which are relatively expensive and which are not always readily available coupled with electrical preheating of the fuel or combustion air or both. The power requirements for electrically preheating the substantial quantity of air and fuel necessary to effect starting at very low temperatures in prior units dictated a power source of considerable size, capacity and cost and thus substantially nullified the advantage of the small size, low cost and portability of the heater itself.

With the foregoing considerations in mind, it is an important object of the present invention to provide improved liquid fuel burning air heaters which will start quickly and operate efficiently at temperatures as low as -70° F. without requiring excessive electrical power or special fuels which are needed in prior heaters operating under similar conditions.

It is a further object of the present invention to provide improved liquid fuel burning air heaters in which the combustion air circuit is completely isolated from the fresh air circuit and in which the incoming combustion air is heated by the combustion products to provide operation of the heater under widely varying conditions with a degree of safety and efficiency not obtainable in prior comparable units.

It is a further object of the present invention to provide novel liquid fuel burning air heaters and control apparatus to assure prompt starting and re-starting even under the most adverse conditions.

It is also an object of the present invention to provide improved heaters of the character described in which the prior problem of clogging of the fuel jets or other components of the combustion apparatus is entirely eliminated despite the use of fuels of high viscosity or fuels containing impurities.

It is an additional object of the present invention to provide improved liquid fuel burning air heaters which are compact, lightweight, durable, which have an extended service life and are of relatively simplified low cost construction.

Additional objects and advantages of the invention will become apparent as the description proceeds in connection with the accompanying drawings in which:

FIGURE 1 is a perspective view of the heater constructed in accordance with the present invention;

FIGURE 2 is a central vertical section of the heater taken along line 2-2 of FIGURE 1;

FIGURE 3 is an end elevation of the heater looking from the right in FIGURE 2;

FIGURE 4 is a transverse section taken along line 4-4 of FIGURE 2; and

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FIGURE 5 is a circuit diagram showing the electrical components of a typical control circuit.

Referring now more particularly to the drawings, the principal operating components of the heater are enclosed in a cylindrical barrel 20 on which is supported a rectangular housing 22 enclosing the electrical control components. Legs 28 and 30 carried by straps 24 and 26 support the entire unit. A cup-shaped cover plate 32 is detachably secured by screws 34 to one end of the housing 20 and is provided with a central circular aperture 36 through which the fresh air to be heated is drawn. The opposite end of the cylindrical housing 20 is open to provide an outlet for the fresh air after it has been heated.

A box-like housing 38 is secured to the lower surface of the barrel by suitable means not shown and is provided with an opening 40 adjacent one end which receives a pipe 42 through which the incoming combustion air is directed. Concentrically mounted within the pipe 42 is an additional pipe 44 through which the products of combustion exit from the heater.

The combustion chamber is of generally cylindrical configuration and is provided with an outer cylindrical body member 46 to one end of which a cup-shaped cover plate 48 is sealingly secured and an inner substantially cylindrical section comprising front and rear members 50 and 52, which are positioned concentrically of the housing 46 by brackets (not shown) into which machine screws 51 are threaded, and are welded together. The plate 48 is provided with radial struts, not shown, for attachment to the cylindrical casing 20. A radial baffle 53 is welded to the end of member 50 for a purpose to appear. The main cylindrical portion of the inner body member 50 is provided with first and second sets of air admitting openings 54 and 56 and the forward end portion of the body member 50 is provided with a neck 58 having a final set of air admitting openings 60. The forward end of the outer housing member 46 is provided with a neck 62 welded to the main cylindrical body member 64 of the heat exchanger assembly indicated generally at 66.

An annular space 67 is provided between neck 58 and member 64 for the passage of the remainder of the combustion air.

Secured to the cap member 48 at the inlet end of the combustion chamber is a combustion air shell assembly 68 comprising stamped sheet metal members 70 and 72 which are peripherally welded together to form an airtight structure. The assembly 68 is open at one side to provide an inlet opening 74 in free communication with the interior of the inlet air housing 38. An annular flange 76 welded to the air duct assembly 68 is held by suitable clamps 78 to the wall of the main cylindrical body member 20 to prevent leakage of air between the interior of the chamber 38 and the interior of the main cylindrical portion of the heater. A fractional horsepower electric motor 80 is tightly secured by nuts 82 to the shell assembly 68 and drives both the combustion air blower 84 mounted within the end cover member 48 of the combustion chamber and the fresh air blower 86 positioned adjacent the main fresh air inlet opening 36. Communication between the interior of the shell assembly 68 and the interior of the combustion chamber is effected through aligned openings 88 and 90 formed on the respective members 72 and 48.

The heat exchange assembly 66 comprises the tubular member 64 to which an end closure cap 92 is welded and an annular conduit assembly 94 comprising inner and outer stamped sheet metal members 96 and 98 welded together at their marginal edges to form a gas tight structure. The combustion gases pass from the interior of the tubular member 64 to the interior of the annular

duct assembly 94 through a plurality of short intermediate radially extending ducts 100 formed integrally with the tubular member 64 and the inner duct member 96. To improve the heat transfer efficiency, heat transfer fins 102 are welded to each of the ducts. While three such ducts are illustrated, their number can be varied as desired and experience has shown that a single duct will provide satisfactory and efficient operation. The combustion gases exit from the annular duct assembly through the exhaust tube 44, the inner end of which is welded to the flange surrounding an opening 104 formed in the outer duct member 98. To further enhance the heat transfer efficiency, additional fins 106 are welded to the outer surface of the outer duct member 98 and similar fins 108 are welded to the outer surface of the tubular member 64 between the ducts 100.

The combined fuel feed system, the ignition and pre-heating system which form an important part of the invention will now be described in detail with particular reference to FIGURES 2 and 5 of the drawings. Fuel is supplied to the combustion chamber through a pipe 110 welded as at 112 to the members 52 and which extends along the inner surface of the member 52. A connecting fuel line is suitably mounted on the combustion chamber casing 46 by a seal 114 and a nut 116. A fuel pump 117 and a fuel valve 118 (FIGURE 5) are provided to assure positive controlled delivery of the fuel. The inner terminal end of the supply pipe 110 is received in a pocket 119 formed in one side of an annular ceramic wick 120 which is clamped to the flat base of the combustion chamber end member 52 by a screen 122 tack-welded in place. Mounted concentrically within the wick 120 is an electrical heater element 124 which extends substantially the full length of the wick 120 and is sealingly secured to the member 52 by a nut 126. The heater element 124 is connected to a suitable source of power not shown located within the housing 22 by a conductor 128. The preheater 124 may take a number of other forms. For example, it may be in the form of a loop of heavy wire or rod encircling the base of the wick 120. Regardless of its form, the essential function of the preheater is to effect localized heating of the ceramic wick 120 and combustion chamber members 50 and 52 since it is neither necessary nor desirable in the unit of the present invention to provide for heating of other components of the assembly. The novel ignition assembly of the present invention comprises an electrode assembly 130 extending through a collar 131 welded to the member 50 and sealingly mounted on the combustion chamber member 46 by a nut 132 which compresses sealing members 134 and 136 to provide a gas tight mounting assembly. The igniter is completed by a grounded rod 138 which extends along the inner wall of the wick 120 and is mounted on the base of the preheater 124. The terminal portions of the electrode 130 and the rod 138 are so positioned that when the former is energized a spark is established directly across the adjacent rim portion of the wick 120 to thus establish a glowing pilot area which, when coupled with the pre-heating of the wick, assures positive ignition even under the most adverse conditions and with substantially any type of fuel.

A typical electrical control circuit for the heater is shown in FIGURE 5.

For purposes of illustration, the circuit of FIGURE 5 is shown as a 24 volt D.C. circuit. However it will be understood that the circuit can readily be modified for 115 volt A.C. operation by the incorporation of a suitable step down transformer and a rectifier without changing the essential operation of the circuit or the nature of the components employed in the circuit.

The circuit of FIGURE 5 is effective to control in predetermined sequence the operation of the preheater 124, the ignition coil 140 which in turn controls the energization of the spark assembly 130, the fuel pump 117,

the main fuel valve 118 and the blower motor 80. One of the essential elements of the control circuit is the flame switch 144 which is of conventional construction and, as shown in FIGURE 2, is mounted to position its heat sensitive element in the main combustion chamber. The flame switch has two sets of contacts 146 and 148, the former being closed when the flame switch is heated and the latter being closed when the flame switch is cold. The manual controls include a three position switch assembly 150 which is connected to the main power lead 152 by a conventional circuit breaker 156. Switch 150 is provided with contact 158 for manual operation and a contact 160 which, when closed, connects a conventional thermostat 162 to the circuit to provide automatic operation. A second manual switch 164 is connected in series with the blower motor 80 and is provided with two contacts 166 and 168, the former being normally closed to permit automatic operation of the heater cycle and the latter being closed when it is desired to provide ventilation only.

Assuming that the system is de-energized and that the contact 160 in the manual switch 150 is closed and that the thermostat calls for heat, preheater 124 will be energized through a circuit including lead 170, contacts 148 of the flame switch 144, lead 172, initially closed relay contact 180a and ground lead 176.

After a predetermined time interval which can be set to meet existing requirements, a switch heater element 178a which is energized simultaneously with preheater 124 will close contacts 178b of the timer switch indicated at 178 and thus energizing relay coil 180 which opens relay contact 180a to de-energize the preheater 124 and closes relay contacts 180b, 180c and 180d. When the relay contacts 180d close, the heater element 182a of the second time relay switch 182 is energized to open the normally closed switch contacts after a predetermined interval. The closing of relay contacts 180b energizes the ignition coil 140 and thus the spark assembly 130. The closing of contacts 180c energizes through the normally closed switch contacts 182, the fuel pump 117 and opens the normally closed regulator valve 118. When contacts 180b are closed, the blower motor 80 is also energized through lead 184, manual switch 164 and lead 186. If ignition is promptly initiated as will almost invariably be the case, the flame switch 144 will be heated sufficiently to open the contacts 148 and close the contacts 146 to thus close the normal run cycle circuit. The opening of contacts 148 de-energizes the heater elements 178a and 182a of the timer switches. When the heater element 178a is de-energized, the contacts 178b of the switch 178 are opened and the contacts 178c of the same switch are closed. The relay coil 180 will continue to be energized through the contacts 146, the lead 188 and contacts 178c of switch 178. The remainder of the circuit will be unaffected, thus continuing the operation of the ignition coil, the fuel pump, the regulator valve and the blower motor.

In the event of failure of the ignition, the flame switch will remain in a position in which contacts 148 are closed and after a predetermined interval the heater elements 182a will become sufficiently heated to open contacts 182 thus de-energizing the fuel pump and permitting the fuel valve to close. However the blower motor will continue to run to assure adequate purging of the system. If desired, the system may be provided with a no-start signal light to indicate that manual initiation of re-start cycle is required.

When the thermostat 162 no longer calls for heat, the fuel pump 117 will be de-energized and the fuel valve 118 will be permitted to close. However for a predetermined time, the flame switch 144 will hold contacts 146 closed and the ignition coil, spark plugs, and blower motor will continue to operate thus purging the system of all unburned fuel. When the flame switch is sufficiently cooled, contacts 146 will be opened and the system will be restored to its initial position. At any

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time during the purging cycle the heater can be re-started thus eliminating delays associated with prior units.

It will be noted that when the thermostat 162 calls for heat or when the switch 150 is closed to energize the circuit if the thermostat is not being used, the onnly portion of the apparatus put into operation is the preheater 124. The power requirements of the preheater are relatively small, for example only a fraction of the power requirements required in prior units in which either the fuel supply or the air or both were preheated. The pre-heater, after it has been energized for about a minute, will heat the wick 120 and the surrounding metallic elements to a temperature of about 100-150° F. When this relatively small area has been heated, the fuel and air flow are started simultaneously, fuel is immediately vaporized, the adjacent air is warmed and ignition is easily effected, particularly because of the establishment of the hot pilot area at the rim of the wick between the ends of the spark electrode and the rod 138. Combustion is maintained by preheating the combustion air by exhaust gases as the two pass in heat exchange relation through the pipes 40 and 44 which may be made of any desired length. The extent of the preheating of the incoming combustion air is a function of the length of the pipes 40 and 44 which would depend upon the particular environment in which the heater is used. In all cases, however, the outer terminal portions of the pipes will be juxtaposed so that they will be exposed to the same static and dynamic pressure head. This construction entirely eliminates variations in the supply of combustion air.

As pointed out above, the combustion air and circulating air pass through completely divorced circuits. Thus the danger of commingling and backfire and the possibility of introducing combustion gases into the space to be heated is entirely eliminated. It is also to be noted that despite the isolation of the two circuits, the circulation of heated warm air as well as combustion air is effected with a single blower motor thus effecting substantial economies over prior units.

The problem of clogging associated with prior units is entirely eliminated by the present construction since the fuel does not flow through a ceramic wick 120 but rather flows over the surface of the ceramic wick.

Actual tests have shown that the burner will operate in any position because of the unique fuel distribution system. Normally the burner will be operated in the position shown in FIGURE 2. Any fuel in excess of that distributed by the wick 120 will initially fall into a pocket 204 formed between the combustion chamber end plate 52 and an annular overflow baffle 53. As soon as combustion is established, this excess fuel will be heated and vaporized and burned.

Thus it will be seen that the above stated object and advantage of the invention have been fully attained by the above disclosed embodiment of the present invention.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A fuel burning hot air heater comprising an elongated casing having an inlet opening at one end for the admission of fresh air and an outlet opening at its opposite end for the delivery of heated air, a combustion chamber within said casing, means forming an air pre-heating chamber externally of said casing in the region opposite said combustion chamber, said air pre-heating chamber having a first conduit for the admission of air adjacent said opposite end of said casing, means including a second con-

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duit for connecting the interior of said combustion chamber to the interior of said air chamber, a heat exchanger within said casing adjacent the outlet end thereof, means connecting the outlet end of said combustion chamber to the interior of said heat exchanger, means including a third conduit extending through said air chamber and in heat exchange relation with said first conduit connecting the outlet end of said heat exchanger to the exterior of said casing, the outer terminal portions of said first and third conduits being juxtaposed, and a pair of motor driven blowers positioned adjacent the inlet end of said casing and the inlet end of said combustion chamber, respectively, to cause air to move separately through said casing and said combustion chamber.

2. A fuel burning hot air heater comprising an elongated casing open at one end for the admission of fresh air and open at its opposite end for the delivery of heated air, a combustion chamber assembly within said casing, means forming an air chamber externally of said casing in heat exchange relation with a portion of said casing surrounding said combustion chamber assembly, first conduit means connecting the interior of said combustion chamber assembly with the interior of said air chamber, a heat exchanger within said casing adjacent the outlet end thereof, means connecting the outlet end of said combustion chamber assembly to the interior of said heat exchanger, second conduit means connecting the outlet end of said heat exchanger to the exterior of said casing through said air chamber, third conduit means connecting the interior of said air chamber with the atmosphere, said second and third conduit means being positioned in heat exchange relation and the terminal portions of said second and third conduit means being juxtaposed, a drive motor within said casing, and a pair of blowers driven by said motor and positioned adjacent the inlet end of said casing and the inlet end of said combustion chamber, respectively, to cause air to move separately through said casing and said combustion chamber.

3. The combination according to claim 2 wherein said first conduit means is mounted directly on said drive motor and is provided with aligned lateral openings through which the motor shaft extends in free clearance relation.

4. A fuel burning air heater comprising an elongated casing having an inlet opening at one end for the admission of fresh air and an outlet opening at the other end for the delivery of heated air, a cup-shaped combustion chamber member within said casing, means forming an air pre-heating chamber externally of said casing in heat exchange relation with the portion of said casing opposite said combustion chamber member, means including a plurality of sets of openings in the wall of said combustion chamber member connecting the interior of said combustion chamber member to the air pre-heating chamber, a heat exchanger within said casing, means connecting the outlet end of said combustion chamber to the interior of said heat exchanger, conduit means extending through said air pre-heating chamber and connecting the outlet of said heat exchanger to the atmosphere, an annular fuel distributing wick carried by the bottom wall of said combustion chamber member in a relatively protected zone upstream of the majority of said air inlet openings, a fuel supply pipe having a terminal portion within said combustion chamber member for delivering fuel to the outer surface of said wick adjacent said bottom wall of said combustion chamber member, an electrical pre-heater adjacent said wick for heating said wick and the adjacent portion of said combustion chamber member, means for generating a spark adjacent the opposite end of said wick, a drive motor mounted in said casing, and a pair of blowers driven by said drive motor and positioned, respectively to cause fresh air to move through said casing and combustion air to be delivered to said combustion chamber member through said openings.

5. In a fuel burning air heater, a cup-shaped combus-

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tion chamber assembly having an annular side wall provided with sets of air admitting openings spaced axially of said side wall and an imperforate bottom wall, an annular fuel distributing wick mounted on said bottom wall in a relatively protected zone upstream of the majority of said air inlet openings, a fuel supply pipe having a terminal portion extending along said imperforate bottom wall of said combustion chamber for delivering fuel to said wick adjacent said combustion chamber bottom wall, an electrical preheater adjacent said wick for heating said wick and the adjacent portion of said combustion chamber, means for generating a spark adjacent said wick, a casing surrounding said combustion chamber forming a passage through which fresh air flows to be heated by passage along said combustion chamber, a conduit secured to the exterior of said casing and extending axially along said casing a substantial portion of the length thereof in heat exchange relation with the portion of said casing opposite said combustion chamber, first passage means independent of the fresh air passage connecting one end of said conduit to said openings, second passage means connecting the opposite end of said conduit to the atmosphere,

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and a blower in said first passage means for moving air from the atmosphere through said conduit for delivery to said openings, said air being heated by its passage through said conduit.

6. The combination according to claim 5 wherein the spark generating means comprises a pair of spark generating electrodes the adjacent ends of which terminate closely adjacent a portion of said wick to produce a spark effective to heat said portion of said wick to facilitate ignition of the fuel thereat.

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