

March 31, 1925.

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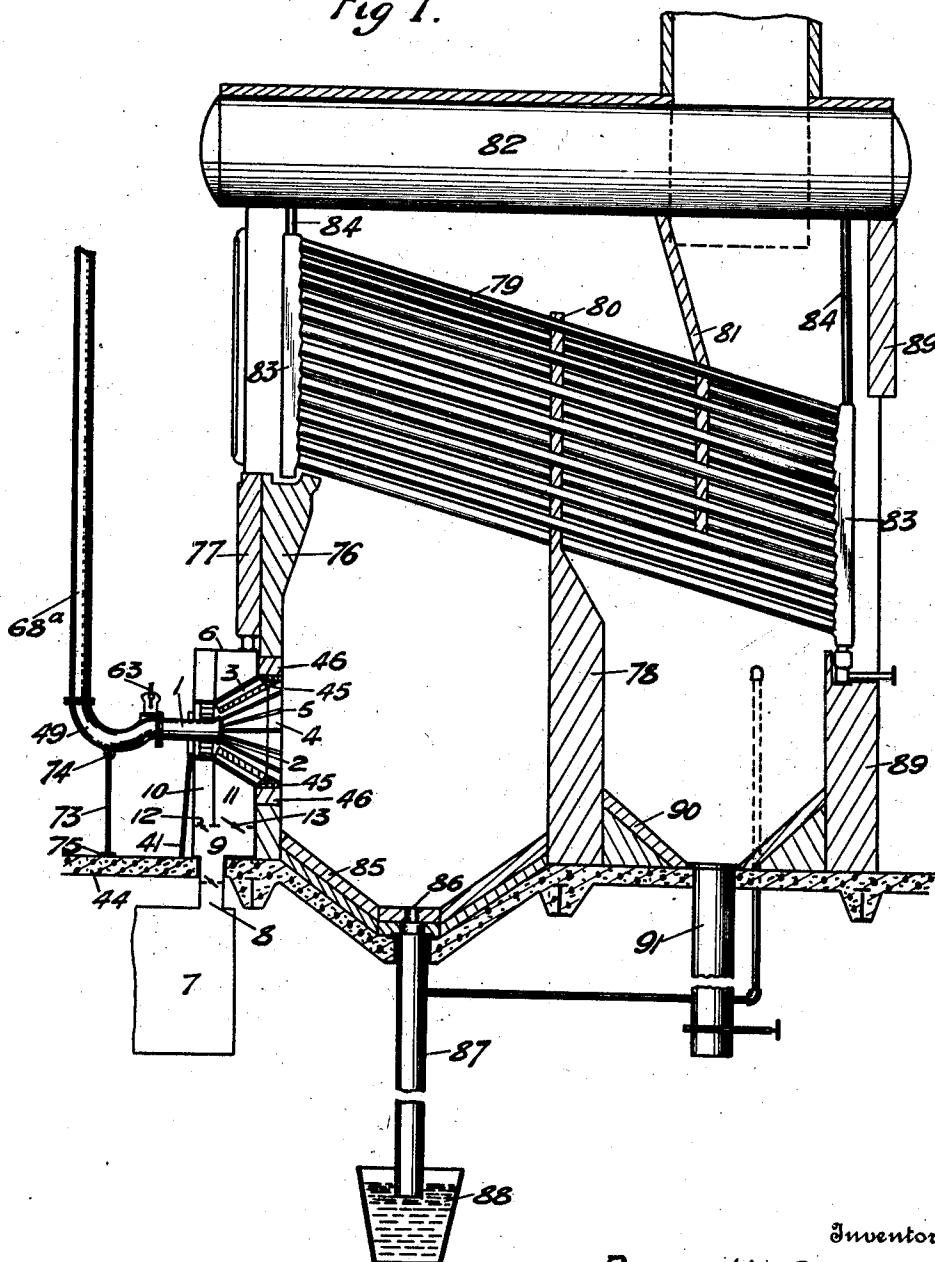
D. H. COUCH

PULVERIZED FUEL BURNER

Filed March 16, 1922

4 Sheets-Sheet 1

Fig 1.



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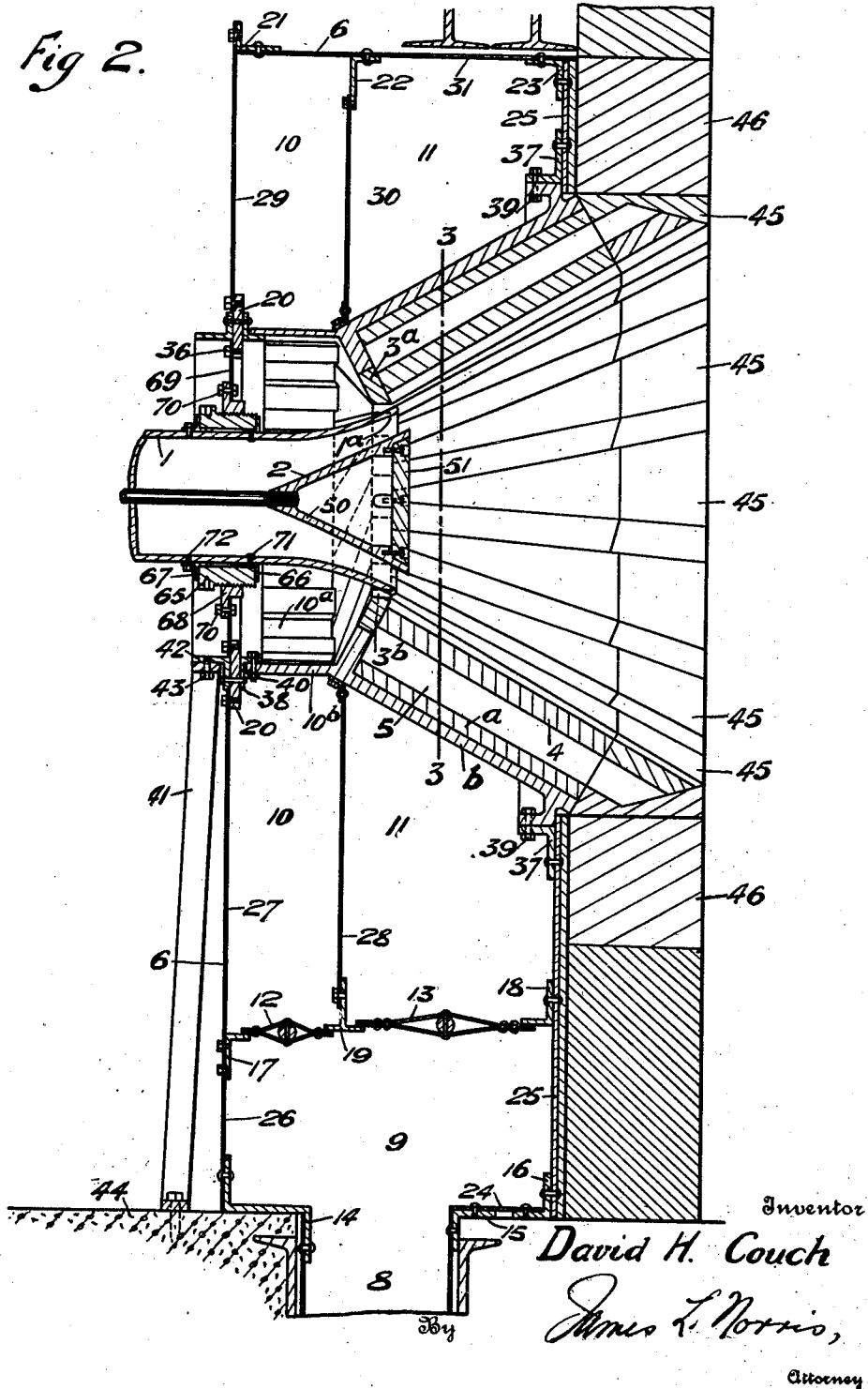
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Fig 2.



March 31, 1925.

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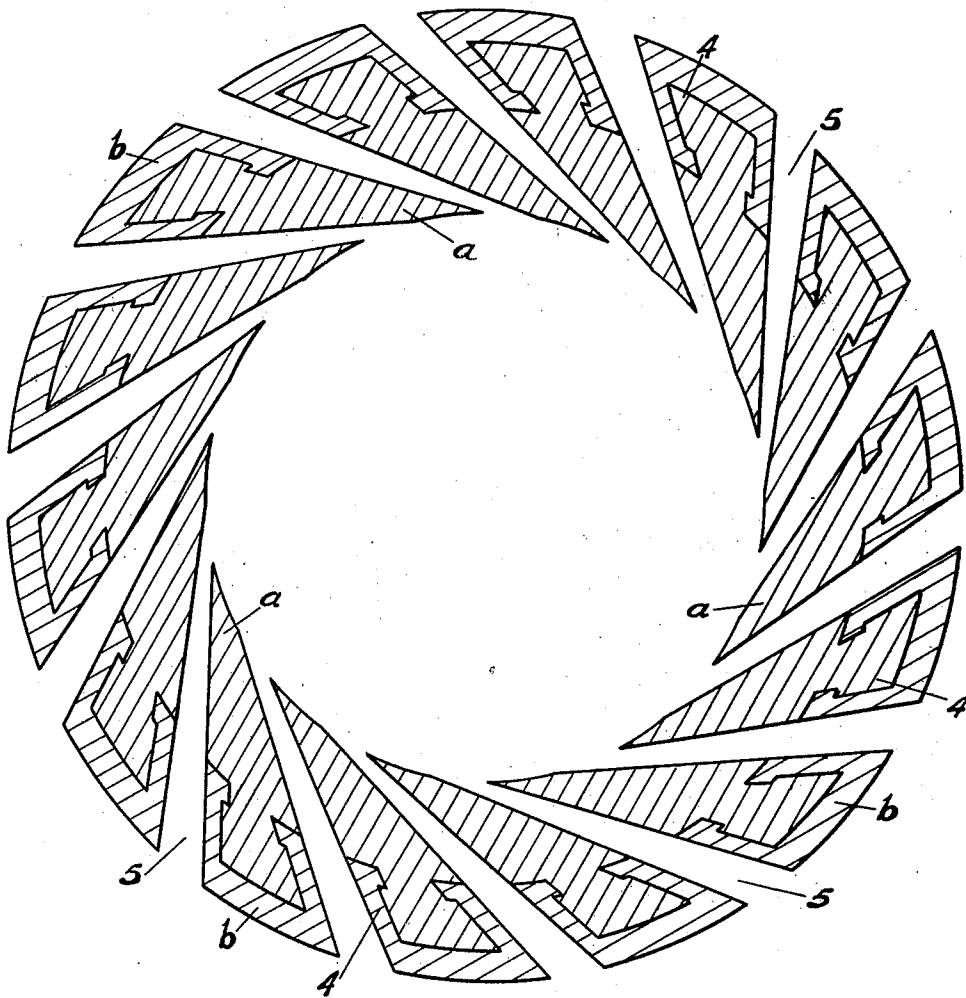
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4 Sheets-Sheet 3

Fig 3.



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PULVERIZED FUEL BURNER

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4 Sheets-Sheet 4

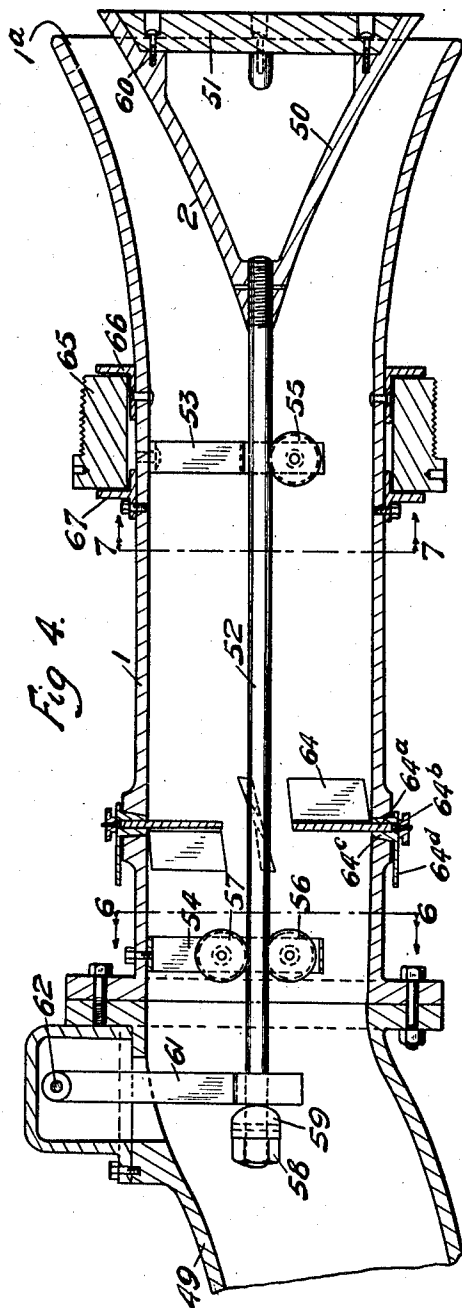


Fig. 4.

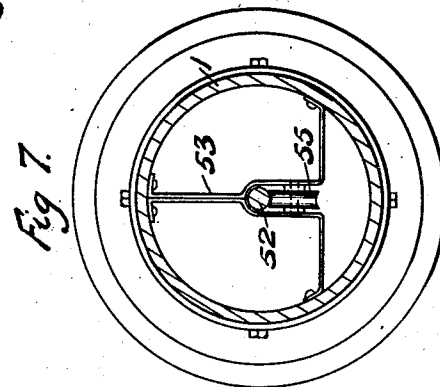


Fig. 7.

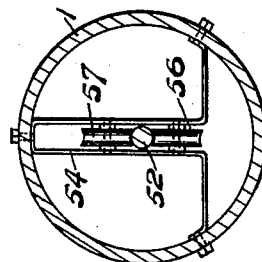


Fig. 6.

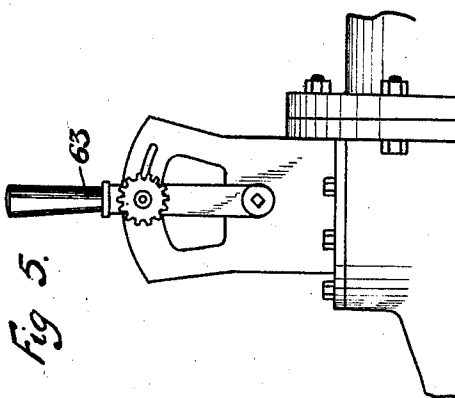


Fig. 5.

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Patented Mar. 31, 1925.

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UNITED STATES PATENT OFFICE.

DAVID H. COUCH, OF WARWICK, RHODE ISLAND.

PULVERIZED-FUEL BURNER.

Application filed March 16, 1922. Serial No. 544,198.

To all whom it may concern:

Be it known that I, DAVID H. COUCH, a citizen of the United States, residing at Warwick, in the county of Kent and State of Rhode Island and Providence Plantations, have invented new and useful Improvements in Pulverized-Fuel Burners, of which the following is a specification.

This invention relates to pulverized fuel burners, and particularly to that type of fuel burner in which pulverized coal or other pulverized fuel is burned and in which all of the air for combustion is admitted through the burner under a slight pressure, part of said air being blown or sucked in with the pulverized fuel and acting as a vehicle or conveyor for said fuel and the remainder of the air for combustion, or secondary air, being forced in through suitable openings in the burner, so as to form an intimate and thorough mixture of air and fuel, thus making possible the complete combustion of the fuel in furnaces of small volume.

A particular object of my invention is to provide a means for obtaining a thorough mixture of air and fuel in the immediate vicinity of the burner tip. This object is accomplished by placing a diffuser or spreader in the discharge end of the fuel pipe to spread the suspended fuel into a thin sheet or hollow cone and force it past suitable streams of air. This diffuser may be applied to fuel pipes of any shape or form and may be used with any type of air admission for secondary air, but the preferred embodiment of my invention is that shown on the accompanying drawings and consists of a circular fuel pipe flared at the discharge end and provided with a cone-shaped diffuser for spreading the stream of fuel and air as it leaves the outlet, so as to form a thin hollow cone or blast of fuel suspended in air and drive it approximately parallel with the inner surface of a truncated cone composed of alternate solid sections and slots, the secondary air for combustion being admitted through said slots and mixed with the fuel.

Other objects will appear in the specification and claims appended thereto.

The preferred design of this truncated cone is that shown on the drawings and consists of sections or segments of refractory or fire-resisting material between which slots are provided for the admission

of secondary air. These slots may be placed at any angle, preferably at approximately ninety degrees to the radius of the inner surface of the truncated cone, so that the secondary air will be directed approximately tangentially to the inner surface of the truncated cone, and thus produce a rotating or whirling motion of the fuel and air and form a thorough mixture of the same. Provision may be also made for the admission of additional secondary air around and parallel with the discharge end of the fuel pipe, should this be found necessary or desirable at certain rates of combustion.

The preferred embodiment of my invention is illustrated in the accompanying drawings, wherein:

Fig. 1 is a vertical longitudinal section through the center of one of the burners of a furnace, showing the application of my invention to a power plant boiler;

Fig. 2 is a vertical longitudinal section through the center of the fuel pipe and burner, showing the means employed for spreading the suspended fuel into a thin hollow cone and forcing it past the secondary air openings in the truncated cone of the burner;

Fig. 3 is a vertical transverse section through the truncated cone on the line 3—3, Fig. 2, showing the angular setting of the sections or segments which make up the truncated cone of the burner and form the air space;

Fig. 4 is a vertical longitudinal section through the fuel pipe, diffuser and diffuser supports;

Fig. 5 is a detail view showing the lever for operating the spreader adjusting mechanism;

Fig. 6 is a section on the line 6—6, Fig. 4, looking in the direction of the arrow; and

Fig. 7 is a further section on line 7—7, Fig. 4, looking in the direction of the arrows.

Referring to Fig. 2, 1 is the fuel pipe, the horizontal portion of which is called the burner section, through which the pulverized fuel is blown suspended in air, only a small percentage of the total air required for combustion being blown in the fuel. The discharge end 1^a of the fuel pipe is flared and provided with a conical diffuser or spreader 2, the purpose of which is to spread the fuel into a hollow cone and direct it approximate-

ly parallel with the inner surface of a truncated cone 3, which is preferably made up of sections 4 of refractory or fire-resisting material which are removable as units and arranged in spaced relation to afford air slots or passages 5 therebetween. These air slots or passages 5 are placed preferably at an angle of approximately ninety degrees with the radius of the inner surface of the truncated cone, so as to direct the several streams of air in jets approximately tangentially to the inner surface of the said cone. This causes the secondary air entering through these slots 5 to cut the hollow cone of fuel as it is blown past these slots and give it a spiral or whirling motion and at the same time force it toward the axis of the truncated cone 3, thus producing an intimate and thorough mixture of air and fuel and causing a large part of the combustion to take place within the truncated cone 3 before the burning mixture passes on into the furnace. The parts 1, 2, 3, 4 and 5 above described constitute the principal parts of the burner and are attached within and housed by the steel windbox 6.

This windbox 6 contains air under a slight pressure supplied from the air duct 7, (see Fig. 1) through the connecting duct 8 into an equalizing chamber 9. Where several burners are used in connection with a furnace, each burner is separated from its neighbor by a partition, preferably of sheet steel, forming an air compartment for the burner, and each burner compartment is divided into two pressure chambers 10 and 11, wherein any desired air pressure may be maintained by properly adjusting the dampers 12 and 13 which regulate the passages between the equalizing chamber 9 and the pressure chambers 10 and 11. The pressure chamber 11 communicates with the interior of the truncated cone through passages 5 described above and chamber 10 through passages 10^a and 3^b, as will be hereinafter set forth.

The windbox 6 is made up of the steel framework 14, 15, 16, 17, 18, 19, 20, 21, 22, 23 and plates 24, 25, 26, 27, 28, 29, 30, 31 and 69, and for purposes of facilitating inspection and removal of sections 4 of the truncated cone 3, the plates 27, 28, 29 and 30 are removable, being held in place by cap screws 36, and each pair of plates, that is, each exterior plate and the interior plate immediately back of it, for instance 29 and 30, give access to approximately one-fourth of the interior of each burner compartment. The sections 4 are secured to the angles 37 and 38 by the bolts 39 and 40, and the weight of the outer end of the burner with the parts attached to the angle 38 and the frame member 20, which is in the form of a ring surrounding pipe 1, is carried by the bracket 41 attached to the angle 42 by cap screws 43 and resting on the floor 44 in front of the remov-

able plate 27. All of the weight of the outer end of the burner is in this manner carried by the bracket 41, thereby permitting the removal of all of the removable plates without affecting the alinement of the burner.

The sections 4 of the truncated cone 3 are preferably each made of a refractory portion *a*, Fig. 3, supported by a portion *b* of metal, such as cast iron, although these sections may be made entirely of cast iron or other heat resisting material. However, the refractory material is preferred as it is a poor conductor of heat and will, therefore, maintain a hotter zone for combustion. A fire brick circle 46 is provided about the larger end of the truncated cone 3 and is lined with blocks 45. The blocks 45 are beveled correspondingly to sections 4 of the truncated cone and are slotted to form continuations of the air space 5. The blocks 45 are fitted tightly into the circle 46, are bonded in said circle by high temperature cement, and are therefore not removable with the sections 4. Leading vertically downward from a source of fuel supply, (not shown), is a fuel supply pipe 68^a which is connected with the burner section of the fuel pipe 1 by means of an elbow 49, as shown in Fig. 1. The elbow 49 is constructed with a double curvature which is intended to overcome the tendency of particles of fuel heavier than air to be thrown by centrifugal force against the outer side of the curve and thus be discharged into the bottom of fuel pipe 1. The double curvature of the elbow causes these particles to continue in a direction practically tangential to the main curve and to be thrown into the center of fuel pipe 1 on leaving the elbow, thus facilitating mixing and preventing the fuel from being precipitated at the bottom of the fuel pipe.

The curvature of the flared discharge end 1^a of the fuel pipe is preferably such that a line tangent to said curve at the point of discharge will be parallel to the inner surface of the truncated cone 3.

The spreader 2 consists of a conical section 50, preferably of cast iron, having a refractory protecting cap 51 held in the base end thereof by means of machine screws 60. The spreader is carried in the flared end 1^a of the pipe 1 by a rod 52 which is supported for longitudinal movement axially of the pipe 1 by means of wheels 55, 56 and 57 carried by supporting members 53 and 54, and the spreader is adjustable longitudinally of said pipe for increasing or decreasing the annular opening between the spreader and pipe wall by means of a hand lever 63 on the outside of the pipe, which is connected with the rod 52 by means of a shaft 62 and lever 61 within the pipe. The shaft 52 has preferably a sliding connection with the lower end of the lever 61 whereby, should there be undue pressure

across the heating surface before being discharged to the stack or uptake. The boiler itself consists of the steam drum 82, the tubes 79, the headers 83, and the connecting tubes 84.

The pulverized fuel burner described above is intended primarily as a forced draft burner, that is, a burner using air at a pressure higher than atmospheric pressure. Since, however, it is possible by creating a sufficiently negative pressure in the furnace to draw in the secondary air at atmospheric pressure, this burner may also be used as a so-called "Natural Draft" burner, especially at the lower ratings.

In all of the figures referred to herein my invention is shown with the fuel pipe 1 mounted in a horizontal position, but fuel pipe 1 and therefore the center line of the burner may be mounted in any desired position or in any type of furnace.

Many of the details of design of the mechanical features of my invention as set forth above are typical of what may be used, and the same may be varied as desired without departing from the spirit of my invention.

What is claimed as new is:

1. In a pulverized fuel burner, a truncated cone-shaped member having air ports, a fuel feed pipe discharging into the smaller end of said member, and a spreader in the discharge end of said feed pipe for directing the fuel at a predetermined angle past said air ports.

2. In a pulverized fuel burner, a fuel pipe, a truncated cone surrounding and projecting beyond the discharge end of said pipe and having ports in the walls thereof, and a spreader in the discharge end of said pipe for directing the fuel past said ports at a predetermined angle.

3. A pulverized fuel burner comprising a frustro-conical combustion chamber, the walls thereof being provided with ports communicating with a source of air supply, a fuel feed pipe co-axial with said combustion chamber and a conical spreader in the end of said fuel feed pipe for directing fuel past said air ports in a direction substantially parallel with wall of said combustion chamber.

4. In a pulverized fuel burner, a feed pipe, a conical spreader in the discharge end of said feed pipe, and a truncated cone member located in front of said discharge end consisting of spaced sections so positioned that the passages formed therebetween will lie approximately tangential to the internal surface of said cone member, and means for directing air through said passages.

5. In a pulverized fuel burner, a feed pipe, a conical spreader in the discharge end of said feed pipe, and a truncated hollow cone

member located in front of the discharge end of said pipe, said member having passages formed therein for the introduction of secondary air, said air passages being so arranged as to direct the streams of secondary air approximately tangential to the inner surface of the truncated cone.

6. In a pulverized fuel burner, a feed pipe for supplying a current of fuel-charged air to the burner, a conical spreader in the discharge end of said feed pipe, a hollow truncated cone member surrounding and extending beyond the discharge end of the feed pipe having passages in the walls thereof for secondary air, said passages being arranged to direct said secondary air into the current of fuel-charged air so as to give it a revolving or whirling motion at approximately right angles to its general direction of travel, and means for forcing air through said passages.

7. In a pulverized fuel burner, a hollow truncated cone, a fuel feed pipe having its discharge end at the smaller end of said truncated cone, a conical spreader in said discharge end for directing the fuel in a conical stream substantially parallel with the walls of said truncated cone, and means whereby said stream may be forced toward the axis of said cone.

8. In a pulverized fuel burner, a fuel feed pipe, a hollow truncated cone member located adjacent the discharge end of said fuel pipe, a spreader in the discharge end of the fuel pipe adapted to direct the flow of fuel into said truncated cone, said truncated cone having air passages leading thereinto for a supply of secondary air, the discharge end of the feed pipe and the adjacent end of the truncated cone member having an opening therebetween for the supply of additional secondary air, and means for adjusting the size of said opening.

9. In combination with a pulverized fuel burner, comprising a fuel pipe and a hollow truncated cone associated therewith at its discharge end, a wind box surrounding said burner, said wind box comprising an equalizing chamber and a pair of pressure chambers in communication therewith, said truncated cone having apertures in its walls affording communication between the interior of the cone and one of the pressure chambers, and said truncated cone having a further aperture concentric with the fuel pipe and affording communication between the interior of the cone and the other pressure chamber.

10. In combination with a pulverized fuel burner, comprising a fuel pipe and a hollow truncated cone associated therewith at its discharge end, a wind box surrounding said burner, said wind box comprising an equalizing chamber and a pair of pressure chambers in communication therewith, said trun-

on the base end 51 of the spreader due, for example, to an explosion in the furnace, the spreader will be free to move rearwardly under pressure, thus closing the discharged end of the fuel pipe and preventing further feed of fuel into the furnace. The lever 61 is prevented from becoming disengaged from the rod 52 by means of the nut 58 and washer 59. This arrangement makes the spreader 2 serve not only as a spreader and as a valve for regulating the size of the aperture at the discharge end of pipe 1 as set forth above, but also, in case of serious explosions in the furnace, as an automatic check valve, the spreader 2 being free at all times to move backward in case the pressure in the furnace should suddenly become greater than the pressure in the fuel pipe.

In order to thoroughly mix the air and suspended fuel passing through the pipe 1, it is desirable to give the air a slight rotating motion in a direction counter to the direction of travel of the secondary air received through the passages 5. For this purpose vanes 64 are provided within the pipe 1 having propeller-shaped surfaces which cause the fuel in passing the same to rotate, and in order to regulate the mixing and rotation of the fuel flowing through the pipe, the vanes 64 are made adjustable. This is accomplished by forming the vanes with squared shanks 64^a which are received and held by means of lock nuts 64^b in the bores of frusto-conical sleeves 64^c which are rotatably mounted in complementary apertures formed in the wall of the pipe. The sleeves 64^c may be provided with laterally extending handles 64^d for rotating the vanes to various angular positions, in which positions the vanes may be secured by means of the lock nuts 64^b.

It is preferred that the surfaces of both the interior and exterior of the discharge end of fuel pipe 1 be smooth, but either or both of these surfaces may be fluted or scalloped either longitudinally or spirally, if desired, to give better mixing.

At the rear end of the truncated cone 3 is a reentrant wall 3^a which is provided with a central aperture 3^b adapted to snugly receive the flared discharge end 1^a of the pipe 1. It is desirable under certain circumstances to admit secondary air to the interior of the truncated cone in addition to that admitted through the passages 5, the amount of this additional air varying with circumstances. For this purpose the interior of the truncated cone 3 is afforded communication with the pressure chamber 10 through the passages 10^a between members 10^b and the through aperture 3^b, the aperture 3^b being regulated as to size or entirely closed by proper axial adjustment of the pipe 1 in said aperture. The axial

adjustment of the pipe 1 to regulate the aperture 3^b is effected by providing an annular adjusting screw 65 which encircles the pipe 1 and is mounted for rotary movement relative thereto and to cooperate with the complementary internally threaded part of an annular member 68 for moving the pipe backward or forward. The screw 65 is secured against movement longitudinally of the pipe by an annular angle member 66 and an annular tee 67 fastened to the pipe by rivets 71 and cap screws 72, while the annular member 68 is attached to the ring 20 by means of circular plate 69, bolts 70 and screws 36.

In case no secondary air is desired at this point, the adjusting screw 65 may be turned counter clockwise until the tip of fuel pipe 1 is brought back a short distance into the cast iron portion 3^b of the small end of the truncated cone 3, whereupon the admission of air at this point, even if there should be some leakage through the damper 12, is practically shut off. On the other hand, if the admission of air between the fuel pipe and the small end of the truncated cone 3 is desired, the adjusting screw 65 may be turned clockwise and the fuel pipe caused to move in towards the furnace until its inner end passes through beyond the central aperture 3^b of the wall 3^a. The fuel pipe 1, elbow 49 and fuel supply pipe 68^a possess sufficient flexibility to allow for the above described movement, since the fuel supply pipe 68^a is of considerable length and the weight of these parts is carried on the support 73, Fig. 1, which is attached to the elbow 49 by bolt 74 and rests in a recess in a base member 75 attached to the floor 44 by cap screws not shown, or other suitable means.

Fig. 1 shows the application of the invention to a power plant boiler and the various parts of the burner described above are shown mounted in the wall of the furnace which supports the blocks 45 and consists of fire brick or other refractory material 76 protected on the outside by the usual red or insulating brick covering 77. The bridgewall 78 and all of the interior of the furnace are made of highly refractory material, as for instance, a high grade fire brick, to resist the intense heat of the furnace. Other parts of the furnace are the floor 85, slag or ash discharge opening 86 which is connected with the water cooled slag tank 88 by the pipe 87, the rear wall 89, back connection floor 90, and dust discharge pipe 91. The products of combustion pass from the discharge end of the truncated cone 3 into the furnace and up among the tubes 79 past which they are drawn by the action of stack or induced draft apparatus, the baffles 80 and 81 causing these gases to pass a number of times

5 cated cone having apertures in its walls af-
 10 fording communication between the interior
 of the cone and one of the pressure cham-
 bers, said truncated cone having a further
 15 aperture concentric with the fuel pipe and
 affording communication between the in-
 terior of the cone and the other pressure
 chamber, and means for adjusting the fuel
 pipe for regulating the size of or closing
 20 said last named aperture.

11. In combination with a pulverized fuel
 burner, comprising a fuel pipe and a hollow
 truncated cone associated therewith at its
 discharge end, a wind box surrounding said
 15 burner, said wind box comprising an equal-
 izing chamber and a pair of pressure cham-
 bers in communication therewith, said trun-
 cated cone having apertures in its walls
 forming communication between the interior
 20 of the cone and one of the pressure cham-
 bers, said truncated cone having a further
 aperture concentric with the fuel pipe and
 affording communication between the in-
 terior of the cone and the other pressure
 25 chamber, means for adjusting the fuel pipe
 for regulating the size of or closing said last
 named aperture, and dampers controlling

the communication between said equalizing
 chamber and said pressure chambers.

12. In a pulverized fuel burner, the com- 30
 bination of a pulverized fuel pipe through
 which fuel is blown suspended in air, a
 hollow truncated cone having passages for
 the admission of secondary air, and a
 35 spreader in the discharge end of said fuel
 pipe adapted to spread the suspended fuel
 into a hollow cone and direct it at a prede-
 termined angle past said passages, said trun-
 cated cone comprising sections of heat-re- 40
 sisting material spaced apart to form said
 air passages for the admission of secondary
 air in streams approximately tangential to
 the interior of said hollow truncated cone, an
 adjustable opening being formed between
 the discharge end of the fuel pipe and the 45
 small end of the truncated cone for the ad-
 mission of additional secondary air.

In testimony whereof I have hereunto set
 my hand in presence of two subscribing
 witnesses.

DAVID H. COUCH.

Witnesses:

JACKSON COLE PHILLIPS,
 ARTHUR H. GORDON.