

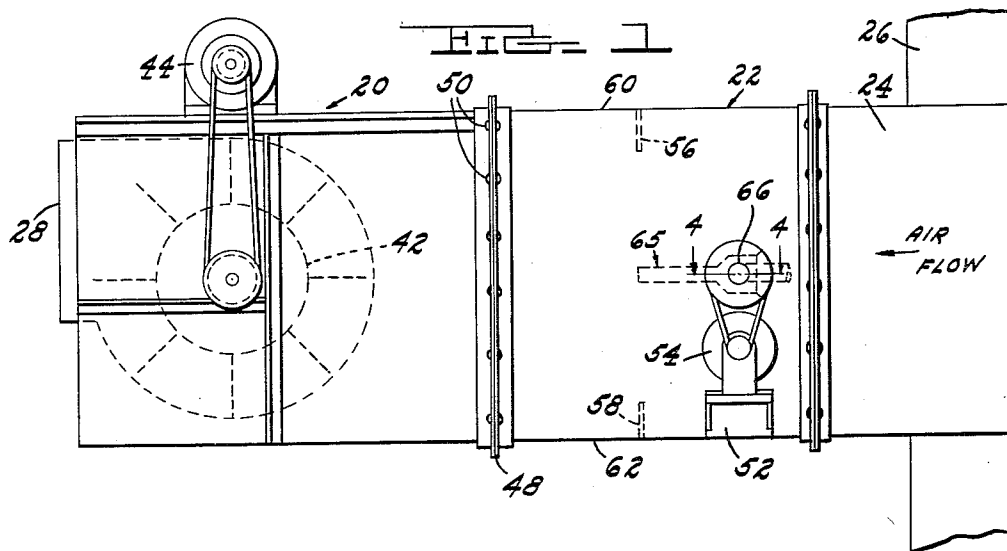
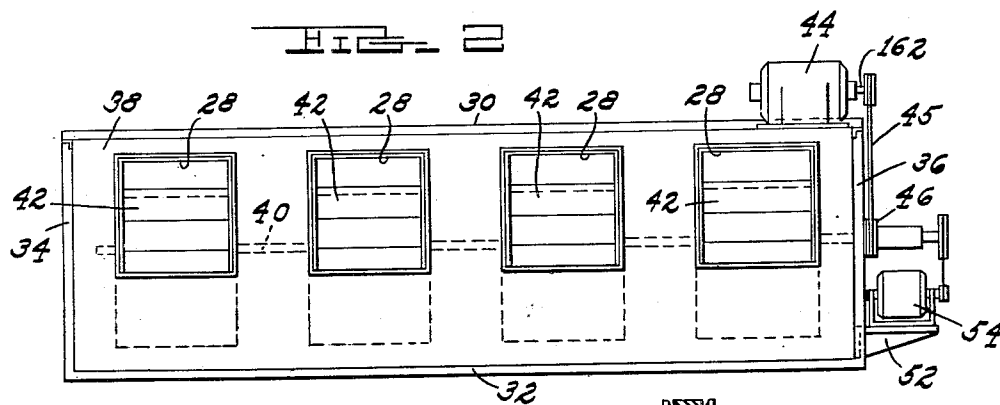
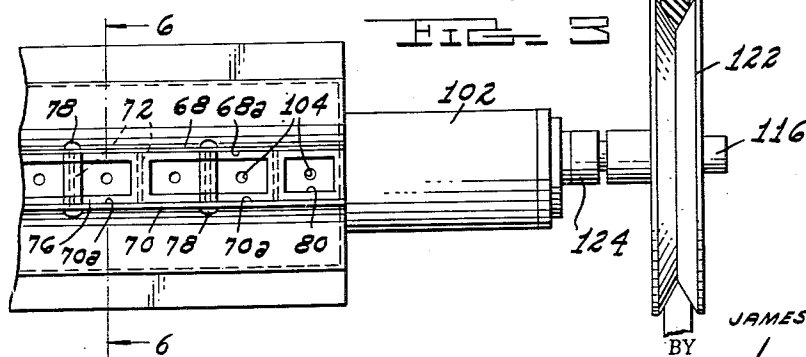
May 27, 1958

J. A. HARRISON
MAKE-UP AIR HEATER

2,836,409

Filed July 27, 1956

2 Sheets-Sheet 1



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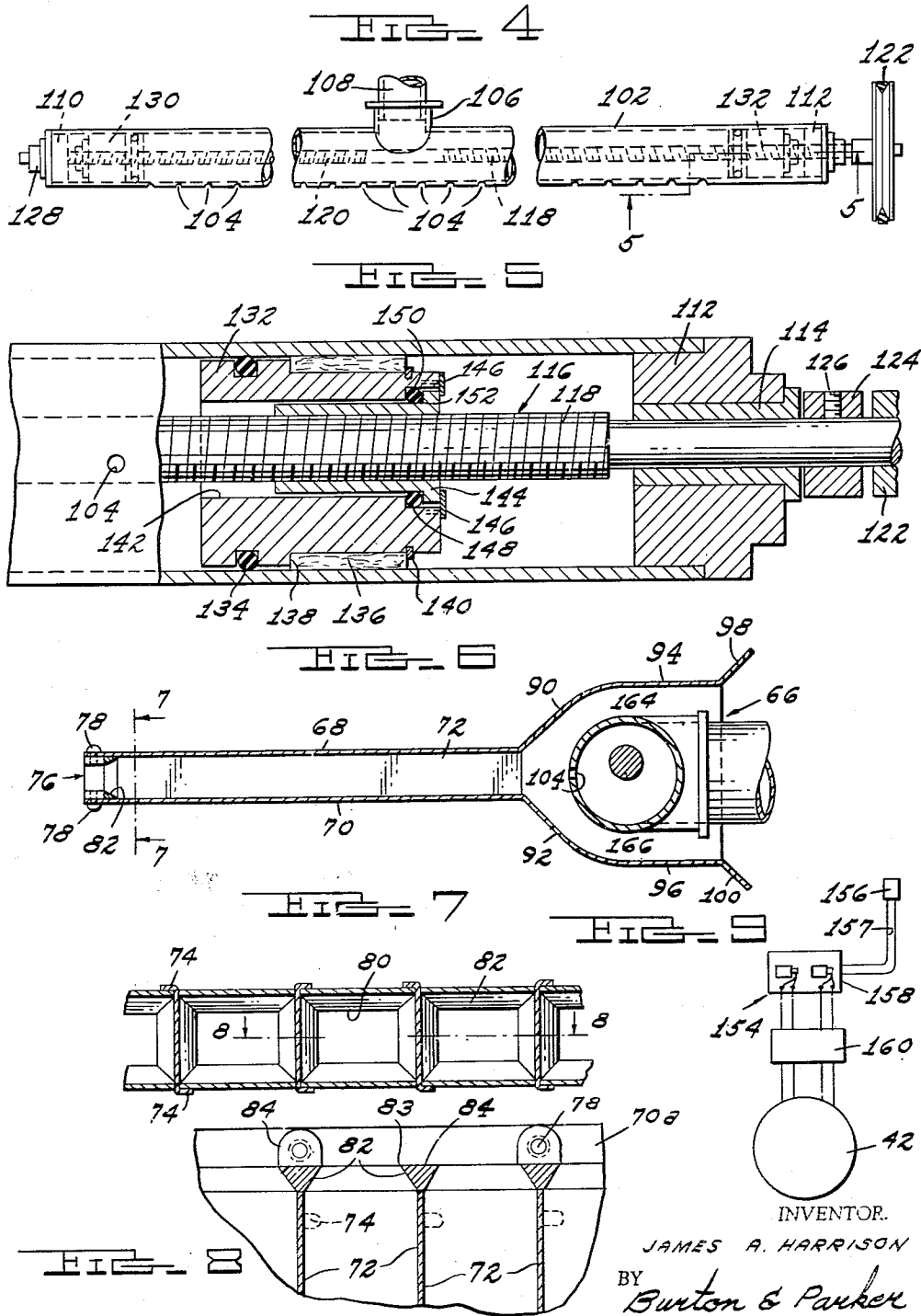
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2 Sheets-Sheet 2



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2,836,409

MAKE-UP AIR HEATER

James A. Harrison, Detroit, Mich.

Application July 27, 1956, Serial No. 600,470

8 Claims. (Cl. 263—19)

This invention relates to a direct fuel-fired, such as a gas-fired, air heater and particularly to a heater for use with air blowers or fans which supply make-up air for shops and factories whose air is rapidly exhausted by paint spray booths, dust collectors, etc.

While my heater is particularly well suited for warming make-up air and is hereinafter described in this conjunction, it is also well suited as an ordinary air heater to heat air recirculated within a building. I have shown the herein-described embodiment as a gas heater, but it will be understood by those skilled in the art that other fuels such as oil, kerosene, or the like might also be used.

In shops and factories having paint spray booths, dust collectors for grinders, and the like, or other equipment which draws large quantities of air out of the shop and blows it outside of the building, provision must be made for drawing fresh air into the building, and during winter months such fresh make-up air must be heated. In the embodiment of the invention herein disclosed, my heater is associated with a conventional blower or fan and warms the air directly by burning natural gas or the like in the air stream blown into the building.

Principal objects of my invention reside in the provision of a gas heater unit for air fans or blowers which is of simple and lightweight construction, may be manufactured at a low cost in proportion to the heating capacity, and which is highly efficient in operation from the standpoint of complete fuel combustion, transfer of heat to the fan or blower air stream, and for the volume of gas burned in relation to the size of the burner. The highly efficient operation of the burner may in great part be attributed to the fact that a pressure drop is established through the whole burner assembly and this is combined with an injection effect by the gas jetted into the burner housing, whereby a very substantial volume of fuel may be burned though the burner is of relatively small size.

Another object of the invention is the provision in an air heater of an elongate straight venturi type burner housing having a pair of parallel walls coextensive with the burner housing and flaring apart along one edge to provide an air scoop with a plurality of partitions extending transversely between the walls and defining a plurality of air passages opening at one end into the air scoop and opening into the opposite end through burner ports, and through which passages a portion of the air stream to be heated passes, with a gas manifold disposed in the air scoop at the intake ends of the passages to discharge gas therinto, with the venturi shape of the burner housing and the injection effect of the gas serving to create a high rate of gas and air flow through the passages.

Another object of the invention is the provision of an improved pilot grid at the discharge ends of the passages in the burner housing which serves to maintain a piloting of the gas and air mixture discharged from the passages by causing a portion of the mixture to eddy around the outlet ends of the passages with such eddying mixture supporting a piloting flame which pilots the remaining portion of the mixture discharging from the passages.

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Still another object of the invention is the provision of a lightweight thin-walled burner housing which may be constructed of sheet metal and so designed as to be cooled by the air stream in which situated.

A still further object of the invention is the provision of an improved gas manifold assembly having an elongate tubular manifold provided with a plurality of longitudinally spaced-apart gas orifices through the wall thereof and with a gas inlet connection for the manifold and a piston in the manifold which is shiftable longitudinally thereof between the inlet connection and the orifices to determine the number of orifices exposed to gas entering the manifold through the inlet connection, and with means connected to the piston to shift the same in response to indications from a thermostatic control device to vary the position of the piston and thereby vary the volume of gas discharging from the manifold in linear relationship to the position of the piston.

Another object of my invention is the provision of a straight venturi type burner housing of the aforesaid character in combination with the improved gas manifold associated together as a burner assembly which is disposed within a heater shell transversely of the air flow through the shell and which shell is provided with orifice plate means for inducing an air pressure differential within the shell between opposite ends of the burner assembly.

In general the invention includes a heater shell which is connected to one side of a fan housing. A burner housing is disposed in the heater shell to extend transversely of air flow therethrough. The burner housing is provided with a plurality of gas passages extending transversely therethrough and opening at the downstream edge of the housing where the gas and air mixture passing through the passages burns. A pilot grid of novel design extends along the downstream edge of the housing and forms burner ports at the discharge ends of the passages. The upstream edge of the housing is scoop shaped. A longitudinally extending perforated gas manifold is disposed along the upstream edge of the housing within the scoop and the perforations of the manifold are directed toward the passages to discharge gas therinto. Within the manifold are one or more reciprocable pistons moving in response to an electric motor suitably connected to the pistons. A gas inlet for the manifold is so disposed relative to the travel of the pistons that as they move in one direction, fewer perforations or orifices of the manifold are exposed to gas in the manifold, while with movement of the pistons in the opposite direction, a greater number of perforations are exposed, with the amount of gas discharging from the manifold being determined by the number of exposed perforations. The motor operates in response to a thermostatic control.

Other objects, advantages, and meritorious features will more fully appear from the specification, claims, and accompanying drawings, wherein:

Fig. 1 is an end view of a make-up air heater of which my invention is a part;

Fig. 2 is a front view of the assembly shown in Fig. 1;

Fig. 3 is a fragmentary end view of my burner assembly including the burner housing and gas manifold;

Fig. 4 is a top view of the gas manifold taken substantially on the line 4—4 of Fig. 1;

Fig. 5 is a cross sectional view taken on the line 5—5 of Fig. 4 through one of the pistons in the manifold;

Fig. 6 is a cross sectional view taken on the line 6—6 of Fig. 3;

Fig. 7 is a cross sectional view taken on the line 7—7 of Fig. 6;

Fig. 8 is a cross sectional view taken on the line 8—8 of Fig. 7; and

Fig. 9 is a schematic view of the thermostatic control for my heater.

The make-up air heater shown in Figs. 1 and 2 comprises a gang-fan assembly 20 and my improved heater unit per se 22 which is connected between the fan assembly and a duct 24 extending outwardly through the wall 26 of the building in which the heater is disposed. The air heater may be hung from the ceiling of the building or otherwise supported in any convenient fashion not shown. Outside air is drawn by the gang-fan assembly through the duct 24, through my heater unit 22, through the fans, and thereafter discharged into the space within the building through ports 28 in the fan housing. While my heater is shown in conjunction with a gang-fan type blower, it is equally well suited for use with other types of blowers.

The blower assembly 20 includes a housing having top and bottom walls 30 and 32, and end walls 34 and 36 connected together in any suitable fashion with the front closed by a wall 38 through which four ports 28 open. Extending longitudinally through the length of the blower housing is a fan or blower shaft 40 upon which are mounted in spaced relation four fans 42 for rotation with shaft 40. An electric motor 44, mounted on the blower housing, drives shaft 40 by means of an endless belt connection 45 and pulley 46 mounted on shaft 40. This gang-fan assembly is of conventional construction and need not be further described.

The heater unit per se embodying my invention may be connected to the outlet or front end of the fan assembly, or as shown in Fig. 1, to the rear end, i. e., the air inlet or suction side of the gang-fan assembly, by any suitable means such as the abutting flanges 48 through which bolts may be extended as at 50. The heater unit 22 is provided with a shell which, in the embodiment shown, is of rectangular shape having four walls corresponding to the top, bottom, and end walls of the blower housing. A motor-supporting bracket 52 is connected in any suitable fashion to one of the end walls of the heater unit and an electric motor 54 is mounted on and supported by the bracket as shown in Figs. 1 and 2. The heater unit 22 is interiorly provided with a pair of orifice plates 56 and 58 which extend across the inner surface of the walls of the shell, and are connected thereto in any suitable fashion, to provide a pressure drop between the air inlet and air outlet ends of the heater shell. The upper and lower shell walls to which the orifice plates are attached are indicated at 60 and 62.

Extending from one side wall to the opposite side wall of the heater shell substantially equidistant between the upper and lower walls 60 and 62, and secured to the side walls in any convenient fashion, is a burner housing generally indicated in Fig. 1 at 65 and shown more particularly in Figs. 3 and 6-8. Disposed in the air inlet end of the housing 64 is my improved gas manifold assembly 66. The downstream end of housing 64 is disposed just beyond the orifice plates 56 and 58 such that the downstream end of the housing 64 is in a lower pressure area than is the upstream end. The direction of air flow is indicated by the arrow in Fig. 1.

The burner housing is a linearly extending structure which may be formed of lightweight sheet metal and comprises a pair of spaced-apart walls 68 and 70 as shown particularly in Fig. 6, which are coextensive with the length of the housing. The walls are held in spaced-apart parallel relation through substantially three-quarters of their width by means of a plurality of partitions 72 which may be provided at their upper and lower edges with ears 74 that extend through slots in the walls 68 and 70 and are bent over as shown in Fig. 7. The partitions 72 provide a plurality of gas and air passages extending transversely of the burner housing throughout the length thereof and through which gas discharged

by the gas manifold passes to the downstream end of the burner housing.

At the downstream end of the burner housing and extending along the discharge ends of the passages is flame retention means in the form of a pilot grid 76. The primary function of the grid 76 is to effect a piloting of the fuel discharging from the passages. It will be noted that the grid is disposed between the walls 68 and 70 of the burner housing, and is secured thereto by bolts, rivets, or the like 78, which extend through ears 79 of the grid. The grid is provided with a plurality of openings 80 therethrough which serve as burner ports. As shown in Figs. 6-8, the inside surface of the grid around each port is beveled as at 82 and each port is aligned with one of the passages. The bevels 82 terminate at the outside surface of the grid in a knife edge at 83, with the outside surface of the grid being flat as at 84. The flat surfaces 84 around each port 76 cooperate with those marginal edge portions 68a and 70a of the walls 68 and 70 to form eddy chambers at the lee side or downstream side of the grid. As the mixture of air and gas flowing through the passages leaves the ports 76, the mixture around the periphery of the fluid stream swirls around behind the surfaces 84. When the mixture is lighted, that portion of the mixture swirling or eddying behind the surfaces 84 serves to pilot the principal portion of the mixture issuing from the ports, thereby sustaining the combustion of the gas.

At the upstream end of the passages in the burner housing, the housing walls 68 and 70 flare apart as at 90 and 92 and thereafter parallel each other as at 94 and 96, and thereafter once again flare apart as at 98 and 100. This enlarged or flared upstream edge of the burner housing provides an air scoop and a space within which my improved gas manifold assembly 66 is disposed. The gas manifold assembly includes a linearly extending pipe or manifold per se 102 which is supported in any convenient fashion within the air scoop of the burner housing. The pipe 102 or manifold per se may be mounted at opposite ends in the opposite end walls of the heater shell. The manifold 102 is provided at longitudinally spaced-apart intervals with perforations 104 through which gas within the manifold may escape. The perforations 104 are directed to discharge gas in the manifold fold into the passages through the burner housing. The manifold may be provided with a gas inlet 106 into which a gas line 108 is connected to supply gas to the manifold.

Opposite ends of the manifold are closed by hollow plugs 110 and 112. Within each plug is a bearing 114 as shown particularly in Fig. 5 in connection with plug 112. A screw shaft 116 extends longitudinally through the manifold 102 with the unthreaded end portions of the screw received in the bearings 114 which support the screw for rotation. The screw 116 is offset the axis of the manifold 102 as shown in Figs. 4 and 5. The screw 116 is provided with right and left-hand threaded portions 118 and 120. The screw 116 extends outwardly of the manifold at both ends thereof. A pulley 122 is mounted, as shown in Fig. 4, on the right-hand end of the screw shaft, and a collar 124, having a set screw 126, is received over the screw shaft 116 between the pulley and the bearing 112. A similar collar is received over the opposite end of the screw shaft as at 128. The collars prevent longitudinal shifting of screw shaft 116 within the manifold.

Disposed within the manifold for longitudinal reciprocable movement are a pair of pistons 130 and 132. Each piston, such as the piston 132 shown in Fig. 5, is provided with an annular O-ring receiving groove in which an O-ring 134 is mounted. A felt lubricating sleeve 136 is disposed about each piston and held between a shoulder 138 thereof and a snap ring 140. The felt sleeve is soaked with a suitable lubricant which improves the sliding fit of the O-ring within the manifold, preventing wear

of the O-ring and leakage of gas by the pistons. Each piston is provided with an axially offset bore 142 there-through and within the bore is disposed an internally threaded collar 144. The collar is threaded upon the screw shaft 116, and small screws or the like 146 threaded into the piston retain the collar 144 in the bore thereof. A suitable seal, such as an O-ring 148, is disposed within the bore 142 of each piston between cooperating shoulders 150 and 152 of the piston and collar respectively, and prevents leakage of gas between the collar and piston. The axial offset of the screw shaft and the offset of the bores in the piston serve to prevent rotation of the pistons upon rotation of the screw shaft.

The pistons 130 and 132 are shown in Fig. 4 in their outermost positions in the manifold such that gas entering the manifold through inlet 106 passes out of the manifold through all of the orifices 104 along the length of the manifold. When the pistons are disposed closer together, fewer orifices are exposed to the gas in the manifold and consequently a lesser volume of gas is discharged from the manifold. The volume of gas discharging from the manifold varies in a linear relation to the position of the pistons in the manifold. Because of this, a simple control device for the movement and positioning of the pistons may be provided. A thermostatic control device 154 is provided as generally shown in Fig. 9 which is of conventional construction and therefore will not be described in detail. The thermostatic control includes a bulb 156 which may be disposed either in the space to be heated by the heater or in the air stream of the heater outlet. The bulb is connected by a tube 157 to a temperature controller 158 which is responsive to the fluid pressure within the bulb 156 and tube 157 to energize a reversing relay 160 which controls the direction of rotation of the shaft 162 of motor 42. The temperature controller 158 may be set to energize the reversing relay to reverse the direction of rotation of the motor shaft when the temperature of the air surrounding bulb 156 rises or falls beyond predetermined limits. Upon rotation of shaft 162 of the motor 42 in one direction, the pistons 130 and 132 are moved toward each other, while rotation of motor shaft 162 in the opposite direction will move the pistons away from each other. It is therefore apparent that the volume of gas discharged from the manifold is in direct relation to the amount of rotation of the screw 116 and consequently the rotation of the shaft 162 of the motor 42. Because of this, a simple type of control of the volume of gas discharging into the burner housing is effected.

The high efficiency of my heater unit is due in substantial part to the fact that the burner housing is, as shown in Fig. 6, a straight venturi and is disposed in the heater shell such that opposite edges of the housing are in high and low-pressure areas and the pressure drop occurs across the whole burner housing both interiorly and exteriorly thereof. This pressure drop is accompanied by an injection effect of the gas being blown from the manifold into the passages. The combination injection effect and pressure drop across the burner housing promotes the flow of a very substantial amount of gas through the housing to be burned at the burner ports thereof though the housing is not of large size.

Because the burner housing is disposed within the air stream at the suction side of the fan, the housing may be made of thin and/or lightweight sheet metal such as aluminum, and the air stream passing around and through the burner housing effects a cooling thereof.

The air spaces 164 and 166 shown in Fig. 6 around the gas manifold and between the manifold and the flaring walls 90 and 92 of the housing are of greater cross section than the air passages between walls 68 and 70 and therefore there is no slowing down of air as it passes around the gas manifold. The air passing around the gas manifold is compressed by the walls 90 and

92 and its speed increases substantially as it passes into passages between walls 68 and 70. This speed is also increased, as mentioned above, by the injection effect of the gas blowing out of orifices 104.

What I claim is:

1. A heater assembly for an air fan comprising, in combination: a heater shell for connection to one side of the fan, a burner housing within the shell extending transversely thereof and provided with a plurality of passages opening at opposite ends upstream and downstream of the air flow through the shell with the downstream ends in a lower pressure area than the upstream ends, said burner housing adjacent the upstream ends of the passages flaring outwardly to provide an air scoop, a fuel manifold extending along the upstream ends of the passages within the air scoop and provided with a plurality of fuel outlets spaced apart along the length of the manifold for discharging fuel into said passages, a fuel inlet connection for the manifold, means sealingly disposed in the manifold and shiftable therethrough between the inlet connection and said fuel outlets to vary the number of outlets exposed to fuel discharging into the manifold from the inlet connection, and other means including a thermostatic control connected to the first-mentioned means for shifting the same in response to temperature indications from the thermostatic control.

2. A heater assembly for an air fan comprising, in combination: a heater shell for connection to one side of the fan, means within the shell establishing an orifice through which air passes in moving through the shell to establish an air pressure differential within the shell, a burner housing within the shell extending transversely thereof and provided with a plurality of passages opening at opposite ends upstream and downstream of the air flow with the downstream ends of the passages in a lower pressure area than the upstream ends, a fuel manifold extending along the upstream ends of the passages and provided with fuel outlets for discharging fuel into the passages, a fuel inlet connection for the manifold, and means for controlling the volume of fuel discharging from the manifold into said passages.

3. A heater assembly for an air fan comprising, in combination: a heater shell for connection to one side of the fan, means within the shell establishing an orifice through which air passes in moving through the shell to establish an air pressure differential within the shell, a burner housing within the shell extending transversely thereof and provided with a plurality of passages opening at opposite ends upstream and downstream of the air flow with the downstream ends in a lower pressure area than the upstream ends, said burner housing at the downstream ends of said passages provided with a piloting grid through which a mixture of air and fuel discharging from said passages passes with the grid provided with a wall portion surrounding each passage opening and around which wall portion the air and fuel mixture eddies in discharging from the passages.

4. A heater assembly for an air fan comprising, in combination: a heater shell for connection to one side of the fan, means within the shell establishing an orifice through which air passes in moving through the shell to establish an air pressure differential within the shell, a burner housing within the shell extending transversely thereof and provided with a plurality of passages opening at opposite ends upstream and downstream of the air flow with the downstream ends in a lower pressure area than the upstream ends, said burner housing adjacent the upstream ends of said passages flaring outwardly to provide an air scoop, a fuel manifold extending along the upstream ends of the passages and disposed in the air scoop and provided with fuel outlets for discharging fuel into the passages, a fuel inlet connection for the manifold, and means for controlling

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the volume of fuel discharging from the manifold into said passages.

5. A gas burner for an air fan comprising: a heater shell for connection to one side of the fan, a burner housing disposed within the shell and provided with a plurality of fuel and air passages opening at opposite ends upstream and downstream of air flow through the shell, a fuel manifold extending along adjacent the upstream ends of the passages and provided with longitudinally spaced-apart perforations for discharging fuel into the passages, a fuel inlet for the manifold, and a piston reciprocable in the manifold between the inlet and the perforations to admit fuel to those perforations lying between the piston and fuel inlet, and means for reciprocating the piston to a variety of positions longitudinally of the manifold to vary the volume of fuel discharging therefrom.

6. A gas burner comprising: an elongate burner housing having a pair of parallel spaced-apart walls coextensive with the length of the housing and held in spaced-apart relation by a plurality of partitions extending transversely between the walls and spaced apart longitudinally therealong, said walls and partitions defining fuel and air passages opening at opposite ends toward opposite lateral edges of the walls, a fuel manifold extending along one edge of the housing adjacent the lateral edges of said walls and provided with perforations opening toward the passages, a fuel inlet connection for the manifold, a piston disposed in the manifold and shiftable longitudinally thereof to admit fuel to those perforations lying between the inlet and the piston, and means connected to the piston and operable to shift the piston to a variety of positions longitudinally of the manifold to vary the volume of fuel discharging therefrom.

7. A burner housing comprising: an elongate sheet metal structure having a pair of parallel spaced-apart

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walls coextensive with the length of the housing and flaring apart along one longitudinal edge to provide an air scoop for catching and passing air transversely between said walls, a plurality of partitions extending transversely of said structure between the walls and spaced apart longitudinally therealong and defining passages through which air entering the scoop passes to discharge at the opposite longitudinal edge of the structure, a pilot grid extending along the discharge ends of said passages and connected to said structure and provided with burner ports aligned with the passages, said grid around each of the ports provided with a wall portion having a flat surface surrounding the opening and behind which surface a fuel and air mixture eddies in discharging from the aligned passage.

8. A heater assembly for an air fan comprising, in combination: an enclosure through which the fan creates a draft, a burner housing within the enclosure extending transversely thereof and provided with a plurality of passages opening at opposite ends upstream and downstream of the air flow through the enclosure with the downstream ends in a lower pressure area than the upstream ends, said burner housing adjacent the upstream ends of the passages flaring outwardly to provide an air scoop, a fuel manifold extending along the upstream ends of the passages within the air scoop and provided with a plurality of fuel outlets spaced apart along the length of the manifold for discharging fuel into said passages, and a fuel inlet connection for the manifold.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,836,409

May 27, 1958

James A. Harrison

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the drawings, Sheet 1, Fig. 2, delete the numeral 162 and accompanying lead line, applied to the shaft of upper motor 44; and to the outer end of the shaft of lower motor 54, apply the numeral 162, and to drive belt between the motor shaft 162 and the pulley above, apply the numeral 163. In Sheet 2 of the drawings, Fig. 8, the numeral "84", as applied to the ear of the grid at the left of that figure, should be -- 79 --. In Sheet 2 of the drawings, Fig. 9, the numeral "42" should be -- 54 --; in the printed specification, column 3, lines 56, 57 and 59, for "64", each occurrence, read -- 65 --; column 5, line 35, for "42" read -- 54 --; same line 35, after "of motor 42." insert the sentence -- Shaft 162 is connected by an endless drive belt or the like 163 to pulley 122 on screw shaft 116. --; same column 5, lines 40 and 47, for "42", each occurrence, read -- 54 --.

Signed and sealed this 3rd day of January 1961.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents