Nov. 23, 1943. J. E. KENNEDY 2,335,188

FUEL BURNER

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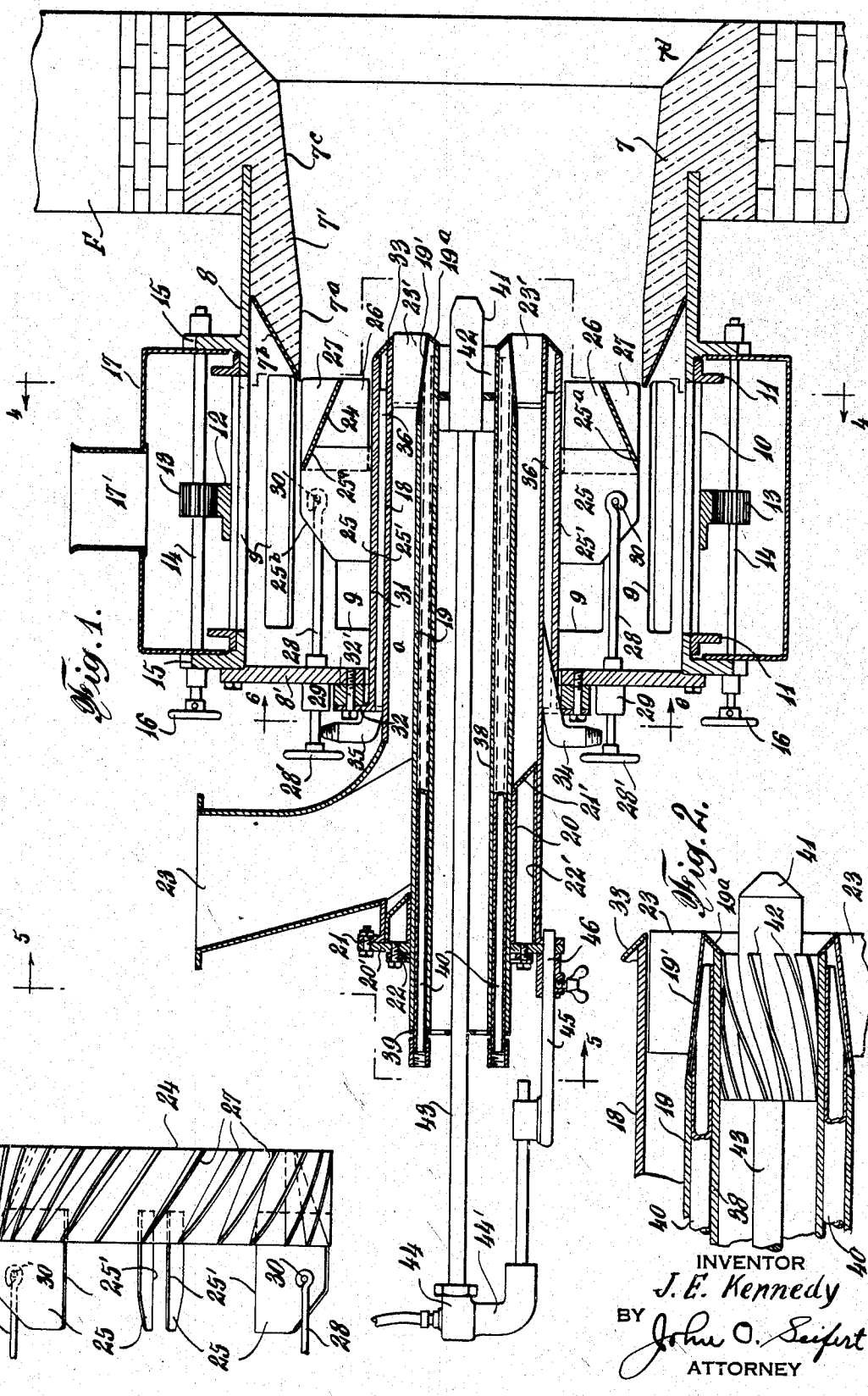


Fig. 1.

Fig. 2.

Fig. 3.

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Fig. 4.

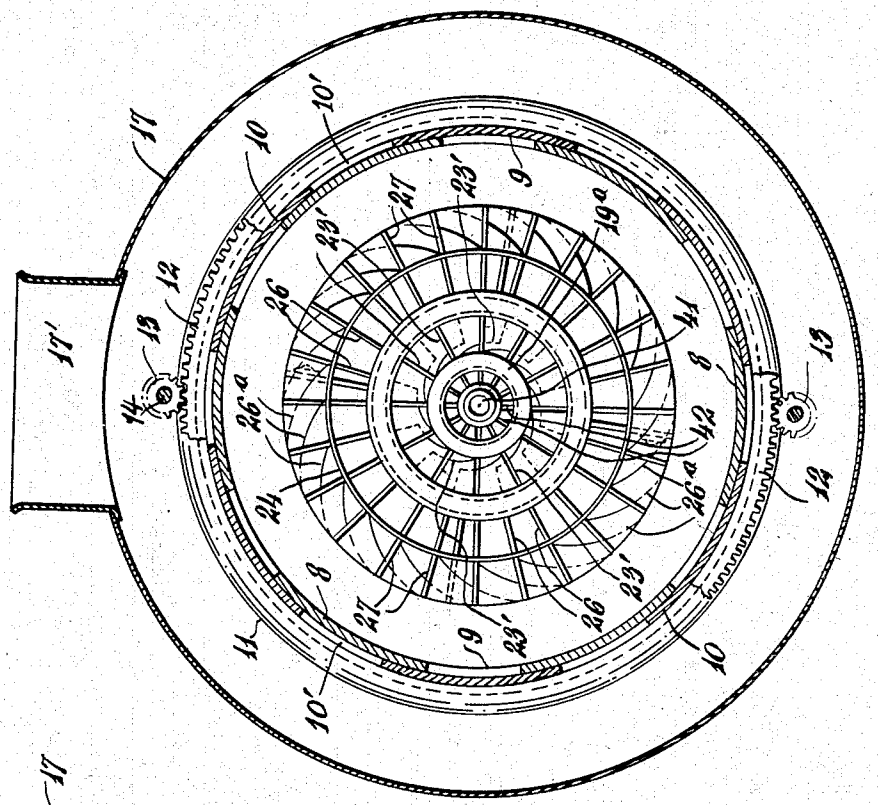


Fig. 5.

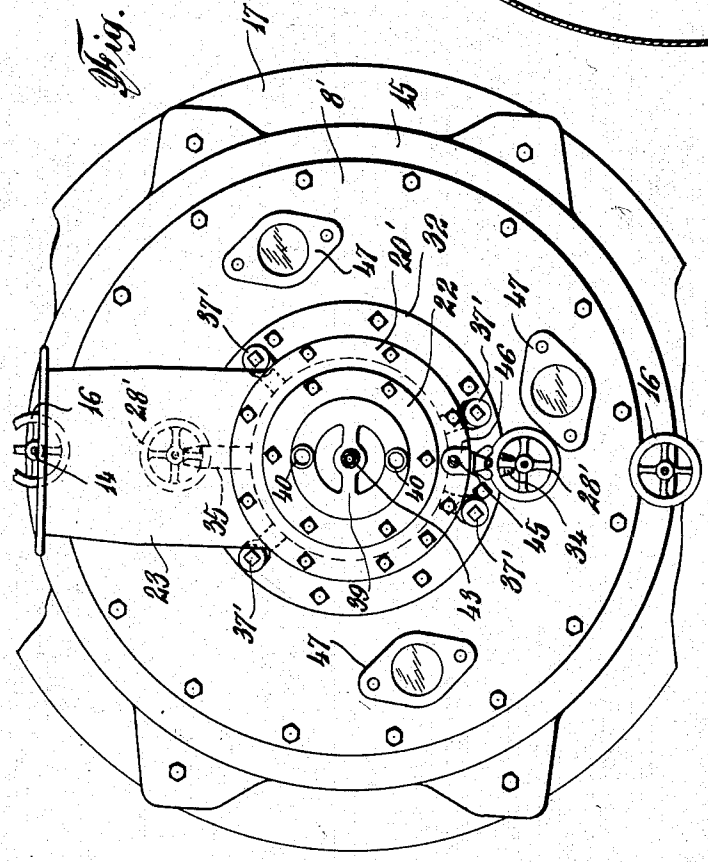
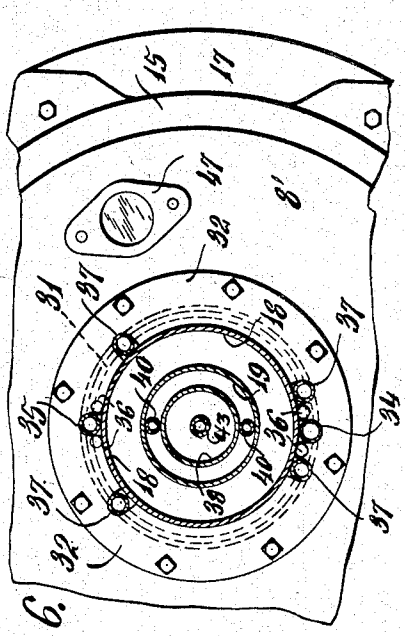


Fig. 6.



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UNITED STATES PATENT OFFICE

2,335,188

FUEL BURNER

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Application August 3, 1940, Serial No. 350,685

8 Claims. (Cl. 110—22)

This invention relates to burners for pulverized fuel, such as coal, pitch and other comminuted materials, in suspension in an air stream and for burning fluent fuel, such as gas or oil.

It is the primary object of the invention to provide an improved burner for burning pulverized fuel in suspension in an air stream and for burning fluent fuel, such as gas or oil, adapted to be used as a combined burner for pulverized fuel in suspension in an air stream and fluent fuel, or for independently burning pulverized fuel in suspension in an air stream or fluent fuel one independent of the other, or the fluent fuel burner may be utilized to ignite the pulverized fuel laden air stream.

It is another object of the invention to provide in a burner for pulverized fuel in suspension in an air stream and/or for burning fluent fuel, means to supply air to the fuel stream discharged from the burner and set up turbulent action and mixing of such air with the fuel stream and constitute a secondary air supply to the burning fuel, and said means being adjustable to vary the direction of flow of the air and shape of the flame of the burning fuel, and to provide means to constitute a member for mounting the burner in an opening in a furnace wall and a chamber in which to mix the secondary air with the fuel.

It is a further object of the invention to provide a burner for pulverized fuel in suspension in an air stream including a tubular member arranged with an annular passage having an outlet at one end and an inlet at the opposite end for the delivery of pulverized fuel in suspension in an air stream into and through said passage with vanes spaced about the outlet arranged to set up turbulent action of the fuel stream discharged from the outlet and cause the fuel stream to converge toward the axis of the burner, and adjustable inwardly and outwardly of the burner outlet to vary the direction of flow of the fuel stream and shape of the flame of the burning fuel, and said tubular member having a passage axially therethrough for supplying additional air centrally of and for mixture with the fuel stream discharged from the burner outlet.

In use burners of this character becomes heated to a relatively high temperature, particularly at the outlet end thereof, which is detrimental in the use of the burner when the pulverized solids in suspension in the air stream consist of pitch, as the particles of pitch in the fuel stream will fuse and combine in a plastic mass and a consequent clogging of the burner.

It is another object of the invention to provide in a burner for pulverized fuel in suspension in an air stream a jacket surrounding the burner for the circulation of a cooling medium, the jacket having inlet and outlet means for the cooling medium arranged to deliver the cooling medium to and withdraw it from the jacket adjacent the outlet end of the burner and thus assuring the cooling of the burner at the region of highest temperature.

Other objects and advantages of the invention will hereinafter appear.

In the drawings accompanying and forming a part of this application,

Figure 1 is a longitudinal sectional view of a fuel burner embodying the invention and shown as mounted in an opening in a furnace wall.

Figure 2 is a longitudinal sectional view, on an enlarged scale, of the outlet end of the burner to show the arrangement of vanes at the outlet of the burner passage and means for admitting and withdrawing a cooling medium from a jacket disposed about the burner.

Figure 3 is a side elevation of a vane carrying member disposed about the outlet end of the burner for setting up turbulent action of a stream of secondary air supplied to the fuel stream discharged from the burner and cause said air stream to converge toward and mix with the fuel stream.

Figure 4 is a cross sectional view taken substantially on the line 4—4 of Figure 1.

Figure 5 is a cross sectional view taken substantially on the line 5—5 of Figure 1; and

Figure 6 is a cross sectional view taken substantially on the line 6—6 of Figure 1.

In the embodiment illustrated for carrying out the invention there is provided a member 7 shown as a cylindrical member of refractory material having an opening therethrough although it may be of oblong or rectangular form. The member 7 constitutes a mounting member for the burner in an opening in a furnace wall F and a chamber in which to mix additional air with the fuel stream discharged from the burner or to serve as a secondary air supply to the burning fuel.

A casing comprising a body member 8 and a plate 8' secured to and closing one end of the body, although the plate may be constructed integral with the body, is mounted at the open end upon a reduced portion 7' of the mounting member 7 with the end engaging a recess therein, as shown in Figure 1. The end of the mounting member converges from the outer surface within the casing member toward a portion of the inner surface 7^a extending parallelly of the axis of the mounting member and preferably has a metallic

sheathing and reinforcing member mounted thereon, as at 7b. The portion 7a of the inner surface of the mounting member is of a length substantially equal to the converging outer surface and merges in a portion 7c diverging outwardly at an acute angle to the horizontal which portion merges with a portion 7d diverging outwardly at an angle of substantially 45 degrees to the horizontal. The open end of the casing is in communication with the opening in the mounting member and is provided with a series of openings 9 spaced about the same adapted for the flow of air into the casing and out through the open end of the casing into the mounting member for mixture with the fuel stream discharged from the burner or to serve as a secondary supply to the burning fuel. To regulate the flow of air through the inlet openings 9 adjustable closure means is provided for said openings, shown in the form of a cylindrical member 10 loosely mounted on the body of the casing to have rotative adjustment about the same between a pair of annular guide members 11 fixed upon the body of the casing. The cylindrical member 10 is arranged with spaced openings 10' corresponding to the openings 9 and adapted to be placed into and out of register with the openings 9 by rotative adjustment of the member 10. Means are provided to adjust said closure member, shown as an annular gear 12 encircling and fixed to the closure member midway the ends and pinions 13 meshing with said gear fixed on shafts 14 rotatably supported at the opposite ends in flanges 15 extending laterally from the body of the casing, the shafts having a hand wheel 16 fixed on the end thereof projecting from the flange at the closed end of the casing. To adapt the casing to supply heated air to be mixed with the fuel or serve as a secondary air supply to the burning fuel, an annular member 17 of channel shape in cross section is mounted at the channel walls upon the flanges 15 extending laterally from the body of the casing and providing an air chamber about the body of the casing in communication with the air inlet openings 9, and is provided with inlet means 17' adapted for connection of a conduit leading from a source of heated air supply.

A burner for pulverized fuel in suspension in an air stream comprises a tubular member 18 extended at one end centrally through the closed end 8' of the casing to within the portion 7a of the mounting member 7. To arrange the tubular member 18 with an annular passage a open at one end to the mounting member, a tube 19 is mounted in the tubular member 18 in concentric spaced relation thereto by mounting said tube in a sleeve 20 having a laterally extending flange 20' and said sleeve extending into the tubular member 18 in concentric spaced relation thereto by bolts engaging openings in the flange 20' and a flange extending laterally from the outer end of the tubular member, as at 21. The flange 20' also serves to close the outer end of the fuel passage a between the tubular member 18 and tube 19. The tube 19 is adapted to have longitudinal sliding adjustment in the sleeve 20 and to provide an air tight connection between said tube 19 and the sleeve said tube is extended through a stuffing box 22 arranged at the outer side of the flange 20'. Pulverized fuel in suspension in an air stream is delivered into and through the fuel passage a through a chute 23 connected to an opening in the tubular member 18 exterior of the casing, the chute preferably declining slightly from the perpendicular in a direction toward the outlet of the burner. To prevent pulverized material packing in the burner passage a rearwardly of the chute and to deflect the fuel stream into the fuel passage toward the outlet thereof an annular plate 21' is fixed to the end of the sleeve 20 and a sleeve 22' concentric of the sleeve 20 and which is also connected at one end to the flange 20' of the sleeve 20. The ends of the sleeves 20, 22' opposite the flange 20' extend diagonally of the sleeves and to which ends of the sleeves the plate 21' is secured, as by welding or otherwise, to decline at a slightly greater angle than the chute.

To set up a swirling or turbulent action of the fuel stream discharged from the outlet of the fuel passage a and cause the stream to flow or converge toward the axis of the burner, a series of vanes 23' preferably of spiral form, as shown at 23' in Figure 4, are equidistantly spaced about the outlet of the passage a. The vanes 23' are of greater width at the outer ends than at the inner ends and this is effected by arranging the upper edge of the vanes in a horizontal plane and inclining the lower edge from the front edge to the rear edge of the vanes at an acute angle to the horizontal. The vanes are mounted on the tube 19, as by welding, and for this purpose the inner end portion of the tube 19 is arranged to converge at an angle corresponding to the inclination of the lower edge of the vanes, as shown at 19', and said converging edge portion of the tube 19 is arranged to extend laterally and incline inwardly at an acute angle to the portion 19', as at 19a, for a purpose hereinafter described. The major portion of the tube 19 is preferably made of steel, and the portion 19', 19a of the tube as well as the vanes 23' are preferably made of copper, the vanes being welded to the portion 19' and the latter to the tube 19. By making the vanes and the tube portion 19' of copper in practice it has been found that the burner will operate more efficiently, particularly so when firing pulverized pitch in suspension in an air stream. By the arrangement of mounting the vanes 23' on the tube 19 and mounting the tube 19 in the sleeve 20 to have longitudinal adjustment the vanes are adapted to have adjustment with the tube inwardly and outwardly of the outlet of the fuel discharge passage or chamber a, this adjustment being for the purpose of varying the direction of flow of the fuel stream and varying the form of the flame of the burning fuel. By adjusting the vanes to extend outwardly from the outlet of the fuel discharge passage a it will produce a flame relatively long and narrow, and by adjusting the vanes inwardly of the outlet of the fuel discharge passage a short and bushy flame will result, the length of the flame being progressively decreased proportional to the adjustment of the vanes in a direction inwardly of the burner outlet. By the arrangement of the tube 19 in concentric relation to the tubular member 18 there is provided a passage axially of the burner for the flow of a stream of air at a high velocity to be supplied centrally to the fuel stream and caused to be mixed therewith by the turbulent action and flow of the fuel stream in a direction toward the axis of the burner.

The tubular member in conjunction with the wall portion 7a of the mounting member 7 forms an annular outlet for the flow of the air from the casing 8 into the opening or chamber in the mounting member to be mixed with the fuel stream discharged from the fuel passage a, or constitutes a secondary air supply to the burn-

ing fuel. To cause air flowing from the outlet of the casing 8 to mix with the fuel stream discharged from the fuel passage *a*, means are disposed about the burner in the casing outlet to set up a swirling or turbulent action of the air and cause such air to flow toward the axis of the burner. As shown in Figures 1 and 3, this means comprises a conical member 24 mounted to encircle the burner within the outlet of the casing with the end of greater diameter of the conical member open to the casing. The conical member is mounted by means of four plates 25 equidistantly spaced about the end of larger diameter of the conical member 24. The one edge 25' of the plates extends in a horizontal plane and is adapted to slidably engage upon the burner. The corner at the juncture of the upper edge and front edge of the plate is cut away to incline at the same angle as the interior surface of the conical member, as at 25ª, and said end of the plates is extended into the conical member a distance equal to the length of said inclined portion 25ª and fixed thereto as by welding. A series of vanes 26 equal in length to the conical member are equidistantly spaced about and extend radially inward from the inner surface of the conical member, said vanes being secured to the conical member, as by welding, and arranged in the form of a spiral, as at 26ª, the curvature of which extends in a direction opposite to the vanes 23' spaced about the outlet of the fuel discharge passage *a*, as shown in Figure 4.

A second series of vanes 27 are equidistantly spaced about and fixed to the conical member, as by welding, to extend outwardly therefrom, the outer edge of said vanes extending in a horizontal plane whereby said vanes are substantially of triangular form, as shown in Figure 1. Said vanes 27 may also be arranged of spiral form. The corner at the juncture of the top and rear edges of the plates 25 are also cut away on a diagonal line, as at 25ᵇ. By the arrangement of the supporting plates 25 for the conical member 24 and the arrangement of the vanes 26, 27 in the form of a spiral, air entering the casing through the air inlets 9 will be guided by the plates 25 to the vanes 26 and part of the air flowing from the casing will be by way of the vanes 27, and setting up a swirling action of the air passing between the vanes from the casing and as such swirling action will be in a direction opposite to the swirling action of the fuel stream discharged from the fuel passage *a* there is effected a thorough mixing of the air with the fuel stream within the chamber of the mounting member 7 and assuring complete combustion of the fuel.

To regulate and control the discharge of air from the casing outlet and thereby vary the shape of the flame of the burning fuel, means are provided to adjust the conical member 24 with the vanes carried thereby inwardly and outwardly of the casing. As stated, the conical member 24 is slidably supported by the plates 25 and to adjust the conical member rods 28 are slidably extended into the casing through bearing members 29 mounted in the end closure plate 8' of the casing and are connected within the casing to diametrically opposite plates 25, as shown at 30. To facilitate the manipulation and adjustment of the conical vane carrying member hand grips 28' are fixed on the outer end of the rods. By adjusting the conical vane carrying member 24 outwardly from the casing outlet there is provided an elongated narrow flame, and by adjusting the same inwardly of the casing outlet there is produced a short bushy flame.

The burner in use becomes heated to a relatively high temperature and in firing pulverized pitch in suspension in an air stream, due to said heating of the burner, the particles of pitch conveyed in the fuel stream through the burner passage *a* are fused and there is a possibility that they may accumulate in a plastic mass choking and clogging the burner passage *a*. To obviate this the fuel discharge passage *a* is provided with a jacket for the circulation therethrough of a cooling medium, such as water. To provide the burner passage *a* with a surrounding water cooling jacket a steel tube 31 of larger diameter than the tubular member 18 is mounted in concentric spaced relation to the portion of said tubular member 18 extended into the casing 8 by means of an annular plate 32 welded to the outer end of the tube 31 and the tubular member 18 and the plate secured to the closure plate 8' for the casing by lag screws extended through openings in said plate 32 and threaded into the closure plate 8' for the casing with an interposed spacing member, as shown at 32'. The one end of the tube 31 terminates within the inner end of the tubular member and the space between said tube and the tubular member 18 at the inner end is closed by a conical member 33 of copper converging from the end of the tube 31 to the end of the tubular member and welded thereto. To admit and circulate the cooling medium through said jacket an inlet pipe 34 is extended into the outer end of the jacket below the axis of the burner, as shown in Figures 1 and 6, and an outlet pipe 35 is extended into the outer end of the jacket above the axis of the burner, the pipes 34, 35 being adapted for connection of a conduit or conduits leading from and connecting the jacket in circulation with a source of the cooling medium.

The burner is heated to a higher temperature at the discharge end than the remaining portion thereof and to assure the cooling of the outlet end of the burner, channels are provided in the jacket with one end of which the pipes 34, 35 communicate, the opposite ends of the channels opening to the jacket adjacent the discharge end of the burner. For this purpose rods 36 are extended through the tube carrying plate 32 at opposite sides of the tubes 34, 35, as shown in Figure 6, the rods being of a diameter substantially equal to the width of the jacket and extended in parallel spaced relation and terminate within the closure plate 33 constituting one end wall of the jacket, as shown in Figure 1. The space between each pair of rods 36 constitutes a channel, the tube 34 communicating with the outer end of one of said channels and delivers the cooling medium into said channel and the channel opening to the jacket adjacent the inner end, thus supplying the cooling medium at its lowest temperature to the region of the burner of highest temperature, the tube 35 communicating with the outer end of the other channel and the opposite end of said channel opening to the jacket adjacent the discharge end of the burner, said end of said channel constituting an inlet for the cooling medium and thus conducting the cooling medium from the jacket and region of the highest temperature of the burner and assuring positive cooling of the discharge end of the burner. The jacket is also provided with a series

of clean out openings through the plate 32 having tube sections mounted therein, as shown at 37 in Figure 6, and said tube sections are internally screw threaded for the threaded connection of closure plugs 37', as shown in Figure 5.

A jacket for the circulation of a cooling medium is also disposed about the interior of the fuel discharge passage *a* which is formed by a second tube 38 of less diameter than and mounted in the tube 19 in concentric spaced relation thereto, as shown in Figure 1. The tube 38 is substantially of the same length as the tube 19 and is secured, as by welding, to and supported at the forward end by the flange 19ª of the annular portion 19' of the tube 19 which also closes the forward end of the jacket. The opposite end of the tube 38 as well as the tube 19 is secured, as by welding, to an annular portion, as 39, of a spider member which also closes said end of the jacket. To admit the cooling medium, such as water, into said jacket adjacent the outlet end of the burner and to also cause the cooling medium to flow from said end of the burner a pair of tubes 40 are extended into the jacket through openings in the annular portion 39 of the spider, one tube being disposed below the axis of the jacket and constituting an inlet tube and the other tube disposed above the axis of the jacket and constituting an outlet tube for the cooling medium. The tubes 40 extend to adjacent the end wall 19ª of the jacket and are open to the inner side of the annular portion 19' at the end of the tube 19, for which purpose the side wall at the inner ends of the tubes is cut away at an angle corresponding to the angle of the annular portion 19' of the tube 19 and spaced therefrom to permit the cooling medium to pass over the side walls of the cut away portion of the inlet tube against the portion 19' and the cooling medium entering into said end of the outlet tube through said cut away portion in the circulating of the cooling medium through the jacket. The tubes 40 project from the end of the jacket and are screw threaded for the connection of a coupling member to connect tubes thereto leading to and from a source of the cooling medium. The wall of the inner jacket or the tube 38 provides an annular passage for the flow of air axially or centrally of the burner for mixture with the fuel stream discharged from the passage *a*.

To adapt the burner for the burning of fluent fuel, such as oil or gas, a nozzle 41 is disposed axially in the tube 38, the nozzle projecting forwardly of the outlet of the fuel passage *a* and is of less diameter than the tube 38 forming an air passage between the nozzle and said tube. The nozzle has vanes 42 of spiral form spaced about and disposed between the nozzle and the tube 38 and whereby the nozzle is supported in said tube. A fuel conducting tube 43 is connected at one end axially to the nozzle and extends through an opening axially in the spider 39 and is connected to a coupling member 44 for connecting said tube with a source of fuel. The coupling member is arranged with a right angle elbow 44' having a rod fixed at one end therein and extending substantially parallel to the tube 43, said rod being mounted in a support 45 slidably mounted in an opening in the flange 20' of the sleeve 20 and in a bracket fixed to said flange, as shown at 46, whereby the nozzle carrying tube 43 with the nozzle 41 is adapted to be adjusted longitudinally inwardly and outwardly of the tube 38. The vanes 42 are arranged to set up a swirling or turbulent action of the air passing between the nozzle and the tube 38 and cause thorough mixing of the air with the fuel discharged from the fuel passage *a* and from the nozzle 41. The nozzle 41 is also adapted to serve as a torch to ignite the fuel discharged from the fuel passage *a*.

By the provision of the spacer 32' the burner may be adjusted longitudinally as a unit inwardly or outwardly from the opening in the mounting member 7. To observe the burning of fuel the closure plate 8' for the one end of the casing is provided with a series of openings, shown as three in number, spaced about said plate and said openings having closures with transparent portions releasably secured to the closure plate, as shown at 47 in Figure 5.

It will be obvious that various modifications may be made in the construction and arrangement of the parts without departing from the scope of the invention and that portions of the invention may be used without others and come within the scope of the invention.

Having described my invention, I claim:

1. In a fuel burner, a mounting member having an opening therethrough and a portion of reduced diameter extending from one end, an open end casing mounted at the open end upon and encircling the reduced portion of said mounting member and having air inlet openings in the side wall thereof, a tubular member arranged with an annular chamber therein opening through one end of said member and extended centrally through the casing into and forming with the reduced portion of the mounting member an annular outlet from the open end of the casing to the opening in said mounting member, and said chamber having an inlet at the opposite end exterior of the casing for the delivery of pulverulent material in suspension in an air stream into and through said chamber, vanes spaced about and within the open end of said chamber arranged to set up turbulent action of the fuel stream discharged from said chamber, and vanes spaced about and encircling the tubular member within the annular outlet of the casing arranged to set up turbulent action of the air flowing through the casing outlet and mixing in the reduced portion of the mounting member of said air with the fuel stream discharge from the chamber in the tubular member.

2. In a fuel burner, an open end casing adapted to be mounted at the open end relative to an opening in a furnace wall and having openings spaced about the side wall for the passage of air into and out of the open end of the casing, adjustable closure means for said openings to regulate the flow of air through said openings into the casing, a tubular member having an opening in the side wall adjacent one end mounted in the closed end of the casing with one end terminating within and radially spaced from the open end of the casing and the end portion having an opening in the side wall exterior of the casing, a tube of greater length and less diameter than the tubular member extended into the tubular member having vanes spaced about and extended laterally from one end thereof supporting said end of the tube concentrically in the end of the tubular member opening to the casing, means mounted on the end of the tubular member exterior of the casing slidably supporting the tube concentrically of the tubular member and closing said end of the space between the tube and tubular member and forming said space as an annular chamber closed at one end and open

at the opposite end with the vanes on the tube disposed in said open end of the chamber, and the opening in the side wall of the tubular member constituting an inlet to said chamber adapted for the delivery of pulverized fuel in suspension in an air stream into and discharge of said stream through the open end of said chamber relative to the vanes on the tube to cause turbulent action of the fuel stream discharged from the chamber.

3. In a fuel burner as claimed in claim 2, vanes slidably mounted on the tubular member within the casing to set up turbulent action of the air flowing from the casing and cause said air to mix with the fuel stream discharged from the chamber and the stream of air delivered by the tube, and means adjustably mounted on the closed end of the casing and connected to said slidable vanes to adjust the vanes toward and away from the open end of the casing to control the discharge of air from the casing.

4. In a fuel burner as claimed in claim 2, an annular member of channel shape in cross section mounted on and encircling the casing to form an annular chamber communicating with the air inlet openings in the casing and adapted for connection with a source of air supply.

5. A fuel burner as claimed in claim 2, wherein an annular jacket is disposed about the exterior of and extends longitudinally of the tubular member from the open end of the chamber to the closed end of the casing and is provided with an inlet and an outlet exterior of the casing adapted for connection to a source of and for circulating a cooling medium through said jacket, and a jacket disposed about the interior and extending the full length of the tube and provided with an inlet and an outlet at the outer end adapted for connection to a source of and for circulation of a cooling medium through said second jacket.

6. In a fuel burner, a tubular member of uniform diameter having an opening in the side wall adjacent one end, a tube of uniform and less diameter than the tubular member, means to mount the tube concentrically in the tubular member at the end adjacent the opening in the side wall and forming the space between said tubular member and tube as an annular chamber closed at one end and open at the opposite end and the tube forming a passage centrally of the chamber, the opening in the side wall of the tubular member constituting an inlet to the chamber for the delivery of pulverized fuel in suspension in an air stream into and discharge of said fuel stream from the open end of said chamber, vanes fixed to and spaced about the end of the tube at the open end of the chamber arranged to set up turbulent action of the fuel stream discharged from the chamber, a fluid fuel burner nozzle mounted axially in the passage and to extend beyond the open end of the chamber, said nozzle being of less diameter than said passage to permit air to flow through said passage for mixture with the fuel discharged from the nozzle and open end of the chamber.

7. In a fuel burner, a tubular member of uniform diameter having an opening in the side wall adjacent one end, a tube of uniform and less diameter than the tubular member, means to mount the tube concentrically in the tubular member at the end adjacent the opening in the side wall and forming the space between said tubular member and tube as an annular chamber closed at one end and open at the opposite end and the tube forming a passage centrally of the chamber, and to which chamber the opening in the side wall of the tubular member constitutes an inlet to the chamber for the delivery of pulverized fuel in suspension in an air stream into and discharge of said fuel stream from the open end of said chamber, vanes fixed to and spaced about the end of the tube at the open end of the chamber arranged to set up turbulent action of the fuel stream discharge from the chamber, a fluid fuel burning nozzle mounted axially in the passage and projecting beyond the open end of the annular chamber and being of less diameter than the passage to permit air to flow through said passage, a tube connected to the nozzle extended through said passage to connect the nozzle to a source of fuel, and vanes spaced about the nozzle in the passage adapted to set up turbulent action and mixing of the air flowing through said passage with the fuel discharged from the nozzle and open end of the chamber.

8. In a fuel burner, a tubular member of uniform diameter having an opening in the side wall adjacent one end, a tube of uniform and less diameter than the tubular member, means to mount the tube concentrically in the tubular member at the end adjacent the opening in the side wall and forming the space between said tubular member and tube as an annular chamber closed at one end and open at the opposite end, and the tube forming a passage centrally of the chamber, the opening in the side wall of the tubular member constituting an inlet to the chamber for the delivery of pulverized fuel in suspension in an air stream into and discharge of said fuel stream from the open end of said chamber, vanes fixed to and spaced about the end of the tube at the open end of the chamber arranged to set up turbulent action of the fuel stream discharged from the chamber, and jackets disposed about the chamber exterior of the tubular member and the interior of the tube of the chamber having inlets and outlets adapted for connection with a source of and circulating a cooling medium through said jackets, the interior jacket extending the full length of the passage centrally of the chamber.

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