Dec. 28, 1948. J. M. CROWE 2,457,304

ATOMIZING FUEL BURNER WITH COOLING JACKET

Filed Jan. 23, 1945

2 Sheets-Sheet 1

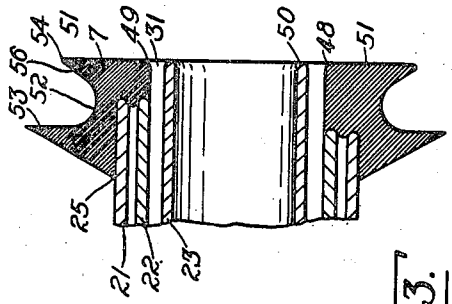


Fig. 3.

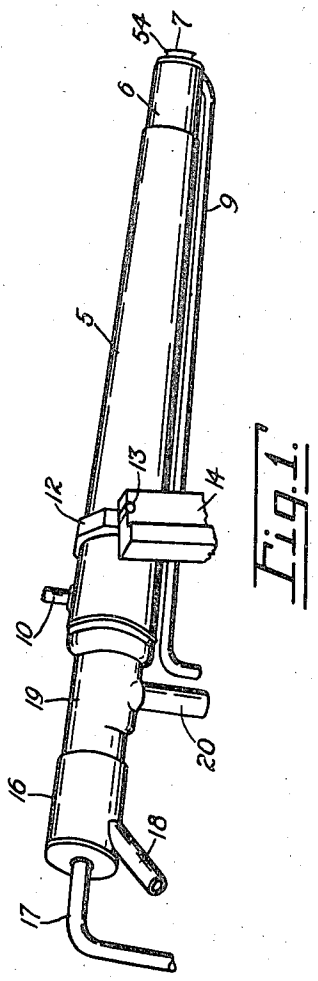


Fig. 1.

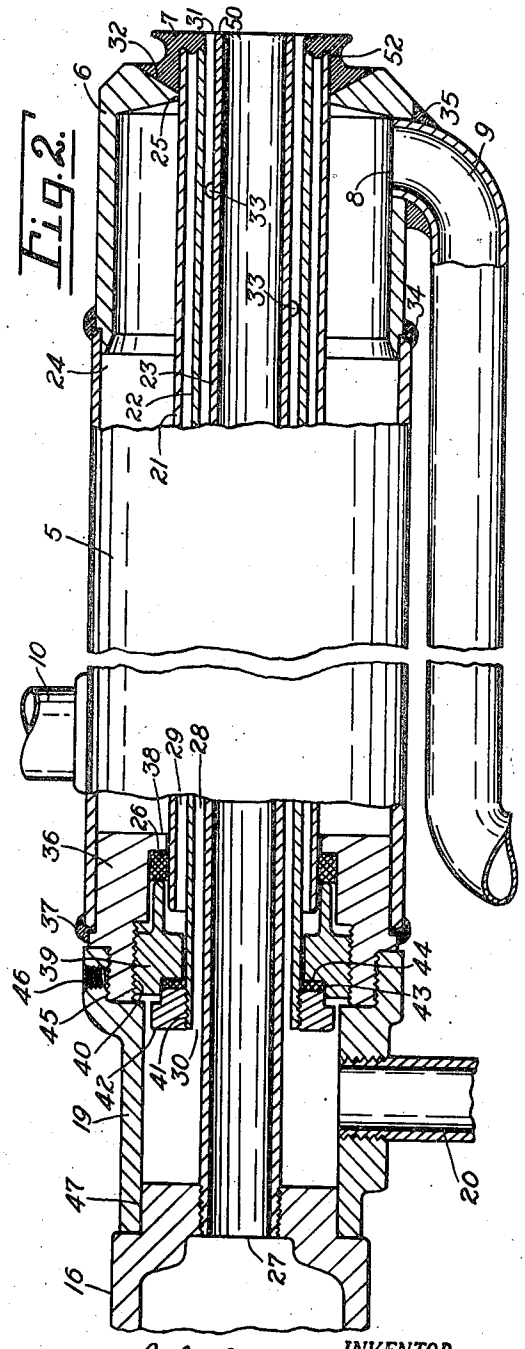


Fig. 2.

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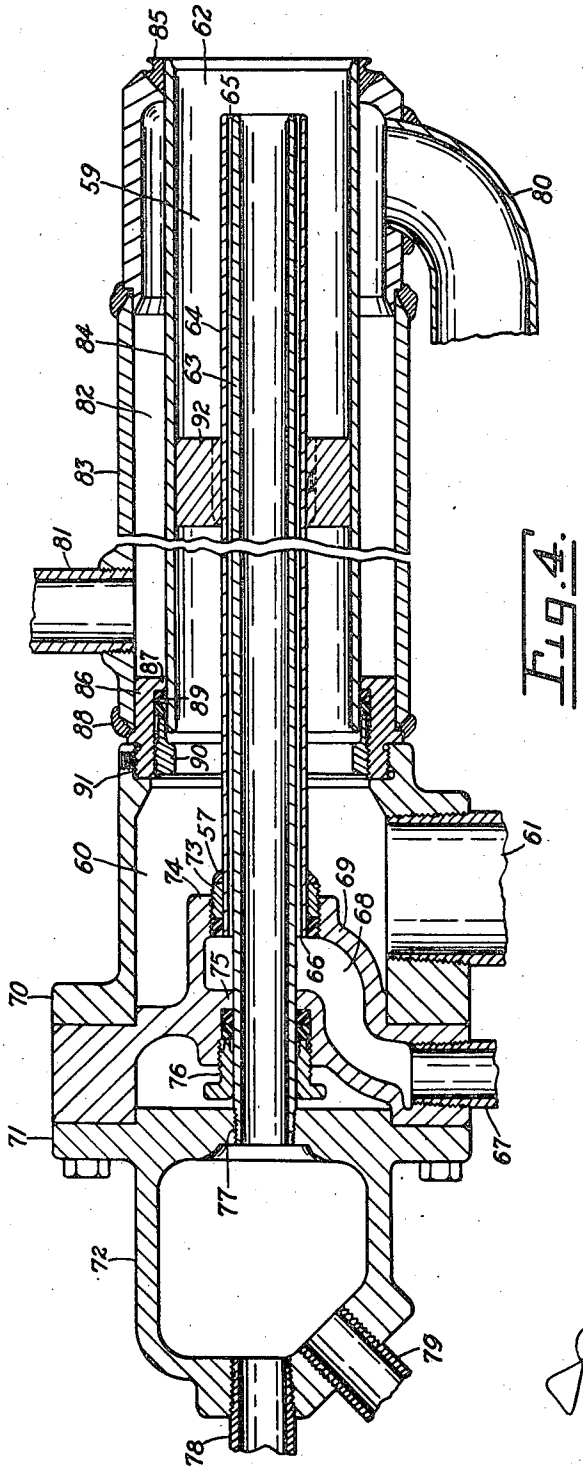


Fig. 4.

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Patented Dec. 28, 1948

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UNITED STATES PATENT OFFICE

2,457,304

ATOMIZING FUEL BURNER WITH COOLING JACKET

John Marshall Crowe, Covington, Ky.

Application January 23, 1945, Serial No. 574,049

9 Claims. (Cl. 158—11)

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This invention relates to a burner of the general character illustrated and described in my issued U. S. Patent No. 2,338,623, dated January 4. 1944. Although the burner may be employed in other environments, it is particularly adapted for operation under conditions of high temperature surroundings, for example, within the combustion chamber of an open hearth steel manufacturing furnace, a heat treating furnace, or the like.

One of the objects of the invention is to provide a burner constructed to withstand the destructive effects of high temperature surroundings as above mentioned.

Another object is to provide a burner of the character stated, which will operate at high efficiency using as a fuel such heavy viscous substances as fall within the category of pitch, tar, or any of the heavy oils.

Another object is to provide in a burner of the character referred to, means for effectively preventing congestion of heavy fuel within the burner when used in intermittent operation, and to avoid the formation of a slag at the tip of the burner causing deflection of the fuel and interfering with projecting the flame onto the object or area to be heated.

A further object is to provide the aforesaid type of burner with a self-cleaning nose, whereby the burner is maintained always in proper condition for effective use.

The foregoing and other objects are attained by the means described herein and illustrated in the accompanying drawings, in which:

Fig. 1 is a perspective view of a complete burner, showing the various water, steam and fuel connections.

Fig. 2 is an enlarged fragmental elevational view of the burner, parts being broken away and shown in cross-section.

Fig. 3 is a detail view showing on an enlarged scale the tip of the burner nose.

Fig. 4 is a view similar to Fig. 2, showing a modification of the burner.

Before proceeding with a detailed explanation of the instant burner, an understanding should be had concerning the conditions under which such a burner is often required to operate. For instance, in an open hearth steel manufacturing furnace, it is customary to employ batteries of burners at opposite ends of the hearth, the burners being directed toward the melt of the hearth and exposed to the extremely high temperature of the combustion chamber. The temperature of the furnace may rise to 3150° F. and

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in order for the burners to withstand the heat, they are jacketed and cooled by means of a copious stream of cold water circulated therethrough.

Under some systems of furnace operation, the burners at opposite ends of the hearth are placed in operation intermittently, or alternatively. This practice, while favorable to the operation of the furnace, often results in choking of the burner or burners not in use. It has been discovered that slag from the melt will sometimes enter the nose of a burner not in operation, and thereby impair the efficient operation of the burner when restored to use. Another difficulty arose from choking of a burner at rest, with its own fuel. This condition was noticeable particularly in the burning of heavy fuels such as pitch, tar and heavy residues of a similar nature. Difficulties also arose from a tendency of the furnace roof to release siliceous drippings onto the nose of the burner, thereby interfering with the free discharge of fuel therefrom.

All of the foregoing difficulties have been overcome by constructing the burner in accordance with the present disclosure. The improved burner is not subject to clogging either while in operation or while at rest, even though the fuel employed for its operation be of the consistency of pitch or like substances.

Referring to the accompanying drawing, the character 5 indicates the body of the burner, or the outer tube or cylinder thereof, which carries at its front end a nose piece 6, and at its rear end the means necessary for introducing fuel into the burner. The nose of the burner has a tip 7, and includes a port 8 through which a coolant fed by a pipe 9, enters the forward end of the burner, and circulates therethrough until released through the outlet pipe 10. The burner preferably is dirigible, and may accordingly include a saddle 12 having trunnions 13 at opposite sides of the burner resting upon suitable supports 14. At the rear of the burner is fixed a mixer or atomizer 16, into which fuel from pipe 17 may be fed, while steam enters the mixer through a second pipe 18 to violently agitate and break up the fuel preparatory to ejection through the burner and onto the object or area to be heated. The character 19 indicates a steam manifold housing into which steam under pressure may be fed through a pipe 20, for purposes to be explained hereinafter.

By referring to Fig. 2, it will be noted that the body of the burner comprises a series of tubes or cylinders, these being numbered 5, 21, 22 and

23. The tube 5 constitutes the outer wall of a water jacket 24, of which the tube 21 forms the inner wall. This water jacket is in communication with the coolant supply pipe 9 at the forward end of the burner and extends practically the full length of the burner. Water entering the jacket through the pipe 9 circulates along and about the inner jacket wall or tube 21, and finally leaves by way of the exhaust pipe 10. The jacket space 24 is water tight at 25 where the tube 21 is welded or otherwise fixed to the nose of the burner. Adjacent its rear end, the tube 21 may be sealed exteriorly by means of packing 26, as shown.

As indicated upon the drawing, the innermost tube 23 extends to the extreme front of the burner tip, and in the rearward direction it passes through the manifold 19 and has its open rear end 27 in communicating relationship with the fuel mixer or atomizer which is indicated generally by the character 16. As the mixer or atomizer forms no part of the present invention, and is available in various forms, it will be unnecessary to describe same in detail herein. It may be noted, however, that fuel enters the atomizer through a pipe 17, and upon reaching the interior of the atomizer, the fuel is subjected to the atomizing effect of steam introduced through the pipe 18. This mixture of fuel and steam enters the rear open end of the fuel tube 23, and is ejected at the tip of the burner nose.

It is important to note that an intermediate tube 22 concentric with and spaced from both tubes 21 and 23, is a steam conveying tube which establishes a steam chamber 28 and another chamber 29 entirely separated from each other. Steam chamber 28 opens into the steam manifold 19 at the location 30, and extends along the full length of the innermost tube or fuel cylinder 23. The character 31 indicates the annular discharge port for steam emerging from the tip of the burner nose. In traveling along the length of the fuel tube, steam from manifold 19 maintains the fuel tube constantly in a heated condition such that any fuel or heavy residue thereof may not have an opportunity to solidify therein.

The function of the intermediate tube 22 is that of providing insulating means between the steam jacket and the water jacket, thereby preventing the coolant water from chilling the fuel tube along its length. In the preferred construction, the insulating means between the steam jacket and the water jacket consists of the dead air space or jacket space 29, which is sealed at its opposite ends. From the foregoing, it will be understood that the low temperature of the coolant in contact with tube 21 will not readily be transferred through the dead air space between tubes 21 and 22, and conversely, the high temperature of steam flowing in jacket 28 between the fuel tube 23 and the insulating tube 22, will not readily be transferred and lost to the cooling medium within the jacket 24. Thus, the cooling medium that protects the exterior of the burner from the heat of the furnace, is prevented from chilling any section of the steam heated fuel tube.

The series of concentric tubes 5, 21, 22 and 23 may be maintained in the stated relationship in any suitable manner. In the example illustrated by the drawing, the forward ends of tubes 21 and 22 are made integral with the burner tip by welding the parts together. It may be noted that the tip of the burner indicated at 7, might itself be a welded formation, the material thereof being a special alloy highly resistant to destruction

by the heat and other elements encountered in the furnace interior. Thus, the entire tip forwardly of the annular surface 32, may be a welded structure formed integrally with the forward ends of tubes 21 and 22.

The extreme forward end of tube 23 preferably is not supported in the region of the burner tip, but at various locations along the length of said tube 23, any suitable spacers 33 may be provided for maintaining the identity of steam chamber 28. The spacers may be in the form of small projections or bosses formed on the exterior surface of the fuel tube at intervals along its length. By this means, the annular discharge port for steam, indicated at 31, is open continuously about the fuel pipe.

The characters 34 and 35 indicate, respectively, welds joining the nose to the burner body 5 and to the coolant inlet pipe 9.

The supporting structure for the various tubes in the region of the rear end of the burner body, may assume any satisfactory form. In the example, the rear end support means for the tube comprises a plug element 36 in the form of a ring fitted within the rear end of the exterior tube 5. By means of a circumferential weld 37, these parts may be joined permanently together. An annular shoulder 38 of the plug may be drilled to accommodate the tube 21, and may serve also as a support for the packing material 26. The packing compressor nut 39 places the packing 26 under compression as the nut is screwed into the interiorly threaded bore 40 of the plug, thereby providing a leakproof joint between the water jacket 24 and the dead air chamber 29 within tube 21.

The intermediate tube 22 may be threaded at its rear end 41 to receive a retaining nut 42. This nut may enter an annular recess 43 of the plug, so as to maintain a desired space constituting the steam jacket 28. Nut 42 may bear against a packing seal 44, if desired. In any event, there is to be no communication between the steam jacket 28 and the insulating dead air space 29 at opposite surfaces of the tube 22.

By means of a threaded connection 45 and a locking screw 46, the steam manifold housing 19 may be mounted upon the rear end of the burner tube or body 5. A tight joint is provided at 47, between the atomizer or fuel mixer 16 and the housing 19 of the manifold.

The mounting means for the tubes as just described, will be seen to permit compensating movements lengthwise of the burner, resulting from expansion and contraction due to changes in temperature conditions about the burner. The construction prevents the occurrence of injurious strains and stresses which in time might cause leakage nad general deterioration of the various joints and connections.

In the operation of the burner, a heavy fuel is forced into the atomizer or mixer 16 through the fuel pipe 17, and is acted upon by the steam under pressure at 18 to condition the fuel for ejection through the innermost tube of the burner. At the same time, steam introduced into the manifold by way of pipe 20, will surround the fuel tube and discharge from the annular port 31 at the front end of the burner. This constant discharge of steam along the fuel tube serves to maintain a heated condition of the tube, thereby preventing any tendency of the fuel to solidify or drop its heavy constituents within the fuel tube.

Since the steam jacket about the fuel tube is well insulated from the cooling jacket 24 by

means of the dead air chamber 29 provided by tube 21, the heating of the fuel tube does not materially affect the cooling of the burner body by the coolant surrounding the tube 21. Conversely, the extremely cold water surrounding the jacket tube 21 cannot materially overcome the heating effect of the steam upon fuel tube 23. As the result of this construction, the over-all efficiency of the burner is greatly enhanced.

Under certain operating conditions, it may be desirable to continue the feed of steam through the jacket 28 and along the fuel tube, even though the burner may not be operating. In that event, the force of steam issuing from the port 31 at the nose of the burner effectively precludes entry of foreign particles into the forward end of the fuel tube. This precaution is to be observed particularly when the burner at rest is located across the hearth from a burner which is operating, since in that event the burner in operation will tend to throw slag and other foreign particles toward the burner which is not operating. If the inoperative burner is furnished with steam through the manifold 19, the force of steam issuing at the forward end 31 will deflect slag and the like which might otherwise enter the forward open end of the fuel pipe. In the operative condition of the burner, the steam-heating of the entire fuel passageway ensures a smooth and even flow of the combustible mixture from the burner, without liability of the fuel to strike any cold spots in the fuel pipe and thereby tend to solidify or congeal before ejection.

Attention is now directed to the construction of the burner nose and tip. As previously stated, the tip may desirably be formed on the nose area 32 as a weld of metal, or an alloy, specially formulated to resist the destructive effects of heat and other elements encountered in the combustion chamber of a furnace. The circular opening 48 at the front of the tip is larger in diameter than the fuel tube 23, by an amount approximating twice the width of the steam chamber 31. The opening 48 may be flared slightly outwardly as indicated at 49, to enhance the ability of the steam jet to preclude accumulation of slag or residue upon the burner tip. The action may be improved also by rounding off the forward edge 50 of the fuel tube, as shown. It may here be noted that the forceful issuance of steam from port 31 surrounding the fuel tube, creates a suction in said tube for boosting the rate of fuel mixture ejection, and performs also to shear off any matter tending to adhere to and build up on the forward face 51 of the tip.

The burner tip is of a generally bell-shaped formation, and has two substantially flat forward faces 51 and 53, one in advance of the other, and separated by an annular open groove 52. Both forward faces are disposed substantially at right angles to the axis of the burner body, and the inner edge 49 of the foremost face terminates at and surrounds the steam port 31. At its periphery, the foremost face 51 is bounded by an outwardly directed shearing edge 54, the function of which is to cut off any roof drippings that might fall onto the tip area of the nose. The groove 52 catches and directs away from the front of the tip, any drippings sheared by the edge 54. Edge 54 is in the plane of the fuel and steam exit ports, and has an incline 56 directed inwardly and rearwardly from the tip edge toward the base of groove 52. The contour of the tip is found highly effective in precluding congestive accumulation of foreign matter which could, under ordinary circumstances, interfere with the desired dirigibility of the burner flame. Keeping the nose of the burner clean is obviously of great importance and advantage in maintaining efficiency and reliability in the operation of the burner.

Various advantages and improvements in addition to those herein mentioned will be recognized by persons skilled in the art to which the invention pertains; however, those of the greatest importance and interest have been specifically set forth. It is to be understood that the structure is susceptible to various modifications and changes in its details, within the scope of the appended claims, without departing from the spirit of the invention. By way of example, it should be obvious that tube 22 might be formed from an insulating material, in which case it need not be spaced from tube 21. In fact, if tube 22 be made of a suitable insulating material, the tube 21 might be eliminated entirely.

The modified form of burner illustrated by Fig. 4, is structurally very similar to the burner of Figs. 1, 2 and 3. The principal difference between the two forms of burner, is that in the Fig. 4 burner the jacket space or insulating chamber 59, instead of being a dead air chamber as at 29 of Fig. 2, is open at its front and rear ends to furnish a passageway for a current of combustible gas introduced into a gas chamber 60 by means of a supply pipe 61. Gas introduced at 61 enters the chamber 60 and passes forwardly under pressure through the passageway 59 until it is released at the discharge port 62. Said gas meets the mixture of fuel and steam discharged from the two innermost tubes or cylinders 63 and 64, and aids or augments combustion forwardly of the burner tip.

Tube 63 is the fuel tube corresponding to tube 23 of Fig. 2, and the concentric surrounding tube 64 is an intermediate tube corresponding to that indicated at 22 of Fig. 2. Between tubes 63 and 64 is a space or chamber having a forward open end 65 and a rear open end 66, whereby a current of steam under pressure may be passed continuously along the fuel tube along substantially its full length, for maintaining a heated condition of said fuel tube. Steam under pressure is fed to the rear end 66 of the steam passageway, by means of a steam pipe 67 which supplies a steam chamber or manifold 68 provided by a suitable housing 69. This housing may be built into the gas chamber 60 as shown, and clamped between the flange 70 of the gas chamber and the flange 71 of the atomizer housing 72. By means of a leak-proof threaded bushing 73 surrounding the tube 64 and welded thereto at 57, a connection may be effected between said tube and the forward end 74 of the built-in housing.

Housing 69 supports the rear end of tube 63 at the flange 75, and will preferably carry a packing gland 76 to prevent leakage of steam from chamber 68 rearwardly along the tube. The rearmost end of tube 63 communicates with the chamber of atomizer housing 72, and may be maintained in fixed relationship thereto by means of the threaded connection 77. Thus, fuel from the supply pipe 78 and steam from the pipe 79 may be mixed within the atomizer and conveyed freely to the forward end of the burner by means of the fuel pipe 63. As previously stated, substantially the entire length of the fuel pipe is kept heated by steam supplied at 67 and directed along the fuel pipe to the discharge port 65.

As in the first form of the device, the modified structure includes an entry pipe 80 and an outlet pipe 81 for water or other coolant circulating

through the water jacket 82 provided by the outer tube or cylinder 83 and the concentrically arranged tube 84, all as previously explained in the description of Figs. 1, 2 and 3. The water jacket, of course, is sealed at its forward and rear ends. At the forward end, the seal is effected by means of the welded burner tip 85, the latter being similar to that of Fig. 3. At the rear of the water jacket, a coupling 86 may be provided, having a central aperture 87 to support the rear open end of tube 84, the coupling being welded or otherwise fixed within the outer tube 83 as at 88. The connection at the rear end of tube 84 may include packing 89 and a suitable gland 90 to maintain it in a compressed condition. At 91 the coupling threadedly engages the gas chamber 60 to provide a leak-proof joint at that location. The character 92 indicates spacing means between the tubes 64 and 84, said spacing means being such as will permit a free flow of gas through chamber 60 to the discharge end of the burner. If necessary, suitable spacers may be furnished between the tubes 63 and 64 to maintain a concentric relationship of these tubes without materially interfering with the passage of steam between them.

In respects other than those specifically mentioned above, the burner of Fig. 4 is structurally similar to that of Fig. 2, and possesses the same virtues and advantages with the addition of means to feed a combustible gas along the chamber or passageway 59 to augment the flame and at the same time preclude the inner wall of the water jacket from materially reducing the temperature of the steam heated fuel pipe 63.

It will be unnecessary to repeat the function and operation of the burner tip 85, as it corresponds plainly with the burner tip of Figs. 2 and 3. As in the first form of the burner, the various tubes or cylinders constituting the Fig. 4 burner are so supported as to compensate for expansion and contraction occurring as the temperature of the burner varies under different operating conditions.

Throughout the disclosure, steam has been specified as the heating medium for the central fuel tube, and water has been specified as the coolant for the burner. It should be understood that hot gas or other fluid might constitute the heating medium, and some fluid other than water might be employed as a coolant, within the purview of the invention.

What is claimed is:

1. In a burner of the class described, the combination of a burner body including a cooling jacket, tubular in form and having an open passageway axially within it, a fuel tube extending longitudinally through said passageway, and having a fuel inlet end and an outlet end, fuel atomizing means at the inlet end of the fuel tube, a second tube surrounding the fuel tube in spaced relationship, to provide a heating fluid chamber extending substantially from end to end of the fuel tube, said heating fluid chamber being open at the outlet end of the fuel tube for discharge of heating fluid in the direction of the fuel discharge, and means for directing a heating fluid into said chamber.

2. In a burner of the class described, the combination of a burner body including a cooling jacket, tubular in form and having an open passageway axially within it, a fuel tube extending longitudinally through said passageway, and having a fuel inlet end and an outlet end, fuel atomizing means at the inlet end of the fuel tube, a second tube surrounding the fuel tube in spaced relationship, to provide a heating fluid chamber extending substantially from end to end of the fuel tube, said heating fluid chamber being open at the outlet end of the fuel tube for discharge of heating fluid in the direction of the fuel discharge, means for directing a heating fluid into said chamber, and means insulating the heating fluid chamber from the cooling jacket to minimize heat transfer between said chamber and said jacket.

3. In a burner of the class described, the combination of a tubular elongated burner body having an apertured nose end and a rear end, an elongated inner tube extending from the nose to the rear end of the burner body to establish within the burner body a cooling jacket, a steam manifold housing on the rear end of the burner body, including an entry port for steam under pressure, a fuel mixer having a port aligned with the axis of the burner body, a fuel tube communicating with the fuel mixer port and passing through the steam manifold housing and the cooling jacket tube, to terminate at the nose aperture of the burner, said fuel tube being smaller in diameter than the nose aperture and having its adjacent end open and in spaced approximate concentricity to the wall of said aperture, a steam tube larger in diameter than the fuel tube, and surrounding the latter in spaced relation to include the space between the nose aperture wall and the fuel tube, said steam tube extending from the burner nose to the steam manifold housing, for conveying steam from said housing about and along the length of the fuel tube and discharging same through the space at the nose aperture, and means supporting the steam tube in spaced approximate concentricity with both the fuel tube and the inner tube of the cooling jacket.

4. In a burner of the class described, the combination of a tubular elongated burner body having an apertured nose end and a rear end, an elongated inner tube extending from the nose to the rear end of the burner body to establish within the burner body a cooling jacket, a steam manifold housing on the rear end of the burner body, including an entry port for steam under pressure, a fuel mixer havbing a port aligned with the axis of the burner body, a fuel tube communicating with the fuel mixer port and passing through the steam manifold housing and the cooling jacket tube, to terminate at the nose aperture of the burner, said fuel tube being smaller in diameter than the nose aperture and having its adjacent end open and in spaced approximate concentricity to the wall of said aperture, a steam tube larger in diameter than the fuel tube, and surrounding the latter in spaced relation to include the space between the nose aperture wall and the fuel tube, said steam tube extending from the burner nose to the steam manifold housing, for conveying steam from said housing about and along the length of the fuel tube and discharging same through the space at the nose aperture, means supporting the steam tube in spaced approximate concentricity with both the fuel tube and the inner tube of the cooling jacket, and means sealing the space between the steam tube and said inner tube of the jacket.

5. In a burner of the class described, the combination of a burner body including an apertured nose, a fuel tube extending through the burner body, and having a forward open end spaced cir-

cumferentially from the wall of the nose aperture, means for ejecting steam under pressure through the space aforesaid, and a bell-shaped tip on the plane of the fuel tube end, said tip having a substantially sharp peripheral flange bounding said face, and a slag collector channel behind said flange.

6. In a burner of the class described, the combination of a burner body including a cooling jacket tubular in form and having an open passageway axially within it, a fuel tube extending longitudinally through said passageway, and having a fuel inlet end and an outlet end, fuel atomizing means at the inlet end of the fuel tube, a second tube surrounding the fuel tube in spaced relationship, to provide a heating fluid chamber extending substantially from end to end of the fuel tube, said heating fluid chamber being open at the outlet end of the fuel tube for discharge of heating fluid in the direction of the fuel discharge, means for directing a heating fluid into said chamber, and means insulating the heating fluid chamber from the cooling jacket to minimize heat transfer between said chamber and said jacket, said insulating means comprising a passageway open at its opposite ends, and means for maintaining a flow of gas through said passageway.

7. In a burner of the class described, the combination of a burner body including a cooling jacket tubular in form and having an open passageway axially within it, a fuel tube extending longitudinally through said passageway, and having a fuel inlet end and an outlet end, fuel atomizing means at the inlet end of the fuel tube, a second tube surrounding the fuel tube in spaced relationship, to provide a heating fluid chamber extending substantially from end to end of the fuel tube, said heating fluid chamber being open at the outlet end of the fuel tube for discharge of heating fluid in the direction of the fuel discharge, and means for directing a heating fluid into said chamber, said second tube being spaced from the cooling jacket to provide a passageway therebetween terminating in a discharge port at the outlet end of the fuel tube, and terminating in a gas entry port near the opposite end of the fuel tube, and means for feeding gas under pressure to said entry port.

8. In a burner of the class described, the combination of a tubular elongated burner body having an apertured nose end and a rear end, an elongated inner tube extending from the nose to the rear end of the burner body to establish within the burner body a cooling jacket, a steam manifold housing on the rear end of the burner body, having an entry port for steam under pressure, a fuel mixer having a port aligned with the axis of the burner body, a fuel tube communicating with the fuel mixer port and passing through the steam manifold housing and the

cooling jacket tube, to terminate within the nose aperture of the burner, said fuel tube being smaller in diameter than the nose aperture and having its adjacent end open and in spaced relationship to the wall of said aperture, a steam tube larger in diameter than the fuel tube, and surrounding the latter in spaced relation to occupy part of the space between the nose aperture wall and the fuel tube, said steam tube extending from the burner nose to the steam manifold housing, for conveying steam from said housing about and along the length of the fuel tube and discharging same through the space at the nose aperture, means supporting the steam tube in spaced substantial concentricity with both the fuel tube and the inner tube of the cooling jacket, said space being open at the discharge end of the steam tube, and means for feeding a current of gas through the space about the steam tube for discharge through the nose of the burner.

9. In a burner of the class described, the combination of a burner body including an apertured nose, a fuel tube extending through the burner body and having a forward open end spaced circumferentially from the wall of the nose aperture, a bell-shaped tip on the burner nose, including a flat forward face in substantially the plane of the fuel tube end, said tip having a substantially sharp peripheral flange bounding said face, a slag collector channel behind said flange, and means forcibly ejecting steam under pressure through the space between the wall of the nose aperture and the forward open end of the fuel tube, for constantly cleaning the nose of the burner.

JOHN MARSHALL CROWE.

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