Nov. 26, 1935. A. MACCHI 2,022,513

OIL BURNING APPARATUS

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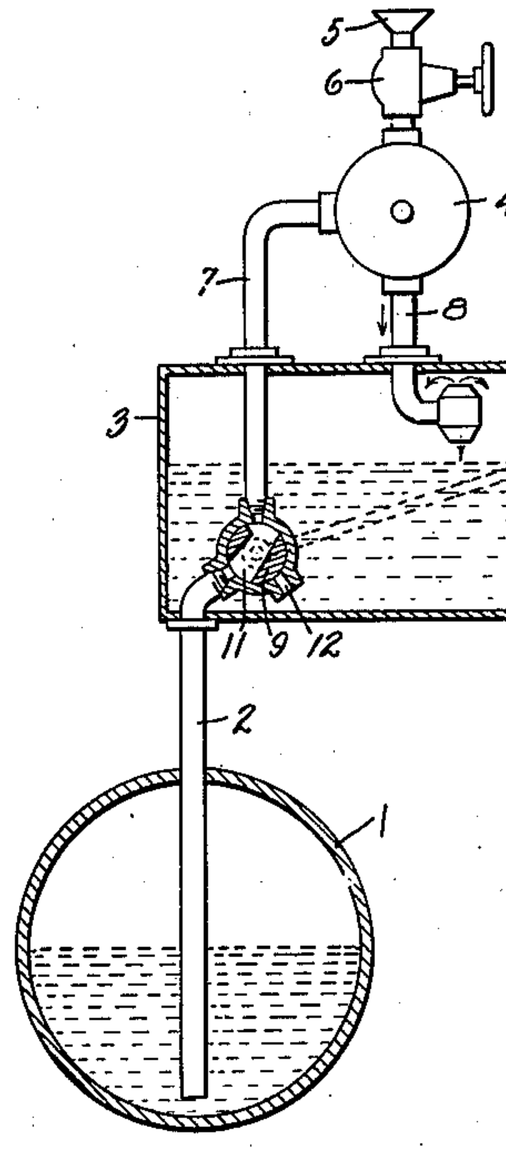

Fig. 1.

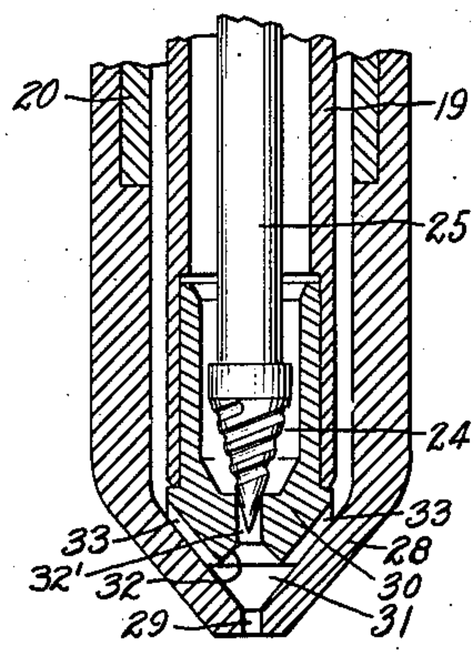

Fig. 2.

Inventor:
Aldo Macchi,
by Harry E. Dunham
His Attorney.

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OIL BURNING APPARATUS

Aldo Macchi, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application July 11, 1933, Serial No. 679,885

4 Claims. (Cl. 158—76)

My invention relates to oil burning apparatus, and particularly to apparatus for supplying, mixing, and delivering oil and air to the point where the oil is to be consumed. This application is a continuation-in-part of my copending application for Oil and air arrangement for oil burners, Serial No. 505,867, filed December 31, 1930.

One object of my invention is the provision of improved apparatus of this character by which the oil is delivered at a uniform rate in a highly atomized state and thoroughly mixed with air. Another object is the provision of improved oil burning apparatus which will produce a hot, steady, quiet and dependable flame.

My invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, Fig. 1 is a diagram illustrating one embodiment of my invention and Fig. 2 shows a detail thereof drawn to a larger scale.

While the apparatus which I am about to describe may be used for a variety of purposes where a hot, steady and quiet flame is desired, I have chosen to illustrate it as forming a part of a steam boiler of the character shown and described in my aforesaid application. Throughout the specification and claims I use the term "oil" as a convenient term to cover any liquid fuel whether such fuel in reality is an oil or not.

In Fig. 1 I have shown the oil storage tank 1 from which the oil is drawn through pipe 2 to the pressure chamber 3. Air to be mixed with the oil in the nozzle, which will be described later, also is supplied to the pressure chamber 3 whereby the oil and air pressures are equalized. If desired, separate pumps may be employed for the oil and the air, however, for a reason which I shall explain later, I prefer to employ a combined oil and air pump. In the drawing I have represented such a combined pump at 4 which for example may be of the sliding vane type. Air is drawn into the pump through the inlet 5 controlled by the valve 6; oil is drawn into the pump through pipe 7 and both oil and air are discharged from the pump at the desired pressure, which for example, is of the order of 15 lbs. per sq. in., through pipe 8 into chamber 3. The pump 4, which operates at uniform speed and preferably is driven by an electric motor, is constructed to deliver oil to the chamber 3 at a rate which is in excess of that which will ever be taken by the nozzle. In order to preserve a substantially constant level of oil in the chamber 3, or at least to keep it within definite limits, I employ the float actuated valve 9 through which oil may be drawn by the pump either directly from the storage tank 1 or from the pressure chamber 3 depending upon the position of the valve. The valve 9 is actuated by the float 10 and has the passage 11 therein which in accordance with its position connects pipe 7 either with pipe 2 or with the intake opening 12. It will be clearly seen that as the oil level rises above that illustrated where the pump is drawing oil entirely from the tank 1, the valve 9 is turned counterclockwise to cut off the connection of pipe 7 with pipe 2 and establish connection between pipe 7 and opening 12 whereby the oil then taken by the pump is drawn solely from the chamber 3. When the level of oil in chamber 3 descends the reverse operation takes place and the oil is again drawn from the tank.

The oil and air is conveyed from the chamber 3 by the feed pipes 15 and 16 respectively to the nozzle 17 to which I have already made reference and which I shall now describe. In accordance with my aforesaid application I have shown the nozzle arranged to direct the mixture of air and atomized oil which it produces in a downward direction where, for example, the nozzle constitutes a part of a steam boiler. It may, however, be pointed in any desired direction and be employed for various purposes where a hot flame is needed other than in a boiler. The nozzle 17 has a base or connection head 18 to which are secured the inner or oil pressure feed tube 19 and the outer or air pressure feed tube 20 which is concentric therewith. The inner tube connects by passage 21 with the oil supply pipe 15; the outer tube connects by passage 22 with the air supply pipe 16. For regulating the rate of oil consumption I provide a valve at some point in the supply pipe 15 through which the oil is supplied to the nozzle. Such a valve which is shown by way of example at 23 may comprise any well known form of regulating valve.

Adjacent the tip of the nozzle I have provided the oil shut-off valve 24, see Fig. 2, which is solenoid operated and has only two positions, namely, is either open or closed. By arranging this valve close to the nozzle tip, oil contained in the pipe 19 when the valve is closed and the flame extinguished is prevented from dripping from the nozzle. Valve 24 connects through the valve rod 25 with the plunger or armature 26 which is surrounded by the coil 27. The plunger 26 is guided

by a sleeve on the connection head by which it is in communication with the oil but which seals the coil from the oil. When the coil is energized the plunger is raised opening the valve and when the coil is deenergized the valve closes by reason of the weight of the plunger, the valve rod and the valve assisted by a small spring engaging the plunger. The upper portion of valve **24** has spiral grooves thereon which give the oil a rotary movement.

The outer tube **20** is provided with a tapered tip **28** having the central discharge opening **29**. The inner tube **19** has secured to it the valve seat member **30** which is tapered to fit the member **28** and has its end cut off to form with the member **28** a mixing chamber **31** for the oil and air. Member **30** has the bevel face **32** connecting with the central passage **32'** leading from the valve seat whereby the chamber **31** is enlarged and there is formed an expanding oil discharge orifice, the oil and air thereby becoming the more thoroughly mixed. The compressed air is delivered from the annular space between the inner and outer tubes to the mixing chamber **31** through the channels **33** formed in the face of the member **30**. Preferably these channels are slightly inclined so as to be tangential to the discharge opening **29** thereby causing the oil and air to rotate in the mixing chamber in the same direction that the oil rotates and becoming more intimately mixed. An important feature of my invention is that the discharge opening **29** restricts the discharge of the oil and air mixture since it is not only smaller than the combined passages **32'** and **33** but is smaller than the oil passage **32'** alone. The oil and air thus are mixed in the chamber **31** under a pressure materially above that of the atmosphere. Since the oil and air are supplied to the tubes **19** and **20** from the same pressure chamber **3** they will have approximately the same pressure except for small losses in pressure head due to friction and the valve **23**. This equalized oil and air pressure construction has the advantage that if any variation in pressure occurs both the oil and the air pressure must vary alike. I am therefore able to avoid difficulties due to improper proportioning of oil and air such as might result from a change in the pressure of either one alone.

In order to insure a proper and adequate flow of oil to the mixing chamber for producing the correct mixture I construct the channels **33** of such a size that they restrict the flow of air to the mixing chamber thus causing a predetermined pressure drop therein. Since the oil and the air are supplied under equalized pressures it will be seen that if any small variations in pressure occur the oil and air pressures must vary proportionally and since the flow of oil to the mixing chamber is dependent upon the pressure drop due to the air flow through the restrictive channels **33** it will be seen that I am able to secure and preserve automatically and by simple means a substantially uniform predetermined mixture of oil and air.

Notwithstanding the pressure drop in the channels **33** the pressure in the mixing chamber **31** is sufficient to expel the mixture of oil and air through the discharge opening **29** at a speed which in the vicinity of the nozzle is greater than the speed of the flame propagation. A few inches beyond the end of the nozzle due to the loss in speed because of friction and the spreading of the stream the rate of flame propagation equals the stream speed for the particular temperature that exists in proximity to the nozzle and at that point the flame is seen to begin.

A microscopic study of the oil spray produced by apparatus such as that described above has shown that the atomization of the oil is very complete. A measurement of the separate particles of oil constituting the spray shows that the particles for the most part vary in size from .0003 to .0015 inch. This study also revealed that the minute particles of oil composing the spray to a considerable extent are bubbles. It is obvious that the oil composing such bubbles has a much greater surface exposed to the air in proportion to its weight than it would if those particles were solid giving rise to a more complete combustion and hotter flame. The oil it might here be mentioned burns with an intensely hot, semi-transparent, bluish flame. The presence of bubbles in the oil spray is due in part to several features of the above described construction. The oil and air being forced into the pressure chamber **3** by the same pump necessarily produces a more or less intimate mixing thereof whereby the oil absorbs a certain amount of the compressed air. A further absorption of compressed air by the oil occurs in the pressure chamber where a considerable surface of oil is exposed to the air, the exposure being increased by any foam that may be present. In the mixing chamber **31** of the nozzle where the stream of air laden oil is met by the converging air blasts the oil and air are intimately mixed enabling further air to be taken up by the oil while the mass of mixed oil and air is rapidly rotated. Upon being discharged under pressure from the opening **29** the air which is mixed with the oil expands suddenly, thereby more completely atomizing the oil and by reason of the release of the pressure the air previously taken up by the oil also expands blowing the small oil particles into minute bubbles. In the presence of the intense heat of the oil vapor flame the oil in such a finely divided state and having such a large exposed surface quickly gasifies.

For the more complete combustion of the gasified oil I supply the nozzle with a steady flow of air externally thereof. I also cause the air thus supplied to flow along the nozzle whereby it serves to cool the nozzle thereby avoiding excessive heating thereof due to the intense heat of the flame. For this purpose I have provided the casing **36** which encloses the nozzle and to which air under low pressure is supplied by any suitable means such, for example, as the pipe **37** which may connect with a blower. At one end the casing is secured to the base **18** of the nozzle but at the other end it has an enlargement **38** terminating in a flange by which it is secured to the boiler shell **39**. At the lower end of the casing **36** and forming a portion thereof adjacent the discharge opening of the nozzle I have provided the combined heat shield and air deflector **40** which preferably is constructed of copper or some other good heat conducting material and is connected with the shell **39** in a manner to provide a good heat conducting joint. Member **40** thus serves to shield the nozzle from much of the heat of the flame. For the best results as an air deflector I have found that this member should be in the form of a flat truncated cone substantially of the form illustrated in Fig. 1 whereby the low pressure air is caused to converge at low velocity toward the discharge opening of the nozzle. Low pressure air is discharged into the enlargement through several openings **41**. Supported by the

enlarged portion 38 of the casing are the two electrodes 42 by which the oil vapor is ignited. To further protect the nozzle from the intense heat of the flame I have shown the inner casing or shield 43 which has air openings 44 therein and which terminates adjacent the shield 40.

The above described apparatus is particularly adapted to be used as the heat source of a steam boiler or hot water heater for domestic use. As so employed the apparatus would be used intermittently in accordance with the demand for heat and if controlled by a thermostat would be turned on and off automatically. Assuming the apparatus to be shut down and there is a demand for heat, the pump 4 is started and when the proper pressure has been built up in chamber 3 the circuit of solenoid 27 is closed to lift the valve 24 allowing the oil to pass into the mixing chamber where it is mixed with air already flowing through the passages 33 and discharged through the opening 29. Simultaneously a spark is made to jump between the electrodes 42 which ignites the mixture of oil and air. The flame stabilizes very quickly, becoming self-supporting, so that the spark then may be discontinued. When the nozzle is to be shut off the solenoid is deenergized allowing the oil valve 24 to close by gravity and pump 4 is stopped. Air continues to be discharged from the nozzle, however, until the pressure in the chamber 3 falls to that of the atmosphere, thus carrying with it any oil that may be left in the mixing chamber. What oil is left in the tube 19 of the nozzle is prevented by the valve 24 from dripping from the nozzle after being shut off.

I have chosen the particular embodiment described above as illustrative of my invention and it will be apparent that various other modifications may be made without departing from the spirit and scope of my invention which modifications I aim to cover by the appended claims.

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

1. In oil burning apparatus, an atomizing nozzle comprising a connection head, a tubular portion having oil and air passages therethrough secured at one end to said connection head and having a discharge opening at the opposite end, an enclosing casing for said tubular portion, means for supplying low pressure air thereto, said casing having an end portion constructed to shield the nozzle from the heat of the flame and to deflect said air toward the discharge opening and an intermediate air conducting casing also secured to said connection head for shielding the nozzle and conducting heat therefrom.

2. In an oil burner atomizing nozzle, the combination of an oil feed tube provided with an externally tapering tip at the end thereof having an expanding oil discharge orifice axially therethrough and having an internal oil valve seat formed at the small end of said orifice and provided with external slots terminating adjacent the large end of said orifice, a valve stem slidably mounted inside the oil tube and carrying a tapering valve head in operative relation with said valve seat, an air feed tube surrounding the oil feed tube and provided with a complementary internally tapering tip engaging the oil discharge tip to form an oil and air mixing chamber therebetween with restricted air inlets through said slots and provided with a restricted orifice for the mixed oil and air in alinement with said oil discharge orfice.

3. In oil burning aparatus, an atomizing nozzle comprising an inner tubular oil supply member having a discharge opening at the end thereof, a valve controlling said opening, a valve rod extending through said member, an air supply tubular member surrounding said oil supply member and a pressure mixing chamber at the end of said opening arranged to receive oil passing said valve and air from said air supply member, said chamber having a discharge opening in alignment with and smaller than said oil discharge opening.

4. In oil burning appaartus, an atomizing nozzle comprising inner and outer tubular members for supplying oil and air respectively, said nozzle having a pressure mixing chamber adjacent the end thereof provided with separate oil and air inlet passages connecting said chamber with said tubular members, a valve adjacent said chamber for controlling the flow of oil through said oil inlet passage and a valve stem extending through said oil supply member, said mixing chamber having a discharge passage which is smaller than said oil inlet passage.

ALDO MACCHI.

CERTIFICATE OF CORRECTION.

Patent No. 2,022,513. November 26, 1935.

ALDO MACCHI.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 22, claim 2, before "orifice" insert discharge; and line 24, claim 2, for "orfice" read orifice; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of January, A. D. 1936.

Leslie Frazer

(Seal) Acting Commissioner of Patents.