June 15, 1948. G. J. FAIRBANKS 2,443,556

INTERMITTENT COMBUSTION HOT AIR HEATER

Filed Feb. 15, 1945 3 Sheets-Sheet 1

Fig. 1.

Inventor:
Gordon J. Fairbanks
By Williams, Bradbury & Hinkle
Attorneys.

June 15, 1948. G. J. FAIRBANKS 2,443,556

INTERMITTENT COMBUSTION HOT AIR HEATER

Filed Feb. 15, 1945 3 Sheets-Sheet 2

Fig. 2.

Fig. 3.

Inventor:
Gordon J. Fairbanks
By Williams, Bradbury & Hinkle
attorneys.

June 15, 1948. G. J. FAIRBANKS 2,443,556

INTERMITTENT COMBUSTION HOT AIR HEATER

Filed Feb. 15, 1945 3 Sheets-Sheet 3

Patented June 15, 1948 2,443,556

UNITED STATES PATENT OFFICE

2,443,556

INTERMITTENT COMBUSTION HOT-AIR HEATER

Gordon J. Fairbanks, Glenview, Ill., assignor to Stewart-Warner Corporation, Chicago, Ill., a corporation of Virginia

Application February 15, 1945, Serial No. 577,955

5 Claims. (Cl. 126—116)

1

This invention relates to internal combustion heaters and it is concerned with providing a simple, rugged, and compact structure adapted for use in various situations.

One object of the invention is to provide a new and improved heater having an igniting device arranged for continuous operation whenever the heater is working and including means to render the ignition reliable at all times and especially at high altitudes when the heater is employed in aircraft.

Another object of the invention is to provide a new and improved heater of relatively simple construction and of the rapid cycling type in which a single thermostat controls the operation by controlling the fuel supply.

A further object of the invention is to provide a new and improved heater in which a single motor serves to operate a pump for supplying fuel and a make and break device for the continuously operating igniter mechanism.

Other objects and advantages of the invention will appear from the following description taken in connection with the drawings, in which:

Fig. 1 is a longitudinal sectional view of a heater embodying this invention showing the fuel pump motor, the ignition coil and the make and break device therefor together with a circuit diagram of the electrical control;

Fig. 2 is a rear elevation of the motor as compared with Fig. 1, showing the fuel pump associated therewith;

Fig. 3 is an end elevation of the motor and pump taken as indicated at line 3—3 on Fig. 2;

Fig. 4 is a vertical sectional view taken as indicated at line 4—4 on Fig. 2;

Fig. 5 is a detail section of the pump mechanism taken substantially as indicated at line 5—5 of Figs. 3 and 4;

Fig. 6 is an elevation partly in section as indicated at line 6—6 on Fig. 4;

Fig. 7 is a detail section taken as indicated at line 7—7 on Fig. 5.

The drawing illustrates a type of internal combustion heater adapted to burn gasoline or similar liquid fuel mixed with air and to transfer its heat to a stream of ventilating air by means of a heat exchanger. For simplicity of operation and also for reliability, this heater is provided with electrical igniting means which remains in operation continuously whenever the heater is in service; and the fuel is supplied by means of a motor driven pump working at constant pressure and thus supplying fuel which is available to the burner at a substantially definite rate whenever the burner operates. A heater of this type may therefore be thermostatically controlled in accordance with the temperature of the heated air at the outlet so that the burner will stop working whenever the temperature of this air attains a

2

satisfactory maximum and will be placed in operation again as soon as the temperature drops to a predetermined minimum. The maximum and minimum limits may be within a fairly close range, resulting in frequent operation or cycling of the heater. This result is secured by permitting the fuel pump to run continuously but arranging a thermostat to control a solenoid operated valve in the fuel line so that when the maximum temperature is attained the fuel is held in the feed pipe and instantly available when the temperature drops to the minimum limit. It is found that when a high tension spark is employed for igniting fuel under these conditions it is not always effective instantly upon closing of the electric circuit; apparently the electrodes themselves must become heated by the spark to assist in igniting the fuel and this may require 10 or 15 seconds. Therefore, it is found preferable to operate the spark continuously even when the fuel valve is closed and the burner is not working; this insures instant ignition of the fuel when it is turned on again by the thermostat. It also has been found that the ordinary buzzer type of interrupter does not insure a reliable spark, especially at high altitudes, and the present device therefore includes a cam driven make and break mechanism which will produce an effective reliable spark under a wide range of conditions. Since the fuel pump is to be operated continuously and the spark mechanism is to be kept working even when the burner itself is idle, it is found convenient and desirable to operate the fuel pump and the make and break device by means of the same motor.

As shown in the drawings, the heater itself includes an outer cylindrical shell or housing 10, having an inlet 12 for ventilating air and an outlet 14 through which the heated air is discharged either into a room or into suitable conduits by which it is carried to the space or spaces to be heated. Spaced within the shell 10 there is mounted a smaller shell or plenum 16 having an inlet 18 for the portion of the air which is to be employed for combustion and within the plenum 16 there is secured a conical combustion chamber 20 having perforations 22 in its wall through which the combustion air is admitted. At the smaller end of the conical member 20 there is a threaded sleeve 24 in which the fuel nozzle 26 is secured. The mixture of fuel and air thus provided in the combustion chamber 20 is ignited by means of a spark plug 28 having a single electrode 30 disposed within one of the holes 22 in the conical wall 20 so that the spark jumps from the electrode to the edge of the hole and is carried into the combustion chamber in a U-shape because of the force of the air current flowing into the combustion chamber through the hole in which the electrode 30 is located. As a result,

the ignition takes place in a zone somewhat removed from the electrode 30 which tends to reduce fouling of the electrode by carbon deposit.

The heat exchanger illustrated in Fig. 1 is of the spiral type more fully shown and described in the copending application of William C. Parrish, Ser. No. 490,162 filed June 9, 1943, now Patent No. 2,432,929, granted December 16, 1947, in which the products of combustion issuing from the conical chamber 20 flow into a cylindrical space 32 which is closed by a wall 34 at the end opposite the combustion chamber 20 but which connects laterally with a spirally formed chamber having spaced convolutions seen at 36 and 38 in Fig. 1. These convolutions are formed by the spaced spiral walls of an air space 40 extending longitudinally of the heater so that the ventilating air entering at 12 flows longitudinally through the spiral air space to the outlet 14 and absorbs heat from the walls of the cylinder 32 and its connected spiral portions 36 and 38. The products of combustion leave the outermost portion of the spiral through an exhaust passage 42.

The liquid fuel is supplied to the nozzle 26 by means of a diaphragm pump 44 which is shown in some detail in Fig. 5. A supply pipe 46 leads to the inlet valve chamber 48 of the pump so that downward movement of the diaphragm 50 draws fuel into the pump chamber 52 above the diaphragm and upward movement of the diaphragm expels liquid through the outlet valve chamber 54 and feed pipe 56, the latter being connected to an elbow fitting 58 mounted in the housing 10 of the heater and connected inside the housing with a pipe 60 leading to the nozzle 26. The pump diaphragm 50 is actuated by rotary cam 62 which may be of eccentric form and which engages a rocker arm 64 pivoted at 66 in the lower half 68 of the pump casing. The diaphragm 50 is normally urged upwardly by a coil spring 70 seated on a shoulder 72 and within the casing 68, and the diaphragm is provided with a stem 74 by which it is actuated downwardly. The stem 74 has a one way drive connection to the rocker arm 64 in the form of a member 76 carried on the pivot 66 and engaged by a lug 78 extending from the rocker arm 64. As one end of the arm 64 is moved upwardly by the cam 62 the opposite end carrying the lug 78 swings the member 76 positively in downward direction, and the member 76, being engaged with the stem 74, as shown in Fig. 7, pulls the stem 74 and diaphragm 50 downward in opposition to the spring 70. A light spring 80 tends to maintain the rocker arm 64 in contact with the cam 62, and return movement of the diaphragm in upward direction, which is its pumping stroke, is effected by the spring 70. The nozzle 26 is thus supplied with fuel at a pre-determined pressure which depends upon the strength of the spring 70. But if the feed pipe 56 is closed, preventing the discharge of fuel from the pump and blocking movement of the diaphragm 50, the rocker arm 64 will continue to be operated by the motor driven cam 62 while the arm 76 will remain stationary as long as the diaphragm is blocked at the lower limit of its range of movement. The pipe 79 is an atmosphere vent leading overboard.

The cam 62 is pinned to a shaft 82 as shown in Fig. 4 and this shaft carries a worm gear 84 meshing with a worm 86 on the shaft 88 of the electric motor 90. A source of electrical energy indicated as a battery at 92 on Fig. 1 has one terminal grounded and has its opposite terminal connected through a switch 94 with a feed wire 96 extending to one contact member 98 of a thermostat indicated generally by the numeral 100. The thermostat is located in the air outlet 14 of the heater so as to be responsive to the temperature of the air delivered by the heater and its cooperating contact 102 is connected by a wire 104 to a solenoid-operated valve 106. The feed wire 96 has a branch 96' connected to one terminal of the motor 90 and the other terminal of the motor is grounded so that the motor circuit is completed whenever the switch 94 is closed and the motor 90 runs continuously and independently of the thermostat. The solenoid valve 106 may be constructed so that it is normally held open as by means of a spring and closed when its solenoid is energized. Then when the burner is operating, the temperature of the air issuing at 14 will rise to a point at which the contacts 98 and 102 of the thermostat are engaged, energizing the solenoid to close the valve 106 and cutting off the fuel supply to the burner nozzle 26. Then when the air issuing at 14 has cooled sufficiently to separate the contacts 98 and 102, the circuit through solenoid 106 will be opened, permitting the valve to open and feed fuel to the burner nozzle 26. Since the motor continues to operate the cam 62 and the rocker arm 64, and the feed pipe 56 is kept filled with fuel even while the valve 106 is closed, the opening of the valve causes the burner to resume operation instantly.

As already mentioned, the reliable operation of the heater, particularly in high altitudes, requires a fat and long spark at the electrode 30 and to insure a spark of this quality it is preferable to employ a mechanically actuated make and break mechanism. As shown in Figs. 1 and 6, this consists of a lever 108 pivoted at 110 in a casing 112 which encloses also a cam 114 carried on the end of the shaft 82. A follower 116 on the lever 108 engages the cam 114 and a contact element 118 at the opposite end of the lever cooperates with a fixed contact 120 carried by a conductor arm 122 from which a lead wire 124 extends to one terminal 126 of the primary winding of the spark coil denoted generally at 128; the other terminal 127 is connected by a wire 129 to the battery or other current source at 92. A spring 130 maintains engagement of the follower 116 with the cam 114 so that as the shaft 82 rotates the contacts 118 and 120 are alternately engaged and separated, producing the desired surges of current in the secondary winding of the spark coil 128. One terminal 132 of the secondary winding is grounded and the other terminal is connected by a wire 134 to the electrode 30 of the spark plug 28. Whenever the switch 94 is closed it serves not only to energize the motor 90 and start the fuel pump 44 in operation, but it also closes the circuit through the primary winding of the spark coil 128 except as it may be opened by the make and break lever 108, and since the operation of the motor 90 causes continuous rotation of the cam 114 the lever 108 is actuated to close the primary circuit of the spark coil at frequent intervals, producing an effective and reliable spark at the electrode 30. If the solenoid valve 106 is open the fuel will flow to the burner nozzle 26 and be ignited, raising the temperature of the ventilating air flowing through the heater until it is sufficient to actuate the thermostat 100 and close the fuel valve 106. This may

occur at ten or fifteen second intervals under some conditions or at much longer intervals where only a moderate supply of heat is required. Preferably as shown in the drawings a condenser 140 is connected across the contacts 118 and 120 to suppress arcing and increase the heat of the spark at the spark plug 28. But for all conditions this arrangement provides a relatively simple mechanism which is comparatively inexpensive to manufacture and which should require a minimum of servicing to keep it in operative condition.

While there is shown and described herein certain structure illustrating the invention, it is to be understood that the invention is not limited thereto or thereby but may assume numerous other forms and includes all modifications, variations and equivalents coming within the scope of the following claims.

I claim:

1. In combination with a liquid fuel burner, a pump connected to supply fuel thereto, spring means actuating the pump in its pumping stroke, a cam for actuating the pump in its return stroke, igniting means for the burner including a spark coil and a make and break device, a cam for actuating said make and break device, a shaft journalled for rotation with both cams secured to said shaft, a continuously operating motor and speed reducing gearing connecting said motor to drive said shaft, means including a heat exchanger for directing a flow of ventilating air in heat exchange relation to hot gases from said burner, a fuel valve interposed between said pump and the burner, and temperature responsive means subject to the temperature of the air discharged from the heat exchanger and operative to control the opening and closing of said valve.

2. In combination with a liquid fuel burner, a pump connected to supply fuel thereto and including a reciprocating member, spring means to actuate said member in its pumping stroke and a cam to actuate said member in its return stroke, igniting means including a spark coil and a cam actuated make and break device therefor, a continuously operating motor connected to drive the pump actuating cam and the cam of the make and break device, means including a heat exchanger for directing a flow of ventilating air in heat exchange relation to hot gases from said burner, a solenoid valve interposed in the connection between the pump and the burner, a source of electrical energy and connections therefrom to the motor, the igniting means and the solenoid valve, and a thermostatic switch device actuating said valve independently of the motor and igniting means and responsive to changes in the temperature of the air discharged from the heat exchanger.

3. In combination with a liquid fuel burner, means including a pump connected to supply liquid fuel thereto, spring means arranged to actuate the pump in its pumping stroke, a cam arranged to actuate the pump in its return stroke, a continuously operating motor connected to drive said cam, a fuel valve interposed in the connection between the pump and the burner, igniting means for the burner operative whenever said fuel valve is opened, means including a heat exchanger for directing a flow of ventilating air in heat exchange relation to hot gases from said burner, and means responsive to the temperature of the air discharged from the heat exchanger and operative to close said fuel valve at a predetermined temperature and to reopen said valve at a predetermined lower temperature, thereby causing the burner to operate intermittently.

4. In combination with a liquid fuel burner, means including a pump connected to supply liquid fuel thereto, driving means to actuate the pump including yielding means operative to cause the pumping stroke and a continuously actuated cam which effects the return stroke, a fuel valve interposed in the connection between the pump and the burner and adapted when closed to block the flow of liquid fuel from the pump to the burner while the cam continues to be actuated, continuously operative igniting means for the burner, means including a heat exchanger for directing a flow of ventilating air in heat exchange relation to hot gases from said burner, and means responsive to the temperature of the air discharged from the heat exchanger and operative to close said fuel valve at a predetermined temperature and to reopen said valve at a predetermined lower temperature, thereby causing the burner to operate intermittently.

5. In combination with a liquid fuel burner, means including a pump connected to supply liquid fuel thereto and including a reciprocating member, driving means to actuate the pump comprising spring means operative to move said reciprocating member in pumping direction, a continuously running motor with a one way drive device actuated thereby and operative to move said reciprocating member in the opposite direction and to stress said spring means, an igniter for the burner and means operated by said motor for energizing said igniter continuously, a fuel valve interposed in the connection between the pump and the burner and adapted when closed to block the flow of liquid fuel from the pump to the burner while said motor continues to actuate the one way drive device, means including a heat exchanger for directing a flow of ventilating air in heat exchange relation to hot gases from said burner, and means responsive to the temperature of the air discharged from said heat exchanger and operative to close said fuel valve at a predetermined temperature and to reopen said valve at a predetermined lower temperature, the continuous operation of said motor serving to condition the pump and igniter to insure prompt resumption of operation of the burner whenever said fuel valve is opened.

GORDON J. FAIRBANKS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 21,515	Karsel	July 23, 1940
1,263,654	Doble	April 23, 1918
1,733,792	Good	Oct. 29, 1929
1,931,083	Rodler	Oct. 17, 1933
1,957,669	Rockwell	May 8, 1934
2,137,581	Myler	Nov. 22, 1938
2,146,397	Kommer	Feb. 7, 1939
2,308,888	McCollum	Jan. 19, 1943
2,330,298	McCollum	Sept. 28, 1943
2,396,655	Heymann	Mar. 19, 1946