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W. A. REED

2,314,288

OIL RATE CONTROL FOR BURNERS

Filed Sept. 26, 1940

Fig. 1.

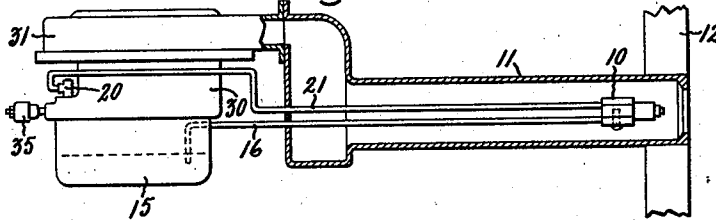


Fig. 2.

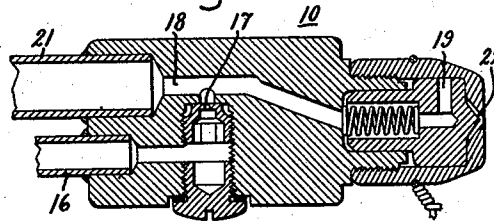


Fig. 6. Fig. 7.

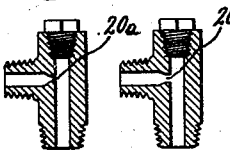


Fig. 3.

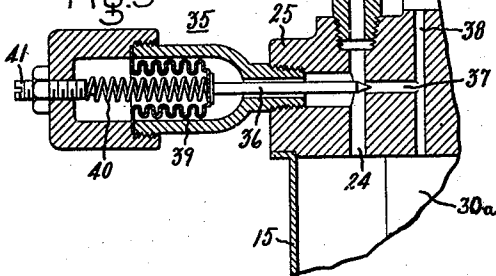


Fig. 5.

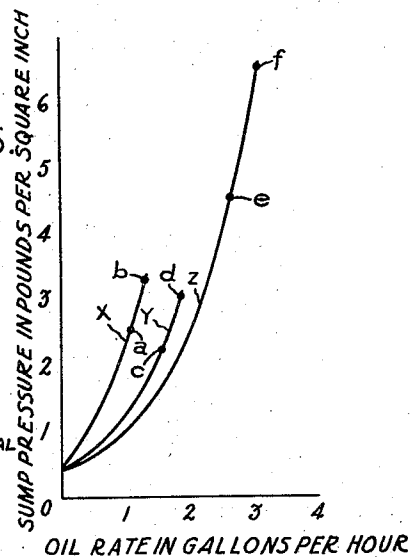
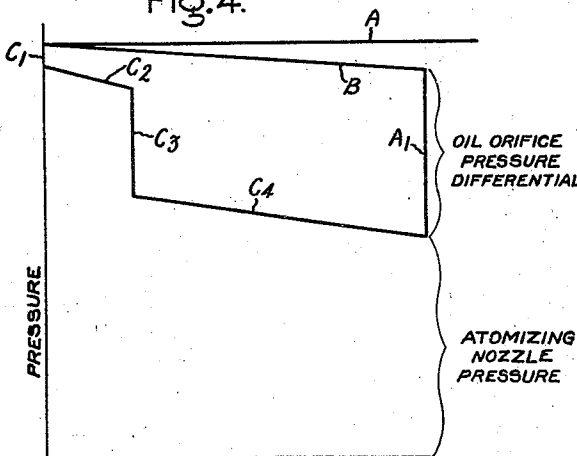


Fig. 4.



Inventor:
William A. Reed,
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

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OIL RATE CONTROL FOR BURNERS

William A. Reed, West Caldwell, N. J., assignor to
General Electric Company, a corporation of
New York

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5 Claims. (Cl. 158—36.3)

This invention relates to oil burners, particularly of the air pressure atomizing nozzle type in which both oil and air are separately supplied from a variable pressure oil and air supply source to an atomizing nozzle wherein the two are mixed and discharged to establish flame. This general type of air pressure atomizing nozzle oil burner is disclosed in the Lum Patent 2,072,761 and the Wotring Patent 2,124,443, both of which disclose and claim improved means for regulating the rate of flow of oil to the atomizing discharge orifice of the burner nozzle.

The principal object of the present invention is to provide an improved oil rate regulating method and apparatus for oil burners of the air pressure atomizing nozzle type.

A specific object is to vary the oil rate by changing the size of an orifice in the air supply line for the air pressure oil atomizing nozzle and also changing the pressure at which both oil and air are supplied to the nozzle with the oil always flowing through an orifice of a fixed size located adjacent the atomizing nozzle tip.

A preferred embodiment of the invention is illustrated schematically in the accompanying drawing in which Fig. 1 shows the improvements of the invention applied to an oil burner of the improved conversion type adapted to be used with furnaces of various types and sizes as described in the application of Aldo Macchi, Serial No. 320,557, filed February 24, 1940; Fig. 2 is an enlarged sectional view of the oil and air mixing and pressure atomizing nozzle which is shown as of the improved type described in the application of Aldo Macchi, Serial No. 320,558, filed February 24, 1940; Fig. 3 is an enlarged sectional view showing the preferred form of the improved air flow regulating means employed in the present invention to control the rate of the supply of oil to the burner nozzle; Fig. 4 is a diagram illustrating the manner in which the air and oil pressures drop as they separately pass from a common pressure sump chamber to the burner nozzle and Fig. 5 is a chart showing the variation in oil rate of the burner obtained by means of the present invention; Figs. 6 and 7 are different modifications of the air flow control orifice 20 shown in Fig. 3 that are employed to vary the oil rate.

As shown in Fig. 1 of the drawing, the burner air pressure oil atomizing nozzle 10 is located within the burner combustion air discharge nozzle 11 which may be sealed into the wall of the combustion chamber of the furnace 12 as illustrated.

Oil under pressure is supplied to the atomizing nozzle 10 from the bottom of the oil and air pressure equalizing sump chamber 15 through the oil supply pipe 16. As shown in Fig. 2, a thin walled sharp edged orifice 17 of predetermined size is mounted in the nozzle 10 at the end of the oil supply pipe 16 in order to meter the flow of oil and also provide viscosity compensation in the manner described and claimed in the above Lum and Wotring patents.

Air under pressure is supplied from the upper part of the sump 15 through an air metering orifice 20 which may be varied in size and preferably is located for convenience in changing to different size orifices adjacent to the sump 15. The air passing through the orifice 20 is conducted through the air supply pipe 21 to the nozzle 10. Both oil and air are pumped into the sump 15 under pressure by an electric motor driven oil and air pumping mechanism 30 which also drives the blower 31 to supply combustion air to the air nozzle 11. A sump pressure regulator 35 is provided for varying the air pressure within the sump 15 as described hereinafter.

Fig. 2 shows the internal construction of the air pressure oil atomizing nozzle 10. In the nozzle 10, the oil supplied under pressure through pipe 16 discharges through the oil flow regulating orifice 17 and mixes in the chamber 18 with the air supplied under pressure through pipe 21. Thus the mixing of the oil and air occurs under pressure. The mixture passes from the mixing chamber 18 through the radial passage 19 and is discharged under pressure at the nozzle discharge orifice 22 which has maximum and minimum pressure limits variable with the mixture for effective atomization of the oil. When the atomizing pressure at orifice 22 falls below the minimum effective limit, the oil and air mixture may drizzle out of the discharge orifice 22 with insufficient velocity to produce effective oil atomization. Under these conditions imperfect combustion and carbonization of the burner inherently results. On the other hand, when the oil and air mixture is discharged from the nozzle 22 at pressures above the maximum effective limit, the velocity of the mixture may become materially greater than the rate of propagation of flame. In this case the flame will be driven so far from the nozzle as likely to be extinguished or at least a noisy, rapidly pulsating, and unstable flame may result.

In accordance with the present invention, the rate of oil flow through the metering oil orifice 17 to the atomizing nozzle 10 may be regulated

through a series of valves by changing the size of the air metering orifice 20 and thereby inversely varying the rate of oil flow through the oil metering orifice 17 and the pressure of the atomizing air supplied to the nozzle 10 while the sump pressure regulator 35 is adjusted to vary the initial oil and air pressure in the sump 15 so as to maintain the pressure of the oil and air mixture within the effective atomizing limits of the nozzle discharge orifice 22.

A preferred construction of the air metering orifice 20 and the sump pressure regulator 35 are shown in Fig. 3. As shown in Fig. 3, air is supplied from the top portion of the sump 15 through the air outlet port 24 formed in the base 25 of the electric motor driven oil and air pressure supply pumping mechanism having the pumping part 30a thereof suspended from base 25 within the sump 15 to supply oil and air under pressure thereto. The air metering orifice 20 is as shown in the preferred form of a special T-connection which is screw threaded into the base 25 in communication with the air outlet port 24. As indicated in Figs. 6 and 7, a plurality of T-connections with different size air metering orifices formed therein are provided for selectively obtaining different oil rates. The preferred form of connection T orifices is employed so as to permit the screw plug 28 at one end thereof to be removed and an air pressure gauge temporarily connected as indicated in dotted lines to indicate the pressure in the sump 15 applied to the orifice.

The pressure in sump 15 is controlled by the automatic regulator 35. This consists of the needle valve 36 which controls the air bypass port 37 which may be connected to the air inlet port 38 of the pumping port 30a of the electric motor driven oil and air pumping mechanism as shown. The needle valve 36 is operated by the bellows 39 which is responsive to the air pressure in the sump air outlet port 24. The spring 40 is adjusted by screw 41 to vary the air pressure to which bellows 39 responds. Thus when the air pressure in the sump 15 increases, the bellows 39 responds to move the needle valve 36 farther away from the port at the entrance to the air bypass 37. This enables more air to pass from the sump 15 through the outlet port 24 and into the by-pass passage 37, thereby reducing the air pressure in the sump 15. Conversely, when the air pressure in sump 15 decreases, the bellows 39 responds to move the needle valve 36 closer to the port at the entrance to the by-pass 37 thereby restricting the flow of by-pass air and causing the air pressure in sump 15 to increase.

Fig. 4 is a diagrammatic illustration of the relative pressure drops occurring in the oil and air supply system to the nozzle mixing chamber 18. Line A represents the initial pressure of both the oil and the air in sump 15. As the oil leaves the sump 15 and passes through pipe 16 to the oil metering orifice 17, a slight gradual reduction in the pressure on the oil occurs due to friction loss in the pipe as indicated by line B. In passing through the oil metering orifice 17 the pressure materially drops as indicated at A1.

The air on leaving sump 15 is subject to an initial rapid pressure drop corresponding to the velocity head as indicated at C1 with a further gradual loss in pressure as the air passes through the outlet port 24 as indicated at C2. When the air passes through the restricted air metering orifice 20 a rapid drop in pressure occurs as indicated at C3. Then a still further gradual

pressure drop occurs as the air flows through the pipe 21 to the mixing chamber 18 as indicated at C4.

The pressure differential effective to produce flow of oil through the oil metering orifice 17 is the difference in pressure at the end of the oil pressure line B on one side of orifice 17 and the air pressure line C on the other side of orifice 17. Likewise the pressure available to blow the air and oil mixture from the mixing chamber 18 and through the nozzle discharge orifice 22 is the difference between the pressure at the end of the air pressure line C and the zero pressure line. Thus, in accordance with the present invention by varying the size of the air metering orifice 20, the air pressure drop indicated by C3 may be varied with a corresponding inverse variation of the differential pressure across the oil flow orifice 17 and the atomizing pressure of the nozzle 10.

When the size of the air metering orifice 20 is varied, there necessarily results a variation in the ratio of oil to air in the mixing chamber with a consequent variation in the mixture projected through the atomizing nozzle orifice 22. The oil and air mixture issues from this nozzle orifice 22 during operation as a fog. Thus the more air that is supplied to the mixture, the less oil can issue from the nozzle tip. Conversely, the more oil that is supplied, the less air can issue from the nozzle tip. Such variations in the ratio of oil and air issuing from the atomizing nozzle tip will change the effective minimum and maximum atomizing pressures required to provide for satisfactory atomization and combustion of the oil.

In practicing the invention in a preferred form, variations in the oil rate have been obtained as indicated in the following data table which tabulates the variations in the size of the air metering orifice, the corresponding variations in sump pressure, corresponding variations in the air line pressure below the air metering orifice, and also the observed pressure differential of the oil metering orifice.

Oil rate gals./hr.	Air orifice dia.	Sump pressure lbs./sq. in.	Air line pressure below air orifice lbs./sq. in.	Pressure difference on oil orifice lbs./sq. in.
	Inches			
1.08	.916	2.5	2.5	0
1.30	.916	3.25	3.25	0
1.69	.104	2.25	1.81	.19
1.89	.104	3.0	3.13	.37
2.65	.082	4.6	3.19	.75
3.06	.082	6.5	5.19	1.19

These results were obtained by selectively employing the different size air flow control orifices 20a and 20b shown schematically in Figs. 6 and 7 with the length of the air pipe 21 about 20 inches and with an inside diameter of .150 inch and the oil supply pipe 16 of a length of about 23 inches with an inside diameter of .150 inch. The oil metering orifice 17 had a diameter of .0465 inch which is a #56 drill size. The discharge orifice 22 of the burner nozzle had a diameter of 1/8 inch.

In the above table it will be noted that at the 1.08 oil rate and also the 1.30 oil rate, the observed oil and air pressure differential on the opposite sides of the oil metering orifice seem to be zero. But since the oil did flow through the oil orifice at the rate indicated, there inherently must have been sufficient differential to give the head of about .01 lb. necessary to make the oil flow at the indicated rate through the

orifice 17. As indicated in the above table, the observed pressure differential across the oil orifice 17 materially increases at the higher oil rates.

The chart of Fig. 5 shows the variation in oil rate obtained with the three different size air orifices indicated schematically in the drawing as 20, 20a and 20b in the air supply line according to the data given in the above table and shows the relation between the oil rate and the sump pressure within the maximum and minimum effective atomizing pressure limits of the nozzle for each of the three air orifices. Thus with the $\frac{3}{8}$ " diameter air metering orifice a sump pressure of 2.5 lbs. provided the minimum effective atomizing pressure at the nozzle discharge orifice 22 below which the flame became unsatisfactory. By raising the sump pressure to 3.25 lbs., an increase in the oil rate to 1.30 gallons per hour was obtained with the maximum effective atomizing pressure at the nozzle discharge orifice 22 above which the flame became too unstable and noisy for satisfactory operation. In order to provide higher oil rates, the air metering orifice diameter was reduced to .104 inch. With this reduced size of air orifice in the system and with a sump pressure of 2.25 lbs. to give the minimum effective atomizing pressure at the nozzle, the oil rate was 1.59 gallons per hour. Upon increasing the sump pressure to 3 lbs., the oil rate was correspondingly increased to 1.89 gallons per hour with the atomizing pressure at the nozzle discharge orifice 22 at its maximum effective limits. To obtain still higher oil rates, the air orifice diameter was then reduced to .082 square inch and the sump pressure increased to 4.5 lbs. This resulted in an oil rate of 2.6 gallons per hour with the pressure at the nozzle discharge orifice 22 at the minimum effective atomizing limits. Then when the sump pressure was increased to 6.5 lbs. so as to bring the pressure at the nozzle discharge orifice 22 up to the maximum effective limits, the oil rate became 3.06 gallons per hour.

Thus by means of the present invention a progressively increasing series of oil rates was obtained by variation of the size of the air metering orifice with corresponding variations of the sump pressure so as to maintain the nozzle atomizing pressure within effective atomizing limits. The atomizing nozzle discharge curves X, Y and Z shown in Fig. 5 indicate the variations in the oil rate that were obtained. Points a and b on curve X correspond respectively with the 1.08 gallons per hour oil rate obtained with the 2.5 lbs. per square inch sump pressure and the 1.30 gallons per hour oil rate obtained with the 3.25 lbs. per square inch sump pressure. Both of these rates were obtained with the $\frac{3}{8}$ -inch diameter orifice in the air supply line.

Points c and d on curve Y correspond respectively with the 1.59 gallons per hour oil rate obtained with the 2.25 lbs. per square inch sump pressure and the 1.89 gallons per hour oil rate obtained with the 3.0 lbs. per square inch sump pressure, both of which were obtained with the .104-inch diameter orifice in the air supply line.

The points e and f on curve Z correspond respectively with the 2.65 gallons per hour oil rate with the 4.5 lbs. per square inch sump pressure and the 3.06 gallons per hour oil rate with the 6.5 lbs. per square inch sump pressure. In this case the diameter of the orifice in the air line was .082.

As previously pointed out, variation in the

diameter of the orifice in the air supply line inherently changes the ratio of oil and air in the mixture discharged from the burner atomizing nozzle. The changes in the slope of the curves X, Y and Z indicate such variations in the ratio of oil and air in the mixture discharged from the nozzle orifice 22.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an oil burner, in combination, means providing a chamber for mixing oil and air under pressure and having a thin walled oil flow regulating inlet orifice for discharging oil into said chamber, discharge means connected with said mixing chamber for discharging said oil and air mixture under pressure to atomize the oil, means including a variable pressure oil and air supply chamber having separate oil and air connections communicating with the opposite sides of said oil flow regulating inlet orifice for supplying oil and air under pressure to said mixing chamber, variable air flow regulating means including a plurality of different size orifice elements, each adapted for mounting in said air pressure supply connection for correspondingly varying the rate of oil flow through said oil regulating inlet orifice and the pressure drop of the air supplied to said mixing chamber, and pressure control means having an adjustable element for regulating the pressure in said oil and air supply chamber to vary the pressure of the mixture supplied from said mixing chamber to said discharge means and correspondingly vary the rate of oil flow through said oil regulating inlet orifice.

2. In an oil burner, in combination, means providing a chamber for mixing oil and air under pressure, discharge means connected with said mixing chamber for discharging said mixture under pressure to atomize the oil, means including a variable pressure oil and air supply chamber having separate oil and air supply connections with said mixing chamber with a thin walled oil flow regulating orifice at the discharge end of said oil pressure supply connection, and means for regulating the rate of oil flow through said regulating orifice including selectively variable air flow orifice means in said air pressure supply connection for varying the air pressure drop in steps and thereby correspondingly varying the oil flow through said regulating orifice and pressure control means having an adjustable element for varying the pressure in said oil and air supply chamber to vary the pressure of the mixture supplied to said discharge means within the effective atomizing limits of said discharge means and correspondingly vary the rate of oil flow through said regulating orifice.

3. In an oil burner, in combination a burner nozzle having a chamber for mixing air and oil under pressure and means for discharging said oil and air mixture under an atomizing pressure variable between predetermined maximum and minimum effective operating limits, oil and air pumping means having a sump for maintaining the air and oil under a common pressure therein, separate oil and air supply connections extending between said sump and said nozzle, a thin walled oil flow regulating orifice in said oil connection for discharging oil into said chamber, variable orifice means for selectively varying the pressure drop in said air supply connection to correspondingly vary the rate of oil flow through said regulating orifice, and means for varying said sump pressure to maintain said atomizing

pressure within said predetermined maximum and minimum limits.

4. In an oil burner, in combination, a burner nozzle having separate air and oil inlets communicating with a mixing chamber for mixing the air under pressure with the oil and provided with an oil and air mixture discharge orifice communicating with said mixing chamber for discharging said mixture under an atomizing pressure having predetermined maximum and minimum effective operating limits, a thin walled sharp edged oil flow regulating orifice mounted at the oil inlet to said mixing chamber, oil and air pumping means having a sump for maintaining the oil and air under a common pressure therein, separate oil and air supply connections extending between said sump and nozzle, and a plurality of different size orifice means, each adapted selectively to be mounted in said air

supply connection remotely from said nozzle for selectively determining the pressure drop in said air supply connection to correspondingly determine the rate of oil flow through said regulating orifice and means for varying said sump pressure to maintain said atomizing pressure within said maximum and minimum limits.

5. In combination, an oil burner atomizing nozzle having an oil and air mixing chamber provided with a thin walled oil flow regulating inlet orifice, oil and air supply means for said nozzle including an oil and air pressure equalizing sump having separate oil and air supply connections with the opposite sides of said orifice, and means for varying the oil rate of said nozzle including a variable flow restricting orifice means in said air supply connection and a pressure regulator for varying the pressure of said sump.

WILLIAM A. REED.