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METHOD OF AND APPARATUS FOR BURNING OIL.

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This invention relates to a method and apparatus especially intended or adapted for burning oil and other liquid or semi-liquid fuel, and aims to provide a method and apparatus of greater flexibility and efficiency than the methods and apparatus heretofore used.

The invention comprises a method wherein the oil or other liquid fuel is atomized by means of steam or air or other suitable gaseous medium under pressure and discharged in the form of a hollow cone, and the invention includes also apparatus for practicing the method.

Before my invention, oil has been burned efficiently in boiler furnaces and other furnaces in two ways, that is, by the use of mechanical atomizers by which the oil is discharged in the form of a hollow cone to which air is supplied from a register or adjustable air inlet means surrounding the atomizer, and by the use of steam or air atomizers by which the atomized oil is discharged with the steam or air in solid sprays of various forms. The use of steam atomizers for spraying the oil has important advantages over the use of mechanical apparatus. On the other hand, the spraying of the oil in the form of a hollow cone from a mechanical atomizer set in an air register has certain advantages over the use of solid sprays.

The method and apparatus of the present invention combines advantages of both mechanical atomization and steam or air atomization by spraying the fuel in the form of a hollow cone from a steam or air atomizer set in an air register or inlet passage through which air for supporting combustion is admitted to the outer side of the spray cone. In burning oil in this way there is secured also certain additional advantages which are not obtained with either of the old methods. The oil burning capacity of the burner apparatus under an available draft is greatly increased because of the greater permeability of the spray which permits the air to penetrate the cone wall and mix with the fuel more readily, and because of the greater volume and sustained velocity of the spray which tends to increase the air flow. Also the spray cone retains its shape or angular width, and the same fineness of atomization may be maintained, through a very wide capacity range, thus

insuring proper air mixture in a given size burner opening in the furnace wall throughout a wide range of capacity.

A full understanding of the invention can best be given by a detailed description of an apparatus of approved form made in accordance with the invention, and the operation thereof, and such a description will now be given in connection with the accompanying drawings illustrating an oil burning apparatus embodying the apparatus features of the invention and adapted for practicing the method.

In said drawings:

Fig. 1 is a central sectional view of an atomizer for discharging atomized liquid in the form of a hollow cone in accordance with the invention;

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

Fig. 3 is a sectional view of an oil burning apparatus comprising an atomizing device such as shown in Figs. 1 and 2 set in an air register mounted in a burner opening in a furnace wall; and

Fig. 4 is a front view of an orifice plate having a modified form of orifice.

Fig. 5 illustrates another form of orifice.

Referring to the drawings, the atomizing device comprises a body 10 formed with an opening or bore extending inward from its front end in which is fitted a removable plug 11 formed with a throat or passage 12 opening from its rear end and an enlarged chamber 13 in its forward portion, the throat 12 opening into the chamber 13 and the chamber 13 opening through the front end of the plug. The rear portion of the plug 11 is of reduced diameter so as to provide an annular chamber 14 within the body 10. The body 10 is also formed with a central opening or chamber 15, the forward wall of which is formed by the rear end of the plug 11 and from which the passage or throat 12 opens. From the chamber 15 a bore or opening extends to the rear end of the body 10, the inner end of which bore is of reduced diameter and threaded to receive a nozzle 16, and the outer end of which is closed by a plug 17, an open space or chamber 18 being left between the inner end of the plug 17 and the rear end of the nozzle 16. The body 10 also has an inlet passage 20 through which the oil or other liquid fuel is supplied to the chamber 15 from a

supply pipe 21. Steam or air or other gaseous medium under pressure is supplied through a supply pipe 22 to an inlet passage 23 formed in the body 10 and which communicates through a port 24 with the chamber 18 and also communicates with the passage 14. A cap or plate 25 held against the front end of the body 10 by means of a ring nut 26 forms the front wall of the mixing chamber 13 and is provided in the apparatus shown with a plurality of discharge orifices 30.

The liquid fuel, which may be fuel oil or crude oil or other suitable oil or tar or other suitable liquid or semi-liquid fuel, is supplied to the inlet passage 20 under pressure sufficient to maintain a supply of the fuel liquid in the chamber 15. The nozzle 16 and throat or passage 12 are arranged in axial alignment, and the rear or entrance end of the throat is somewhat flared and the nozzle is set to extend into the chamber 15 and suitably close to the flared entrance end, or entrance cone, of the throat, so that the jet of steam or other gaseous medium discharged from the nozzle into the throat will act to induce flow of the fuel liquid from the chamber 15 into the throat and to drive the same through the throat into the chamber 13. The fuel liquid thus driven through the throat 12 by the jet of steam or other gaseous medium is thereby broken up or partially atomized and mixed with the atomizing medium.

Leading from the annular passage 14 are a plurality of small passages or ports 35 for discharging jets of the steam or other gaseous atomizing medium into the chamber 13 for further atomizing the fuel liquid and maintaining the fluid in the chamber 13 in motion and the finely divided, or atomized, fuel liquid in suspension in the gaseous medium. These ports 35 are most desirably arranged to deliver the atomizing medium in a direction more or less tangential to the stream of atomizing medium flowing from the throat 12 so as to impart a whirling motion to the body of atomizing medium in the chamber 13 with its atomized fuel in suspension therein; and the discharge ends of these ports are most desirably located at the end of the passage 12 so that the jets issuing therefrom will be directed into the chamber 13 and will strike the stream of atomizing medium and partially atomized fuel as it flows from the passage 12 into the chamber 13. The atomizing medium with the atomized fuel carried thereby is discharged through the discharge orifices 30.

It will be noticed that as shown in Fig. 1 the rear wall of the chamber 13 extends outwardly at right angles from the wall of the passage 12. Having the rear wall of the chamber extend away from the end of the passage at approximately a right angle

seems to have an effect in securing a better atomization at this point.

In the operation of the atomizer, a body of the gaseous atomizing medium under pressure is maintained in the chamber 13 with the finely divided, or atomized, fuel in suspension therein, gaseous mixture from this body constantly being discharged through the discharge orifice or orifices, and the body being constantly renewed by the stream from the throat 12 and jets from the ports 35 in the form of atomizer shown. By suitable arrangement of the discharge orifice or orifices, the spray discharged from the chamber 13 may be given practically any desired form. Not only may solid sprays of various forms be produced, but a spray in the form of a hollow, and hollow cone sprays of other forms having relatively thin walls, may also be produced.

A hollow cone spray may be produced by providing the chamber 13 with a thin front wall such as the cap 25 shown in Figs. 1 and 2, of outwardly bulging form and provided with an annular or circularly arranged series of discharge orifices 30 arranged concentric with the axis or center line of the burner. The gaseous medium with the atomized fuel will be discharged through these orifices in a series of outwardly directed separate jets which as they expand merge together and form a hollow conical spray. The angular width of the spray cone will depend upon the arrangement of the orifices, and the thickness of the cone wall will depend upon the size of the orifices. In the device shown, in which the orifices 30 are formed in a thin cap plate, the direction of the individual jets and the angular width of the spray cone will be determined by the angle to the burner axis of the part of the inner wall of the cap plate in which the orifices are located, since the direction of the pressure of the fluid at the orifice will determine the direction of the jet. The invention is, however, of course not limited to the use of a thin orifice plate having a curvature which determines the jet direction, as the orifice may be otherwise formed to give the desired angular direction to the spray.

The series of orifices 30 arranged as shown may be considered as an annular orifice divided into a plurality of separate discharge openings for the purpose of producing a plurality of circularly arranged separate but closely spaced jets which at a short distance beyond the orifice plate unite to form a closed or circumferentially continuous spray cone wall. The use of a series of closely spaced separate openings has certain advantages, but the invention is, of course, not limited to the use of such a divided orifice, and an orifice formed of one or more slots might, of course, be employed. Fig. 13

4 shows, for example, an orifice plate having an annular orifice formed by three slots 30'.

Combustion air is most desirably supplied to the hollow cone spray, by setting the spray nozzle or atomizer in an air register, or air inlet opening, for supplying a flow of air against the outside of the cone in the same manner as is the practice with mechanical atomizers producing hollow cone sprays. An arrangement is illustrated in Fig. 3 which shows an atomizer A of the construction shown by Figs. 1 and 2 set in the center of an air register B mounted on a furnace wall 40 with the atomizer in position to discharge its spray cone centrally through a burner opening in the wall. The burner opening is provided with a fire-brick ring 41 of suitable form, and the size of the burner opening through the ring 41 and the position of the atomizer is such that the spray cone will substantially fill the opening without having the sprayed fuel strike against the wall of the opening, or surface of the ring 41. The air register or means for admitting air around the atomizer under the suction of the furnace draft, or, as it might be, under forced draft, may be of any suitable construction. An air register of known form is shown constructed to provide a main annular air inlet 42 and a series of inlet openings 43 immediately about and extending in close to the atomizer. An adjustable plate 44 having openings corresponding to the air inlet openings 43 may be provided for adjusting the effective size of the openings 43; and adjustably pivoted shutters 45 may be provided for controlling the amount of air entering through the main air inlet passage 42, and for giving the entering air a revolving or spiral movement. The annular air inlet passage 42 is advantageously shaped as shown to direct the air inwardly in a converging stream against the spray cone, and the firebrick ring 41 is desirably curved to provide a wall extending as a continuation of the outer wall of the air register inward toward the path of the spray cone, and then outwardly, thereby providing a burner opening in passing through which the spray cone will exert a greater flow inducing action on the air than would be the case if the wall of the burner opening were not so formed. The invention is not, however, limited to any particular form of burner opening.

The method of burning liquid fuel by atomizing fuel by means of gaseous medium under pressure and discharging the mixture of fuel and gaseous medium in the form of a hollow cone and directing combustion supporting air against the outside of the cone, and apparatus comprising means for atomizing liquid fuel by a gaseous medium under pressure and discharging the mixture in a

hollow cone spray set in an air register or air inlet means for supplying air to the outside of the spray cone, possess important advantages not realized in spraying liquid fuel in the form of a hollow cone from a mechanical atomizer set in an air register.

A burner constructed and operating in accordance with the present invention has a greater capacity for a given available draft than a mechanical atomizing burner. It has been found that to burn an equivalent amount of oil through the same burner opening in the furnace wall a mechanical atomizer set in an air register demands a much stronger draft and higher velocity of air than a steam atomizer set in an air register and discharging a hollow cone spray. Comparative tests have shown that in so burning an equivalent amount of oil a steam atomizer burner requires only about one-half to one-third of the draft required by a mechanical atomizing burner. This greater capacity of the hollow cone spray steam atomizing burner is probably due to the greater diffusion of the oil in the spray and greater permeability of the steam and atomized oil spray as compared to the spray from a mechanical atomizer; and also to the greater volume and higher sustained velocity of the steam atomized spray resulting in stronger flow inducing action on the entering air.

The wall of the spray cone is also permeable to the air considerably closer to the discharge orifice than is the case with a mechanically atomized hollow cone spray. This is so even if the spray is discharged from an orifice in the form of a continuous or uninterrupted slot, and when the spray is discharged from an orifice formed by a series of closely spaced separate openings, as shown in Fig. 2, the open spaces between the separate jets close to the orifice plate afford opportunity for ready entrance of air striking the spray at this point.

The burner construction of the present invention will also operate efficiently through a much greater capacity range than a burner discharging a mechanically atomized hollow cone spray. This greater flexibility is due not only to the characteristics of steam or air atomization which give a greater flexibility in discharging the fuel in a solid spray, but also to the fact that the hollow spray cone retains the same angular width at all rates of oil consumption within the limits of the burner and furnace. The angular width of the cone of a hollow cone spray from a steam or air atomizer is, as stated, fixed by the form and arrangement of the discharge orifices, and does not depend, as is the case with the mechanical atomizer, on the velocity of rotation and resulting centrifugal force. As in discharging the fuel in a solid spray from a steam or air atomizer, so also in discharging the fuel in a hol-

low cone spray, the same fineness of atomization may be secured at all rates of oil consumption within the range of the apparatus.

6 It may be noted that when steam is employed as the atomizing medium, or if other atomizing medium employed is preheated to a sufficient degree, the oil is more or less vaporized before being discharged from the atomizer.

10 A further very important advantage of the present invention is that it is not limited to the production of a hollow spray which is annular in cross-section, since by using discharge orifices of suitable shapes outwardly spreading hollow sprays of various forms in cross-section may be produced. For example, an orifice shaped as shown by Fig. 5 would produce a half conical hollow spray with a flat side. When an atomizer for discharging such a spray is used in an air register, the burner opening in the furnace wall is made to correspond in shape to the cross-sectional shape of the spray.

25 What is claimed is:

1. The method of burning liquid fuel, which comprises discharging a mixture of the fuel and a gaseous medium in the form of an outwardly spreading thin walled hollow spray, the fuel being in a finely divided condition in suspension in the gaseous medium, and causing air to flow against the outer side of the spray wall and to enter the same.

35 2. The method of burning liquid fuel, which comprises discharging a mixture of the fuel and a gaseous medium in the form of a thin walled hollow conical spray, the fuel being in a finely divided condition in suspension in the gaseous medium, and causing air to flow against the outer side of the conical spray wall and to enter the same.

40 3. The method of burning liquid fuel, which comprises atomizing the fuel liquid by means of gaseous medium under pressure and discharging the gaseous medium with the atomized fuel in suspension therein in the form of an outwardly spreading thin walled hollow spray through a burner opening of such size and form that the spray passes closely adjacent to the wall of the burner opening, and thereby inducing a flow of air into the burner opening and against the spray wall to enter the same and mingle with the atomized fuel.

45 4. The method of burning liquid fuel, which comprises maintaining under pressure a body of gaseous medium having finely divided fuel in suspension therein, discharging the mixture of gaseous medium and fuel in a multiplicity of circularly arranged outwardly directed jets which combine to form a spray in the form of a thin walled hollow cone, and directing air against the outer side of said jets and spray cone.

5. Apparatus for burning liquid fuel, comprising means for discharging a mixture of the fuel and a gaseous medium in the form of an outwardly spreading thin walled hollow spray, the fuel being in a finely divided condition in suspension in the gaseous medium, and means for causing air to flow against the outer side of the spray wall.

6. Apparatus for burning liquid fuel, comprising means for maintaining a body of gaseous medium under pressure with the fuel in a finely divided condition in suspension therein, means providing a discharge orifice through which the mixture of gaseous medium and fuel is discharged in the form of an outwardly spreading thin walled hollow spray, and means for causing air to flow against the outer side of the spray.

7. Apparatus for burning liquid fuel, comprising means for maintaining a body of gaseous medium under pressure with the fuel in a finely divided condition in suspension therein, means providing an orifice through which the mixture of gaseous medium and fuel is discharged in the form of a thin walled hollow cone, and means for causing air to flow against the outer side of the spray cone.

8. Apparatus for burning liquid fuel, which comprises means for maintaining a body of gaseous medium under pressure with the fuel in a finely divided condition in suspension therein, means providing a discharge orifice formed by a series of separate closely spaced circularly arranged openings for discharging the mixture of gaseous medium and fuel in a multiplicity of circularly arranged outwardly directed jets which combine to form a spray in the form of a thin walled hollow cone, and means for causing air to flow against the outer side of the spray cone.

9. Apparatus for burning liquid fuel, comprising an air register mounted on a furnace wall having a burner opening therein extending from the air register; and an atomizing device set in the air register comprising a chamber having a discharge orifice opening from the front thereof, and means for supplying to and maintaining within the chamber a body of gaseous medium under pressure with the fuel in a finely divided condition in suspension therein, the discharge orifice being formed to discharge the mixture of gaseous medium and fuel from the chamber in the form of an outwardly spreading thin walled hollow spray which passes closely adjacent to the wall of the burner opening and is of cross-sectional form corresponding to the shape of the burner opening.

In testimony whereof I have hereunto set my hand.

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