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2,446,642

HEAT-TREATING FURNACE

Filed March 27, 1945

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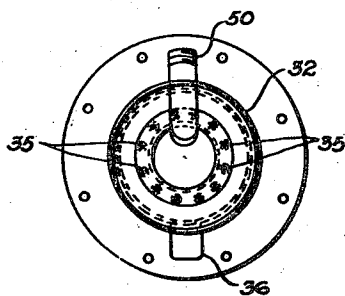
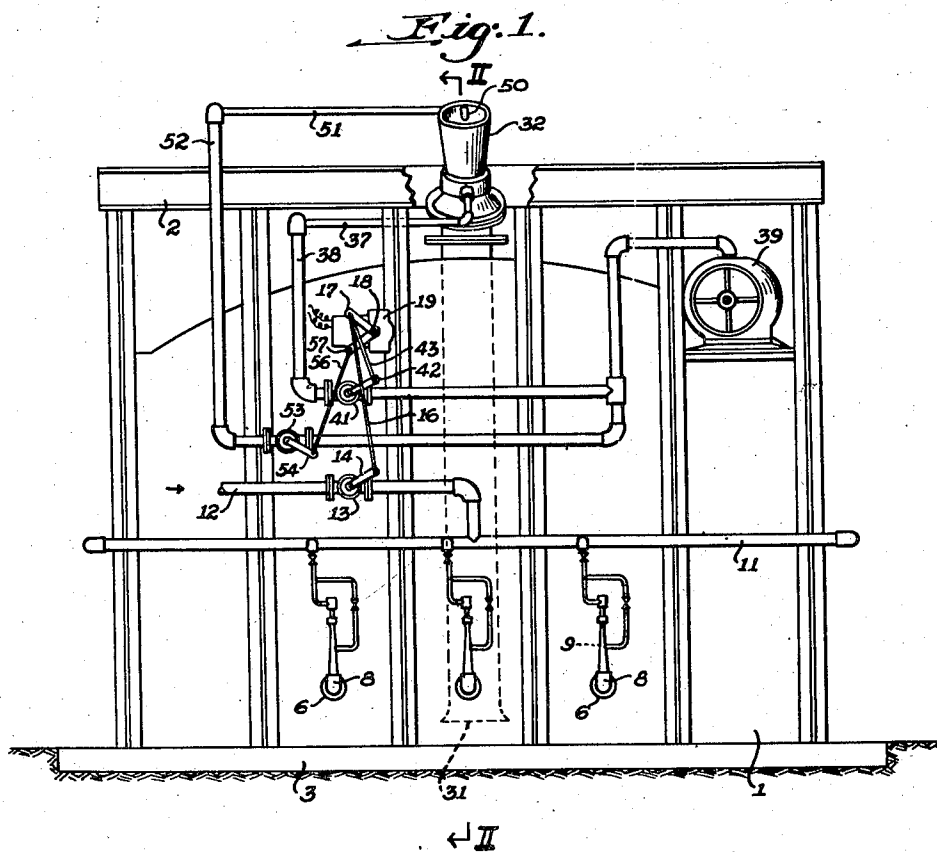


Fig. 4.

WITNESSES:
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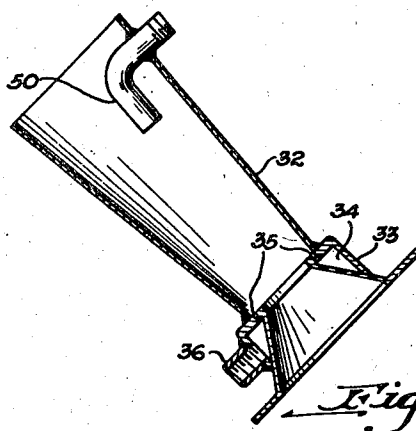


Fig. 5.

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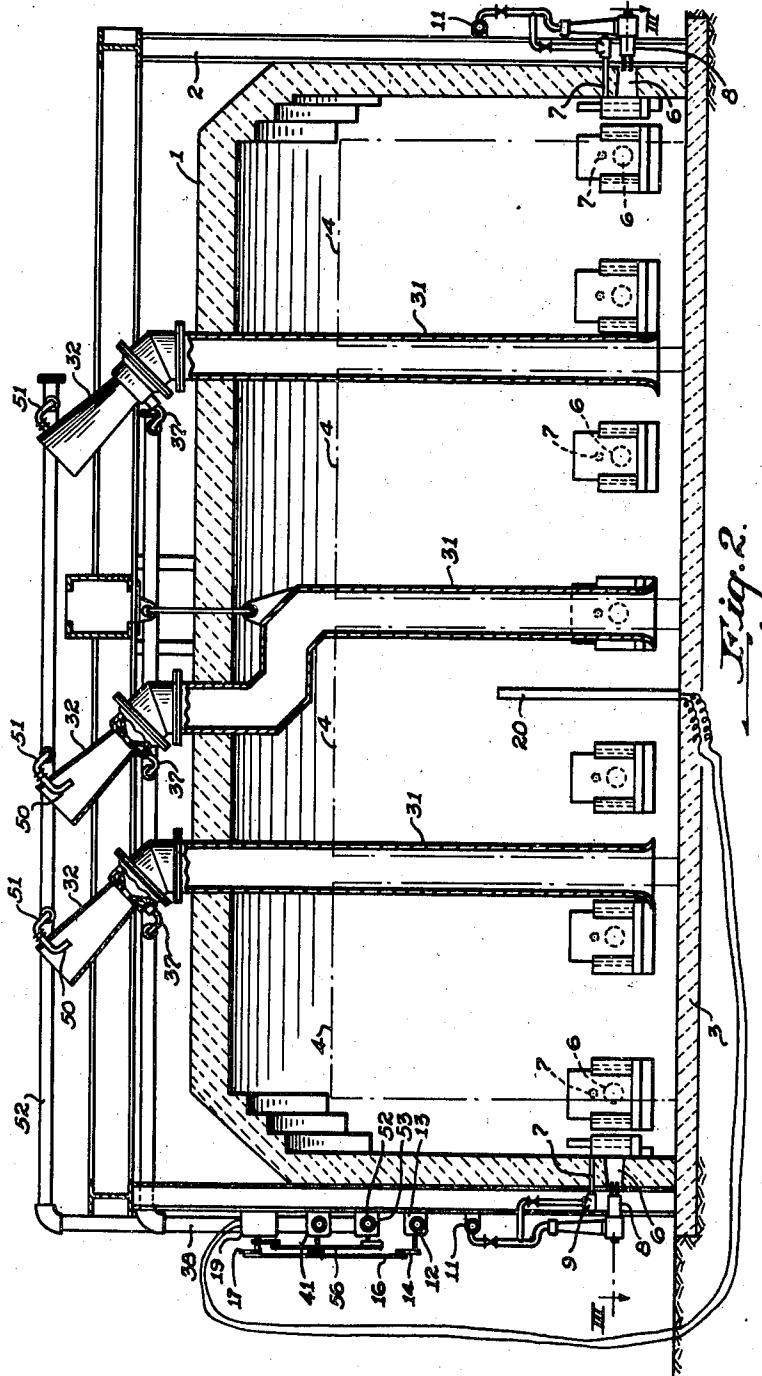
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

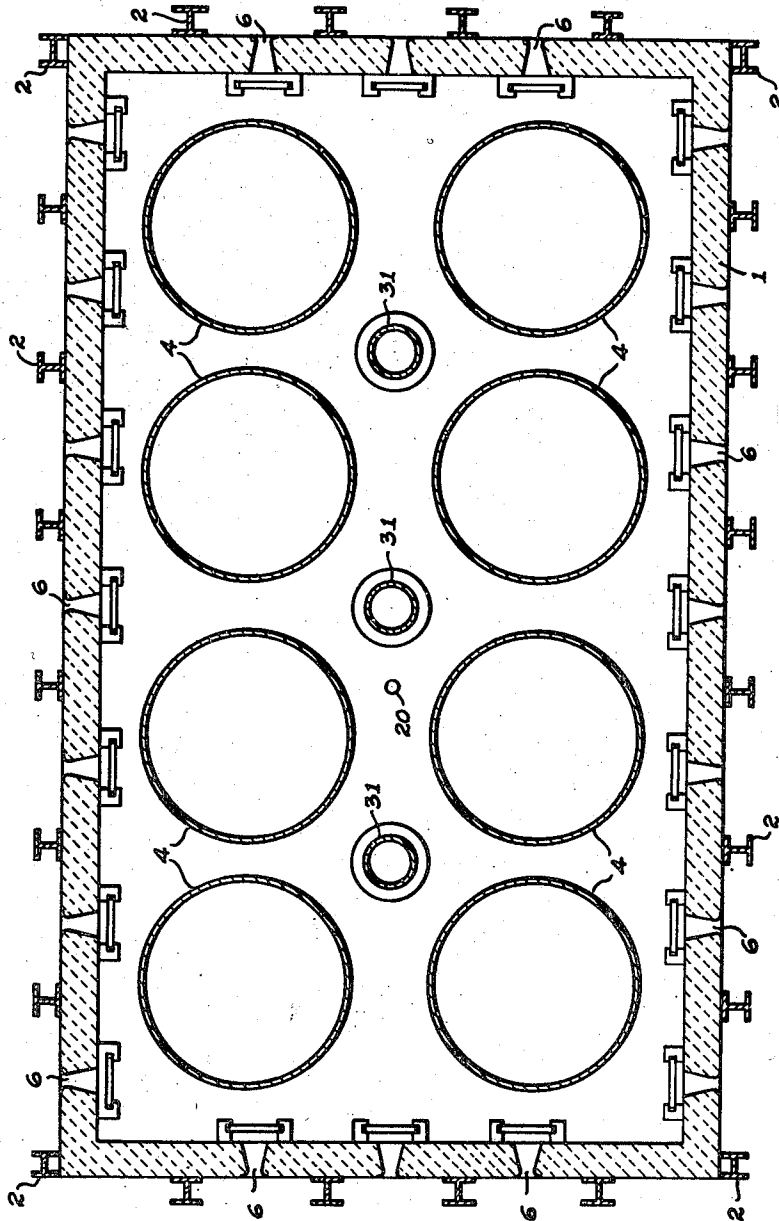


Fig. 3.

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UNITED STATES PATENT OFFICE

2,446,642

HEAT-TREATING FURNACE

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Application March 27, 1945, Serial No. 585,149

10 Claims. (Cl. 158—1)

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This invention relates to direct fired heat treating furnaces, and more particularly to those provided with means for positively exhausting combustion gases therefrom.

It is an object of this invention to provide a heat treating furnace from which the products of combustion are withdrawn by improved apparatus mechanically connected with the valve means by which the furnace burners are controlled, whereby the heat input and the exhaust are regulated simultaneously. Other objects are to provide such a furnace in which the natural draft through the furnace is reduced during periods of low burning, and in which a high temperature is maintained in the lower part of the furnace at all times.

The preferred embodiment of the invention is illustrated in the accompanying drawings in which Fig. 1 is an end view of my furnace; Fig. 2 is a longitudinal section taken on the line II—II of Fig. 1; Fig. 3 is a horizontal section taken on the line III—III of Fig. 2, but with the burners omitted; Fig. 4 is an enlarged end view of one of the eductors for exhaust gases; and Fig. 5 is an enlarged longitudinal section through an eductor.

Referring to the drawings, a heat treating furnace of the bell type is shown in which the refractory walls and roof, collectively designated 1, are supported in a structural steel frame 2 so that the furnace can be lifted by a crane from a suitable base 3 in order to permit charges of metal to be placed on the base for heat treatment. For example, coils of wire or flat strip (not shown) may be stacked on the base and then covered with protective hoods 4 that are shown in section in Fig. 3 and in broken lines in Fig. 2. The furnace is then lowered over the hoods until it rests on the floor around them, whereupon it is ready for operation.

The walls of the furnace are provided near its bottom with a series of laterally spaced burner openings 6 and 7 into which burners are directed. Preferably, the burners burn gas and are of the kind disclosed and claimed in my copending application Serial No. 554,876, filed September 20, 1944, now Patent No. 2,403,431, granted July 9, 1946. Each burner includes a main burner 8 that burns gas mixed with primary and secondary air, and a secondary burner 9 above it that burns raw gas either at the same pressure as or at a lower pressure than the gas supplied to the main burner. The secondary air enters the outer end of openings 6 in the space around the main burners. These burners are connected to a gas pipe 11 that extends around the furnace and that is connected by a pipe 12 to the main source of gas supply.

In pipe 12 there is a throttling valve 13 by which the flow of gas to the burners is controlled.

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The stem of this valve is provided with a laterally projecting arm 14 by which the stem can be turned to adjust the size of the opening through the valve. The valve stem end of the arm is adjustable in any suitable manner around the adjoining stem so that for any given position of the arm the valve may have any desired degree of opening. The outer end of arm 14 is pivotally connected to the lower end of a link 16 the upper end of which is pivotally connected to an arm 17 projecting laterally from an oscillatable member 18 mounted in an electrically or pressure operated valve-actuating device 19 of known construction. If electrically operated, this device is electrically connected to and operated by suitable temperature responsive means 20 (Fig. 2) disposed inside the furnace, whereby member 18 is turned one way or the other, depending on whether the furnace is calling for heat or is becoming too hot.

In order to control the flow of hot gases in the furnace, and to eliminate the necessity for burners in the center of the furnace chamber, a plurality of exhaust conduits 31 of any suitable cross-sectional shape extend down through the roof of the furnace along its center. However, in some cases it may be desirable to place the exhaust conduits at the ends or sides of the furnace. The open lower ends of these conduits are spaced a short distance from the floor of the chamber so that the hot gases that rise from the burners are drawn toward the middle of the furnace and down around hoods 4 to the bottom of the exhaust conduits to keep the lower part of the furnace hot. The products of combustion within the furnace are positively drawn out through conduits 31 by means of air-operated eductors mounted on the upper ends of the conduits above the furnace roof.

In accordance with this invention each eductor includes a Venturi tube 32 forming a continuation of the adjoining conduit 31, the tube being encircled behind its narrowest part or throat by a ring 33 welded thereto in order to form a chamber 34 around the tube. The front wall of this chamber, inside the tube, is provided with a plurality of circumferentially spaced jet holes 35 directed forward. Ring 33 is provided with a laterally projecting coupling 36 connected by a branch pipe 37 to a main pipe 38 that in turn is connected to a suitable source of air supply, such as a continuously operating blower 39. Air entering eductor chambers 34 escapes through jets 35 into the Venturi tubes and thus draws exhaust gases up through conduits 31 from within the furnace. The greater the air flow through the eductors the more rapidly the exhaust gases are drawn out of the furnace.

The air flow to eductor chambers 34 is varied in accordance with the rate of operation of the

burners by connecting a valve 41 in a horizontal section of air pipe 38 above the gas regulating valve. The stem of this valve likewise is provided with an adjustable arm 42, generally parallel to arm 14, and pivotally connected by a link 43 at its outer end to arm 17 of valve-controlling device 19. When this regulating mechanism is installed, the stem of the air valve is adjusted relative to its control arm so that the proper volume of air will be delivered to the eductors for any given amount of gas supplied to the burners.

In operation, when temperature responsive means 20 inside the furnace calls for heat, valve-actuating device 19 will be operated by it to swing arm 17 vertically in order to move links 16 and 43 in the direction that will cause arms 14 and 42 to open the gas and air valves farther. Thus, as the burners operate at higher capacity the eductors likewise do the same, so the combustion gases inside the furnace are withdrawn at a higher rate in keeping with the higher rate at which they are produced. When the furnace temperature starts to become too great, the gas and air valves are turned down simultaneously in the same manner.

Another feature of this invention is that the lower part of the furnace is kept from becoming unduly cool when the burners are turned low after the upper part of the material being heat treated has reached the desired temperature, whereby the lower part of the material is brought up to temperature soon after the upper part. Accordingly, means is provided for reducing the natural draft through the furnace so that there will not be enough cold air drawn in through burner openings 6 to materially reduce the temperature in the lower part of the furnace. This desirable result is accomplished by directing a stream of air down into each eductor during low burning periods to counteract the upward draft that draws air in through burner openings 6. For this purpose an L-shape nozzle 50 is welded in each eductor tube 32 near its outer end with the inner end of the nozzle directed downwardly toward the throat of the tube. The outer end of the nozzle is threaded and coupled to a branch pipe 51 extending laterally from a main pipe 52 above the furnace. One end of the main pipe extends down the end of the furnace and connects with air pipe 38.

The horizontal section of pipe 52 at the end of the furnace is provided with a valve 53 having a stem to which an arm 54 is adjustably connected. The outer end of this arm is connected by a link 55 with a second arm 57 mounted on the oscillatable member 18 of valve controller 19. Valve 53 is set so that it does not open until after the other air valve 41 has closed. Gas valve 13 can not be closed completely. With this arrangement of valves a back pressure is created in the eductors as soon as the air supply to jets 35 is cut off, which occurs when the burners are turned low by valve 13. This back pressure prevents an undesirable amount of cold air from being drawn into the furnace through burner openings 6, but it does not shut off all draft up through the eductors. Consequently, the temperature of the lower part of the material being heat treated is raised much more quickly than it would be if large amounts of cold air were allowed to be drawn into the bottom of the furnace. This increases the tonnage of material that can be heat treated in this furnace per day, and thereby reduces its cost per ton.

According to the provisions of the patent

statutes, I have explained the principle and construction of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In a heat treating furnace, walls defining a heating chamber, a burner therefor directed into the lower portion of the chamber, a conduit for supplying fuel to the burner, said chamber having an open inlet for secondary air for the burner and also having an outlet for exhaust gases, an air-operated eductor connected to said outlet, a conduit for supplying air to the eductor, means responsive to temperatures in said chamber for controlling the flow of fuel to said burner and air to said eductor to thereby increase said air flow when said fuel flow is increased, and means for directing a stream of air backwardly in the eductor to retard the flow of exhaust gases therethrough when said fuel flow is at a minimum and said air flow to the eductor is substantially stopped.

2. In a heat treating furnace, walls defining a heating chamber, a burner therefor directed into the lower portion of the chamber, said chamber having an open inlet for secondary air for the burner and also having an outlet for exhaust gases, a fuel line connected to the burner, an eductor connected to said outlet, an air pressure line connected to said eductor for operating it, throttling valves in said fuel and air lines, valve-actuating means operatively connected to said valves, means responsive to temperatures in said chamber for operating said valve-actuating means, whereby to increase the air flow to the eductor when the fuel flow to the burner is increased, and means for directing a stream of air backwardly in the eductor to retard the flow of exhaust gases therethrough when said fuel flow is at a minimum and said air flow to the eductor is substantially stopped.

3. In a heat treating furnace, walls defining a heating chamber, a burner therefor directed into the lower portion of the chamber, a conduit for supplying fuel to the burner, said chamber having an open inlet for secondary air for the burner and also having an outlet for exhaust gases, an air-operated eductor connected to said outlet, a conduit for supplying air to the eductor, means responsive to temperatures in said chamber for controlling the flow of fuel to said burner and air to said eductor to thereby increase said air flow when said fuel flow is increased, a nozzle directed backwardly into the eductor, an air pressure line connected to said nozzle, a normally closed valve in said air line, and means for opening said valve when said fuel flow is at a minimum and said air flow to the eductor is substantially stopped.

4. In a heat treating furnace, walls defining a heating chamber, a burner therefor directed into the lower portion of the chamber, said chamber having an open inlet for secondary air for the burner and also having an outlet for exhaust gases, a fuel line connected to the burner, an eductor connected to said outlet, an air pressure line connected to said eductor for operating it, throttling valves in said fuel and air lines, valve-actuating means operatively connected to said valves, means responsive to temperatures in said chamber for operating said valve-actuating

means, whereby to increase the air flow to the eductor when the fuel flow to the burner is increased, a nozzle directed backwardly into the eductor, and air pressure line connected to said nozzle, a normally closed valve in said nozzle air line, and means operatively connecting said valve-actuating means to said last-mentioned valve for opening it when said fuel flow is at a minimum and said air flow to the eductor is substantially stopped.

5. In a heat treating furnace, walls defining a heating chamber provided near its bottom with a burner port, a burner adjacent the outer end of said port with a space between it and the port for admission of secondary air, a fuel line connected to the burner, an exhaust conduit extending out of said chamber with its inner end disposed near the chamber bottom, an eductor for exhaust gases connected to the outer end of said conduit, an air pressure line connected to said eductor for operating it, throttling valves in said fuel and air lines, a nozzle directed backwardly into the eductor, an air pressure line connected to said nozzle, a normally closed valve in said nozzle air line, valve-actuating means operatively connected to said valves, and means responsive to temperatures in said chamber for operating said valve-actuating means, said throttling valves being adjusted in unison toward closed and wide open positions, and said normally-closed valve being opened only after said throttling valves have been closed sufficiently to reduce said fuel flow to a minimum and to substantially cut off the air flow through said first-mentioned air line.

6. In a heat treating furnace, walls defining a heating chamber, a burner therefor directed into the lower portion of the chamber, a fuel line connected to the burner, an exhaust conduit extending out of said chamber, an eductor for exhaust gases connected to said conduit, an air pressure line connected to said eductor for operating it, throttling valves in said fuel and air lines, valve-actuating means, means responsive to temperatures in said chamber for operating said actuating means, and mechanical means operatively connecting said actuating means to said valves whereby to increase the air flow to the eductor when the fuel flow to the burner is increased.

7. In a heat treating furnace, walls defining a heating chamber, a burner therefor directed into the lower portion of the chamber, a fuel line connected to the burner, an exhaust conduit extending out of said chamber, an eductor for exhaust gases connected to said conduit, an air pressure line connected to said eductor for operating it, throttling valves in said fuel and air lines, valve-actuating means having an electrically operated valve-actuating member, means responsive to temperatures in said chamber for controlling the movements of said member, links pivotally connected to said member, and control arms for said valves pivotally connected to said links, whereby said actuating means opens both valves simultaneously.

8. In a heat treating furnace, walls defining a heating chamber, a burner therefor directed into the lower portion of the chamber, a fuel line connected to the burner, an exhaust conduit extending out of said chamber, a Venturi eductor

tube mounted on the outer end of said conduit and provided at its throat with a plurality of circumferentially spaced jet openings directed forward inside the tube, said tube being provided with a chamber surrounding the inlet ends of said jet openings, an air line connected to said tube chamber, throttling valves in said fuel and air lines, valve-actuating means, means responsive to temperatures in said chamber for operating said valve-actuating means, and means operatively connecting said actuating means to said valves whereby to increase the air flow to said tube chamber when the fuel flow to the burner is increased.

9. The combination with a heat treating furnace, a burner therefor directed into the lower portion of the chamber, a fuel line connected to the burner, a throttling valve in said line, means responsive to the temperature inside the furnace for controlling said valve, and an exhaust conduit extending out of the furnace, of a Venturi eductor tube connected to said conduit and comprising a forwardly tapered tubular rear portion encircled by a ring forming therewith an annular chamber having a substantially flat front wall provided with a plurality of circumferentially spaced jet openings directed forward, said tube having a rearwardly tapered front portion secured to said wall around said jet openings, an air pressure line connected to said annular chamber, a throttling valve in said air line, and means operably connecting said temperature responsive means to said air valve whereby to increase the air flow to the eductor when the fuel flow to the burner is increased.

10. The combination with a heat treating furnace, a burner therefor directed into the lower portion of the chamber, a fuel line connected to the burner, a throttling valve in said line, means responsive to the temperature inside the furnace for controlling said valve, and an exhaust conduit extending out of the furnace, of a Venturi eductor tube connected to said conduit and comprising a forwardly tapered tubular rear member encircled by a ring forming therewith an annular chamber having a substantially flat front wall provided with a plurality of circumferentially spaced jet openings directed forward, a rearwardly tapered tubular front member secured to said wall around said jet openings, a nozzle mounted in the wall of said front member near its front end and pointing backwardly toward its rear end, air pressure lines connected to said nozzle and annular chamber, valves in said air lines, and means operatively connecting said temperature responsive means to said air valves.

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