

April 21, 1931.

D. J. IRISH

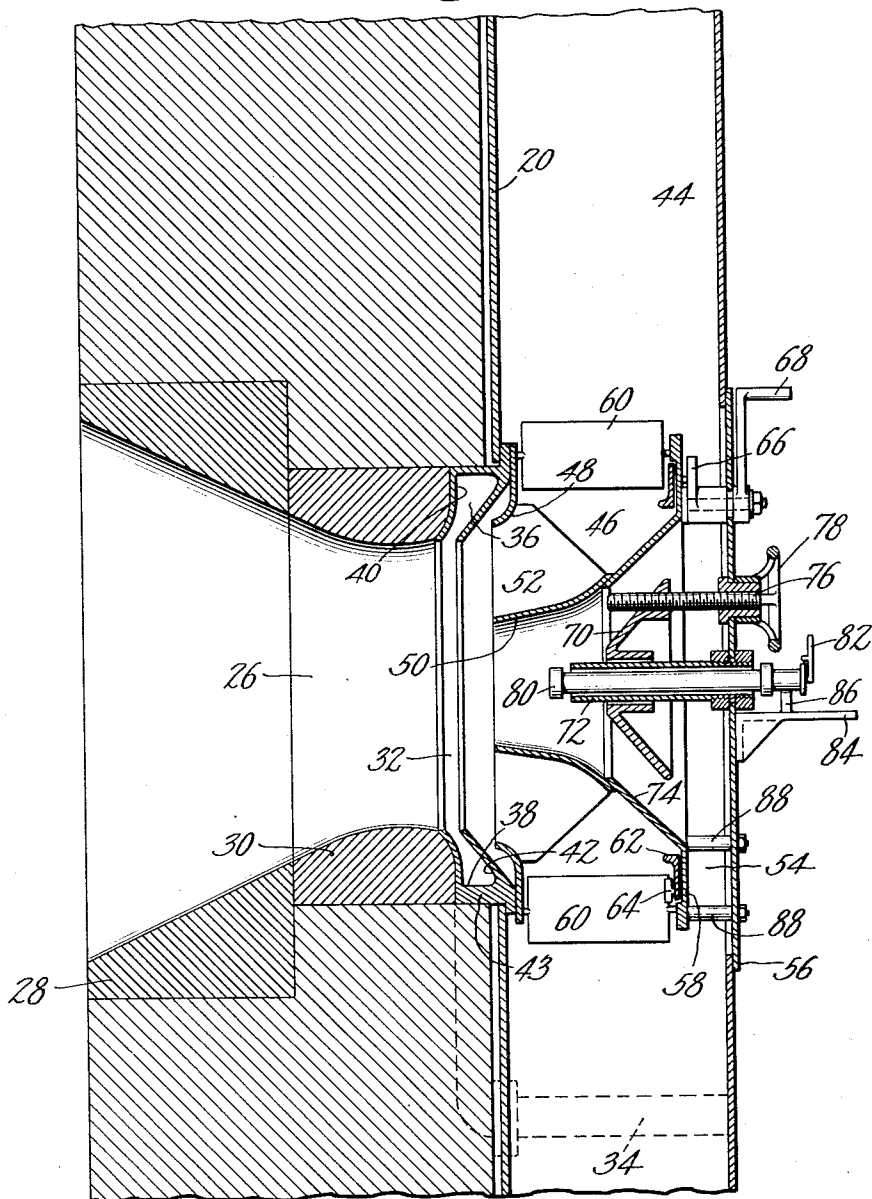
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METHOD AND APPARATUS FOR BURNING FUEL

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Fig. 2.



WITNESS

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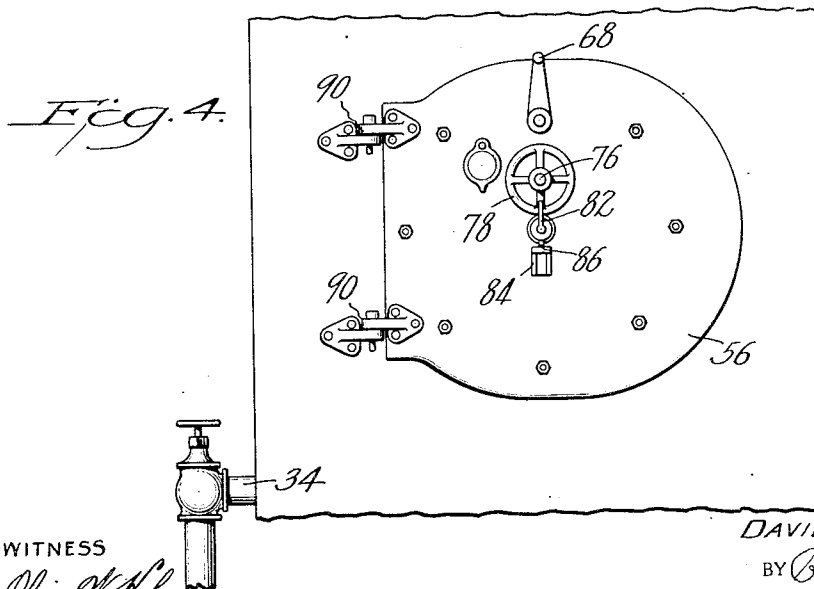
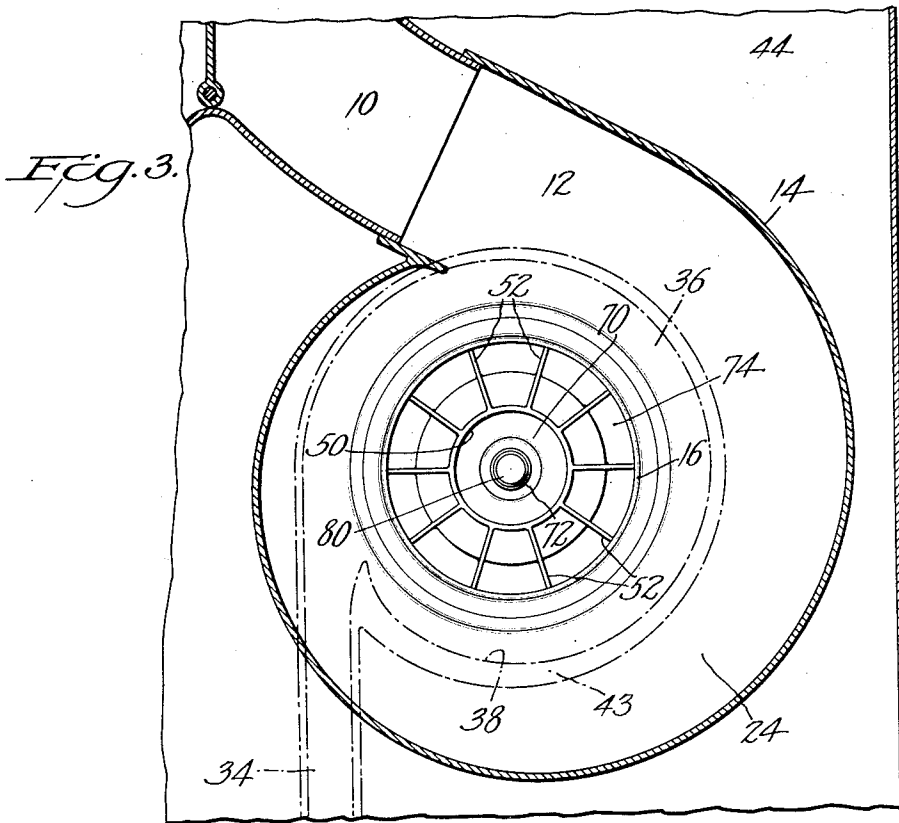
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3 Sheets-Sheet 3



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METHOD AND APPARATUS FOR BURNING FUEL

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My present invention relates to a method and apparatus for burning fuel, and more particularly to methods and apparatus capable of burning liquid, gaseous or solid fuels in a flowing stream either singly or in combination. More specifically the invention relates to a method and apparatus by which the length and dimensions of the flame, and the rapidity of combustion may be controlled and regulated in burning liquid, solid or gaseous fuels.

The quantity of fuel that may be burned in a furnace, and consequently the quantity of heat produced and absorbed in boilers or other apparatus heated by the furnace, is limited very largely by the size of the furnace and the rate of combustion of the fuel. For most efficient combustion, the fuel should be completely burned in the fire box before coming into contact with the relatively cool surface of the boiler or boiler tubes as otherwise the chilling effect of these surfaces interferes with the complete and uniform combustion of the fuel. As it is uneconomical and wasteful of heat to have the fire box larger than necessary to burn the fuel at the required rate, efficiency of combustion is promoted by regulating the rate of combustion and the length and size of the flame in accordance with the demand for heat.

An object of the present invention is to provide a method and apparatus by which the speed of combustion, the length and breadth and intensity of the flame may be controlled to meet varying demands on the boiler or steam generator and to increase the capacity of the boiler when desired.

The burning of different types of fuel in suspension requires different conditions. Thus, gaseous fuels require merely a thorough mixing with air and then ignition; liquid fuels require a preliminary atomizing and heating and vaporization before mixing with the air; while powdered fuel requires that the fuel particles be kept in suspension, heated to the ignition temperature and brought into contact with continually renewed volumes of air until completely burned.

Another object of my invention, therefore, is to provide a fuel burner that is adaptable

to the burning of various types and combinations of fuels, and to adjusting the conditions of combustion to meet the requirements of each fuel or fuel combination.

Further objects and features of the invention are to provide highly efficient means for rapidly and thoroughly mixing streams of fuel and air for combustion, and to provide improved means for controlling and proportioning the streams of air and fuel at the point or place of mixing.

With these and other objects in view, which will appear more fully in the following description, the invention comprises the method and apparatus described and claimed in the following specification and claims.

The various features of the invention are illustrated in the accompanying drawings in which;

Fig. 1 is a vertical sectional view of a fuel burner embodying a preferred form of my invention and showing the burner adapted to burn liquid, gaseous and pulverized solid fuel,

Fig. 2 is a vertical sectional view taken similarly to that of Fig. 1, but showing the apparatus adjusted for the burning of liquid and gaseous fuels, the elements for burning suspended powdered fuels being omitted,

Fig. 3 is a vertical sectional view of the burner taken on line 3—3 of Fig. 1, and,

Fig. 4 is a vertical front view of the furnace and burner.

In the mixing and burning of air and fuel complete and rapid combustion is attained by providing a sufficiently long path of travel and passing the fuel and air through this path at a high speed and with thorough agitation. These conditions are obtained in my present invention by causing the air and fuel to travel in a helical direction, rather than in a straight direct path through the fire box. The length of this path may be controlled by varying the pitch of the spiral and thus the directness of travel. This is accomplished by forcing a direct current of air through the burner axially of the helically moving air and fuel streams. Thus when the pitch of the helix is increased by increasing the velocity of the directing blast of air, a relatively thin, nar-

row flame is obtained while, when the amount of direct blast is decreased and the pitch of the spiral correspondingly decreased, a relatively shorter, spreading flame is produced, permitting a greater amount of fuel to be burned in the furnace. In thus passing the air and fuel in a controlled helical movement, a rotating annular blast of gaseous fuel or of solid fuel suspended in air is formed and the air for combustion and for controlling the flame is blown in centrally of this rotating annular sheet. In forming the annular sheet of fuel it is, of course, necessary that equal distribution should be obtained throughout the circumference and that a concentration or excess velocity of fuel at any portion of the annular sheet should be avoided as this would cause an uneven distribution and imperfect mixture of the air and fuel. For this purpose the gaseous or suspended powdered fuel is caused to circulate in an involute path about an annular opening, the size of the stream being decreased to force the gaseous or suspended solid fuel forwardly in a thin rotating sheet.

Referring more particularly to the accompanying drawings a current of air carrying in suspension finely divided solid fuel is supplied through a conduit 10 which leads into a chamber 12 having an outer wall 14, curved in the form of an involute of a circle about a central ring 16 that forms the inner circumferential wall of the chamber. A side wall 18 of the conduit 12 is positioned against the outer surface of a furnace 20, and the inner periphery of the wall 18 is spaced somewhat from the ring 16 to leave an annular opening 22 therebetween. As the air passes through the chamber 12 it is given a uniform rotating movement by the curvature of the wall 14 and as the radius of the curvature of the wall decreases and the wall approaches the ring 16, the air and suspended fuel are forced in a uniform rotating annular sheet through the opening 22. The air and suspended fuel are also guided toward the opening 22 by the opposite wall 24 of the chamber 12 which is curved towards the opening 22 as it approaches the ring 16. This wall 24 may also be sloped to decrease the width of the chamber 12 as it curves about the ring 16.

The air and suspended fuel passing in a whirling annular sheet through the opening 22 enter a Venturi opening or passage 26 in the wall 20 of the furnace. This Venturi opening 26 is lined with circular fire bricks 28 and 30 and has a gas feeding nozzle 32, between the outer lining brick 30 and the opening 22 of the chamber 12. Gas is supplied to the gas feeding nozzle 32 from a pipe 34 leading to an annular chamber 36, which also has a wall 38 curved in the form of an involute so that the gas is forced to circulate about the nozzle 32 and because of the involute form of the wall 38 is fed forwardly

through the nozzle 32 at a uniform rate throughout the circumference of the nozzle. The chamber 36 has a side wall 40 lying against the outer edge of the brick 30 and curved to retain this brick in place. The other side wall 42 of the chamber 36 forms a guiding surface for the air and suspended solid fuel leaving the opening 22 and entering the Venturi opening 26. The involute chamber 36 is ordinarily curved in the same direction as that of the curvature of the chamber 12. The outside thickness or width of the chamber 36 is uniform throughout its circumference. As the radius of curvature of the outer wall 38 decreases, however, the inside width of the chamber 36 is also decreased by increasing the thickness of the wall 42 as indicated at 43.

Air for combustion of the fuel supplied through the involute chambers 12 and 36 is forced or drawn into an air chamber 44 which encloses and surrounds the involute chamber 12. The air supplied to the chamber 44 passes through an annular passage 46, formed between an annular guiding plate 48 and a funnel 50, arranged concentrically therewith, and thence centrally through the ring 16 and enters the Venturi opening 26 centrally of the annular streams of fuel issuing from the passageway 22 and nozzle 32. The air passing through the passage 46 is given a rotating or whirling movement by a number of spaced curved vanes 52, extending between the outlet portions of the rings 48 and the funnel 50. These vanes 52 are preferably so curved as to rotate the air entering the ring 16 in a direction of rotation opposite that of the fuel entering the venturi 26 from the passages 22 and 32. The counter rotation of the air and fuel streams causes a thorough agitation and mixing of the air and fuel volumes as they meet. Thus the air and fuel are thoroughly mixed before progressing very far into the furnace and a very rapidly burning, short flame is produced.

The length and characteristics of this flame may be modified, however, by causing a portion of the air from the chamber 44 to pass through an annular passage 54, between a door 56 of the chamber 44 and a flange 58 projecting outwardly from the larger edge of the funnel 50, and to then pass forwardly in a direct blast through the funnel 50. By appropriately proportioning the quantities of air passing through the passageway 52 and through the funnel 50, the relation between the rotation of the resulting central blast of air and its forward movement may be controlled. Thus, by increasing the relative quantity of air passing through the passage 46, the rotational, spreading movement of the air may be increased, resulting in a short, intense flame whereas, by increasing the quantity of air passing through the funnel 50 relative to that passing through the pas-

sage 46, the forward movement of the air may be increased and a relatively longer, slower burning flame may be produced.

The quantity of air passing through the passage 46 may be controlled by means of a series of annularly arranged dampers 60 pivoted between the outer edges of the plate 48 and the flange 58, and positioned by means of a rotatable annular plate 62 through pins 64 on the dampers 60 that engage suitable slots of the ring 62. The position of the ring 62 is controlled by means of a crank 66, pivoted on the flange 58 and extending through the door 56 and provided with a handle 68 outside of the door 56. The quantity of air passing through the funnel 50 may be controlled by means of cone shaped valve 70, slidably mounted on a supporting pipe 72 projecting from the door 56 axially into the funnel 50. The cone valve 70 may be moved towards or from a corresponding cone shaped surface 74 of the funnel 50 by means of a rotatable screw 76, mounted on the door 56 and threaded through a suitable opening in the edge portion of the cone 70. The screw 76 may be rotated by means of a hand wheel 78 on the outer face of the door 56. When the screw 76 is rotated in one direction the valve 70 approaches the surface 74 and narrows the annular passage through which the air passes through the funnel. When rotated in the opposite direction, the cone valve 70 is moved away from the surface 74 enabling the area for the passage of air to equal or exceed the area of the outlet passage of the cone 50.

A liquid fuel burner 80 may be mounted to extend through the tubular support 72 and deliver into the outlet end of the funnel 50. This liquid fuel burner is provided with a control valve 82 and is supported on a projecting bracket 84 by means of a movable support 86, which permits the burner to be advanced to the outlet end of the funnel 50 or to be retracted to the position shown in Fig. 1.

The involute chamber 12 and the ring 16 are supported on the outer face of the furnace wall 20 by bolts or other commonly used means. The funnel 50, ring 74 and the associated dampers and control mechanism are mounted on the door 56 so that when this door is swung open on its hinges 90, the air passages are swung out of the chamber 44 and exposed for inspection, cleaning or repairs. For this purpose the funnel 50 is supported on the door 56 by means of spacing bolts 88 extending between the door 56 and the flange 58. The ring 48 is supported on the smaller end of the funnel 50 by means of the vanes 52 which are rigidly secured to both the funnel and the plate 48.

In the arrangement shown in Fig. 1, the apparatus may be used to burn powdered fuel, gaseous fuel or liquid fuel, or to burn any combinations of these fuels. However,

when the apparatus is desired for the burning of oil or gas and not for the burning of powdered fuel, the involute chamber 12 may be removed entirely and the elements compacted to the position shown in Fig. 2. In this case the ring 48 rests directly against the wall 42 of the chamber 36. The air entering through the passageway 46 and through the funnel 50 comes directly into direct contact with gaseous fuel issuing from the nozzle 32. As these streams of gaseous fuel and air preferably rotate in opposite direction an immediate and very thorough mixing is obtained.

Through my present invention it will be apparent that the size and characteristics, and quality of a flame may be easily adjusted to meet any desired conditions. Any unevenness in the mixing of the fuel is also avoided. The apparatus by which these difficult functions are attained is moreover of the simplest construction.

As changes of construction could be made within the scope of my invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

Having described my invention what I claim and desire to secure by Letters Patent is:

1. Apparatus of the type described which comprises an annular fuel feeding chamber encircling a central air passage and having an outlet opening encircling said air passage and an inlet, the radial section of said chamber progressively decreasing from said inlet in one direction about said passage, a central funnel in said air passage, means in the annular space between said chamber and said funnel to create a whirling movement to the air passing through the annular air passage, and a valve slidable axially to and from the wall of said funnel to control the amount of air passing therethrough.

2. Apparatus of the type described which comprises a fuel feeding chamber having a curvature about a central air passage the radial sectional area of said chamber decreasing progressively, and having an annular opening to said air passage, a central funnel in said air passage, a common air supply means for said air passage, means in the annular space between said chamber and said funnel to create a whirling movement in the air passing therethrough, a conical valve slidable axially in said funnel and a stationary screw threaded in said valve to move said valve axially to and from the wall of said funnel.

3. A furnace wall having a Venturi opening therethrough, an annular fuel feeding chamber of decreasing radial sectional area forming the inlet edge of said Venturi opening and having an annular outlet at the inlet edge of said Venturi passage, an air supply

- chamber covering said opening, a funnel positioned in said supply chamber coaxially with said Venturi opening to form with the annular inner wall of said fuel passage a converging annular passage and a central passage to said Venturi passage, means in said annular passage to rotate the air passing therethrough in a direction counter to the direction of rotation of the fuel issuing from said annular outlet, a burner pipe projecting axially into said funnel, and a damper slidable lengthwise of said burner pipe to and from the edge of said funnel.
4. Apparatus of the type described which comprises a furnace wall having a Venturi passage therethrough, a fuel feeding chamber of involute form at the inlet edge of said Venturi passage and having an annular orifice towards said Venturi passage, an air supply chamber covering said Venturi passage and having a door opposite said passage, a funnel mounted on said door in said chamber coaxially with said Venturi passage to form with the annular inner wall of said fuel passage a converging annular passage and a central passage from said air chamber to said Venturi passage, means in said annular passage to rotate air passing therethrough in a direction counter to the rotation of fuel issuing from said involute chamber, a fuel burner pipe mounted on said door and projecting axially into said funnel, and a damper slidably mounted to slide lengthwise of said burner pipe to control the passage of air through said funnel.
5. Apparatus of the type described which comprises a furnace wall having an annular Venturi passage therethrough, a gas feeding chamber of decreasing radial section at the inlet edge of said Venturi opening and having an annular orifice at the inlet edge of said Venturi passage, an annular powdered fuel supply chamber of decreasing radial section positioned against the outer wall of said furnace coaxially with said Venturi passage, and having an annular opening concentric with that of said annular gas chamber, means for supplying an annular blast to the inlet of said Venturi passage axially of said fuel chambers and for rotating said air in a direction counter to the rotation of fuel from said fuel chambers and means for supplying a non-rotating central blast of air entering axially of said annular blast of air, and means for regulating the flow of said central blast of air.
6. Apparatus of the type described which comprises a furnace wall having a Venturi passage, a gas supply chamber of involute form set in the inlet edge of said passage and having an annular outlet at its inner circumference, a ring in front of said involute chamber, a funnel mounted axially of and spaced from said ring, curved vanes spanning the space between said ring and funnel, a liquid fuel burner projecting axially into said funnel and means for moving said burner axially in said funnel.
7. Apparatus of the type described which comprises a furnace wall having a Venturi passage, a gas supply chamber of involute form set in the inlet edge of said passage and having an annular outlet at its inner circumference, a ring in front of said involute chamber, a funnel mounted axially of and spaced from said ring, curved vanes spanning the space between said ring and funnel, liquid fuel burner projecting axially into said funnel and means for moving said burner axially in said funnel, and a damper encircling and movable axially of said liquid fuel burner and said funnel to control the passage of air through said funnel.
- In testimony whereof I hereunto affix my signature.
- DAVID J. IRISH.

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