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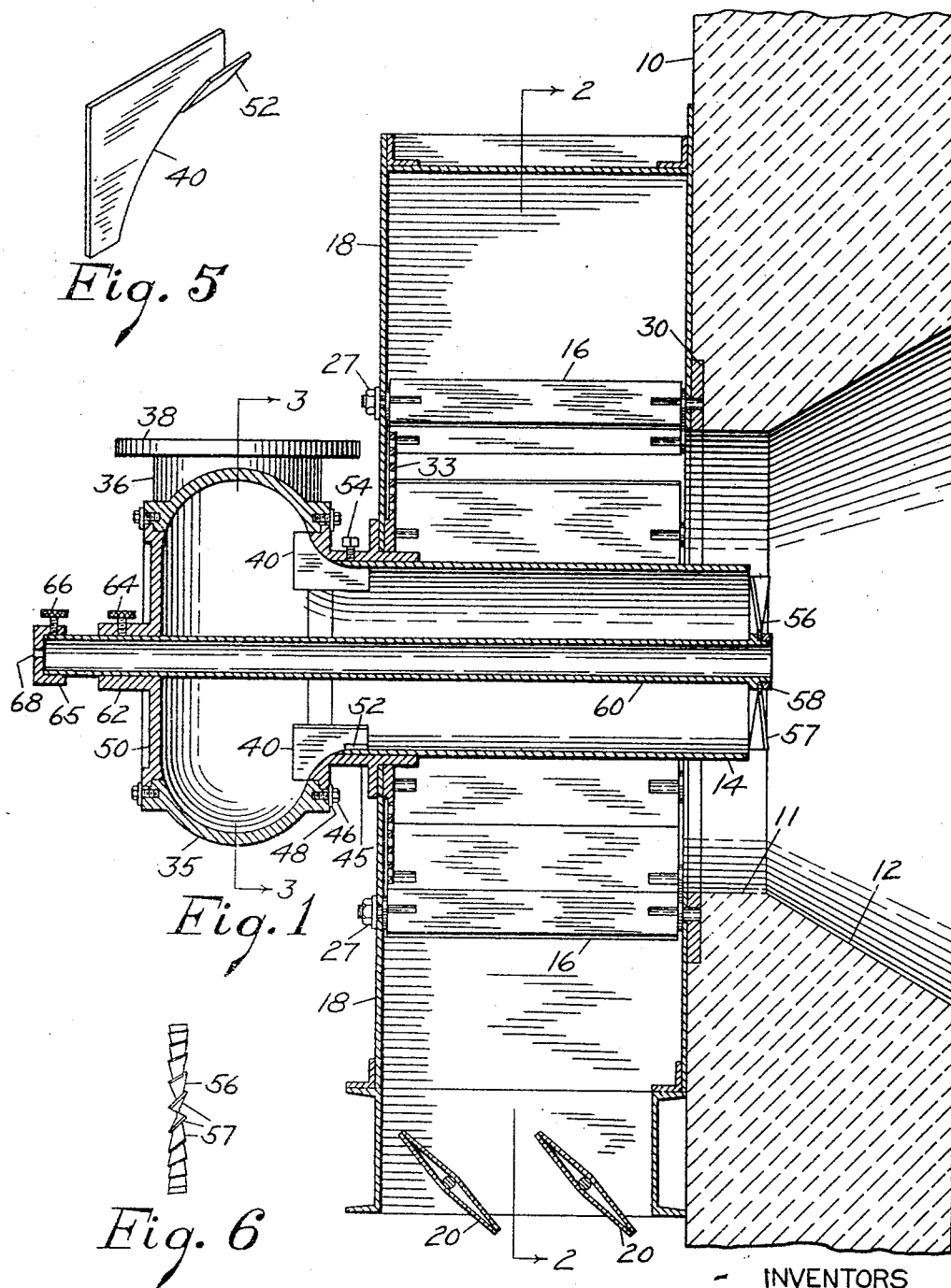
O. CRAIG ET AL

1,843,662

FUEL BURNER

Filed Jan. 20, 1927

2 Sheets-Sheet 1.



WITNESS
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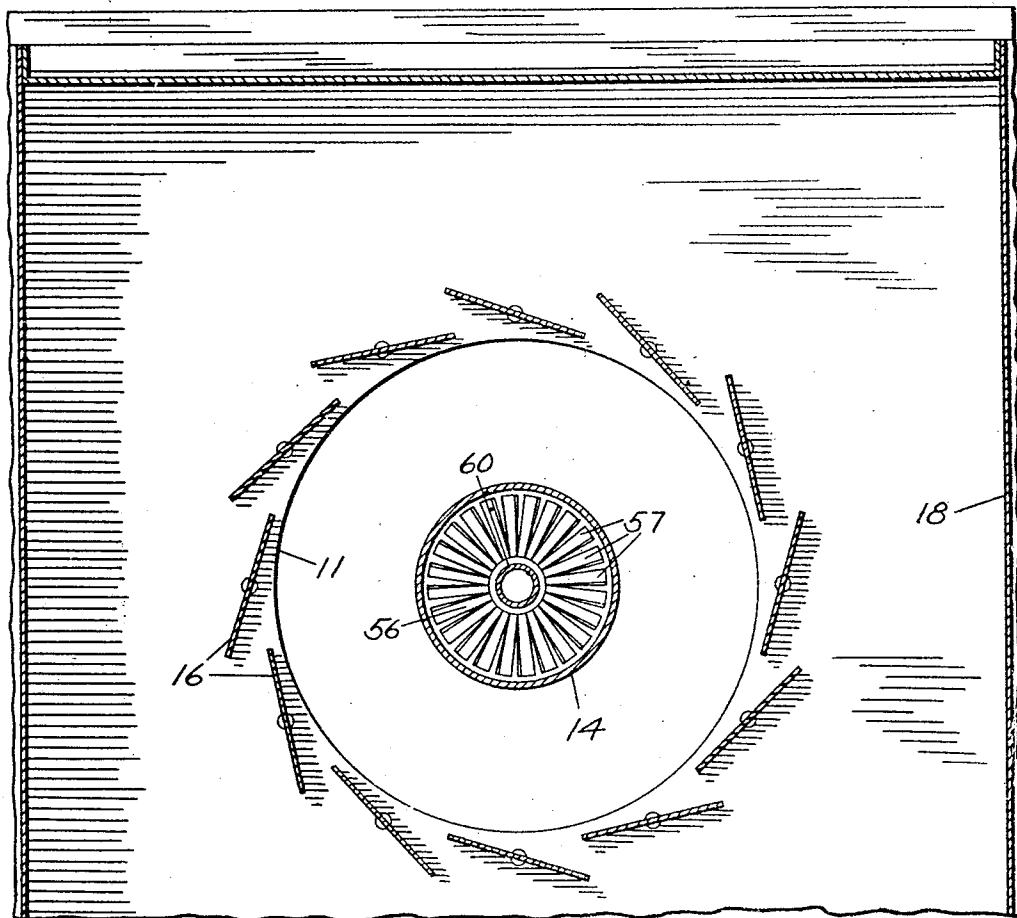
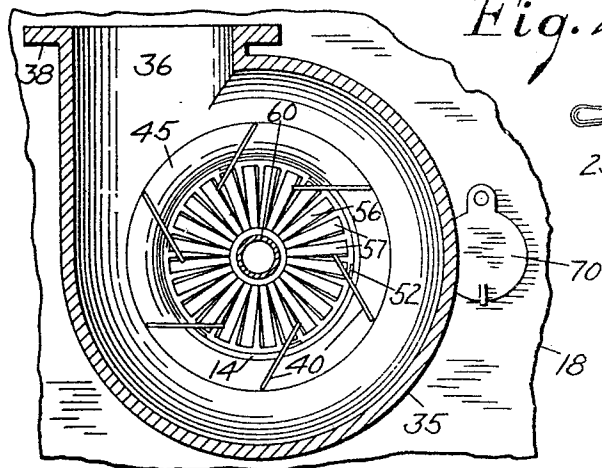


Fig. 2



WITNESS
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Fig. 3

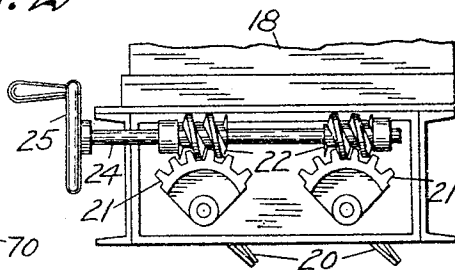


Fig. 4

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FUEL BURNER

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This invention relates to fuel burners, and more particularly to burners for pulverized fuel of the type in which the air necessary for combustion is introduced into the furnace through the burner.

One form of burner comprises a central pipe through which the pulverized fuel and primary air are discharged and around the outside of which the secondary air is delivered to the furnace. It is usually impossible to avoid having several bends and elbows in the fuel pipe, and considerable segregation occurs as a result of centrifugal force which throws the coarser fuel particles to the outside of the bends. In prior burners of this type, this segregation has continued up to the time the fuel and air enter the furnace, the fuel being distributed unevenly around the circumference of the discharge nozzle. Obviously, under these conditions, it is impossible to obtain a uniform mixture of coal and air, and an unbalanced and inefficient flame is the result.

It is accordingly one object of our invention to provide a burner arranged to produce a uniform distribution of pulverized fuel around the circumference of the discharge nozzle, regardless of any bends which may be present in the pipe line leading to the burner.

It is very desirable in burning pulverized fuel to produce a high degree of turbulence in the mixture of fuel and air leaving the burner. Such turbulence results in more rapid combustion and a shorter flame, permitting the use of a furnace having a smaller volume. Attempts have been made to produce turbulence by placing a helical screw thread or blade in the fuel discharge nozzle, causing the issuing fuel stream to whirl. Such prior devices have been unsatisfactory because they increase the fuel segregation, the fuel tending to flow along close to the surface of the blade and leave the nozzle in a concentrated stream.

It is therefore a further object of our invention to provide an improved type of spreader for a pulverized fuel burner, which is adapted to give a whirling movement to the fuel stream as it is discharged without causing appreciable segregation.

With burners for pulverized fuel, it is highly desirable to be able to cover a wide range of boiler ratings, that is, to burn efficiently a large or small amount of fuel as desired, depending on the load on the boiler being fired. Now in attempting to operate at low ratings, it is necessary to reduce the supply of fuel and of secondary air. The primary air cannot be reduced, as it is necessary to transport the fuel to the burner. Therefore, the point is eventually reached where the primary air is sufficient for the amount of fuel being burned, and the secondary air is entirely cut off. It has been impossible to operate satisfactorily under these conditions with prior burners, because they have depended upon the air flow to keep them cool, and if this air supply is cut off serious damage results from the radiant heat.

It is accordingly a further object of our invention to provide a pulverized fuel burner which can be operated efficiently at all ratings, and which is so constructed and arranged that the supply of secondary air may be entirely cut off if desired without the radiant heat seriously damaging various parts of the structure defining the secondary air passage.

A still further object is to provide a burner which will produce a uniform and highly turbulent mixture of air and fuel, and which will be inexpensive to manufacture, easy to install and simple to operate.

With these and other objects in view, as will be apparent to those skilled in the art, our invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

According to our invention, we provide a pipe or nozzle which is suitably located to discharge pulverized fuel and primary air into a furnace. In order to obtain a uniform discharge of fuel around the circumference of the pipe, we introduce the stream into the burner pipe through a tangential inlet. For this purpose the outer end of the pipe is preferably enlarged to form a substantially cylindrical chamber in which the fuel may whirl. Secondary air is introduced uni-

formly around the discharge nozzle, preferably by vanes or louvers arranged to give this air a rapid whirling motion, thereby aiding in the mixing effect. A spreading device may be mounted at the discharge end of the fuel pipe, and this preferably comprises a series of uniformly spaced substantially radial blades each inclined at an angle, so as to give the issuing fuel stream an outward rotary motion. This spreader is preferably mounted for adjustment longitudinally of the fuel pipe on a smaller pipe coaxial therewith. This small pipe is useful particularly in connection with the lighting of the fuel stream, as it permits the introduction of an oil burner or other suitable device for this purpose.

Referring to the drawings, in which like reference numerals indicate like parts:

Fig. 1 is a vertical section showing one embodiment of our invention mounted on the front wall of a furnace, the section being taken through the center of the burner and parts being omitted for the sake of clarity of illustration;

Fig. 2 is a section on the line 2—2 of Fig. 1, parts being broken away;

Fig. 3 is a section on the line 3—3 of Fig. 1, with parts broken away;

Fig. 4 is a side elevation of the damper control mechanism;

Fig. 5 is a perspective view of a guide vane; and

Fig. 6 is a side elevation of the spreading device.

The embodiment of our invention illustrated in the drawings comprises a vertical furnace wall 10 provided with a circular opening 11 having a flaring portion 12 on the furnace side. A horizontal pipe 14 is mounted concentric with the opening 11, and is adapted to discharge into the furnace a stream of pulverized fuel and primary air.

The additional or secondary air required for combustion is supplied through the annular space between the pipe 14 and the wall of opening 11. In order to ensure a uniform distribution of this air, we provide a series of guide vanes or louvers 16, which are preferably arranged to form approximately a cylinder co-axial with the pipe 14 and somewhat greater in diameter than opening 11. By this construction, the vanes are so mounted in relation to the furnace wall 10 that they are protected to a large extent from the radiant heat of the furnace by the intervening refractories. The pipe 14 preferably extends beyond the inner ends of the vanes into the opening 11, whereby the flame is spaced for a substantial distance from the vanes and they will remain at a comparatively low temperature even though there may be very little secondary air flowing through the burner. As shown clearly in Fig. 2, these vanes 16 are placed in an approximately tangential posi-

tion, so that the secondary air is given a pronounced whirl or rotary motion.

In the majority of installations it is desirable to utilize forced draft, and to deliver the secondary air under pressure from a suitable fan. For this purpose we provide a casing 18 to form a plenum chamber around the louvers. This chamber is open at the bottom as shown in Fig. 1, and a suitable duct may be connected thereto for the delivery of the air. In order to control the air pressure within the casing 18, dampers 20 may be arranged. As shown in Fig. 4, each damper shaft may be provided with a worm gear segment 21, and these mesh with worms 22 on a horizontal shaft 24. A hand-wheel 25 on this shaft can be rotated to open or close the dampers as desired.

The louvers 16 may be mounted pivotally in the casing 18, to permit them to be adjusted to various angles. It is clear that with this arrangement they may be turned so as to cause the air to whirl in either direction. By tightening nuts 27 (Fig. 1), the louvers may be clamped at the desired positions.

A heavy annular member 30 with an inner diameter the same as that of opening 11 is attached to the casing 18 on the side next to the wall. This member serves as a stiffener for the casing and provides a circular ledge which is of great assistance to the brick mason in laying up the refractory arch surrounding the opening 11.

An annular plate 33 (Fig. 1) is mounted in the space between the pipe 14 and the louvers 16 to form a protection for the outer casing plate against the radiant heat of the furnace. This plate 33 is preferably perforated as shown to prevent cracking.

As it is highly desirable to produce a uniform distribution of the fuel around the interior of pipe 14, we prefer to arrange an enlarged portion such as the substantially circular chamber or receiving head 35 at the outer end of the pipe, and deliver the fuel stream thereto through a tangential inlet pipe or conduit 36, which may have a standard pipe flange 38 for convenience in connecting to the supply pipe. In this way, a rapidly rotating mass of air and pulverized fuel is set up in the chamber 35, and the mixture passes along the central pipe 14 without segregation. The chamber 35 provides impermeate connections between the inlet 36 and the central pipe 14, so that the entire stream of fuel and primary air passes longitudinally through the pipe as a mass whirling about the axis thereof.

We have discovered that by placing a series of guide vanes 40 in proper positions around the exit passage of the chamber 35, an improvement in operation is obtained. As shown clearly in Fig. 3, these vanes are preferably inclined to the radii extending thereto, and are spaced uniformly around

the burner axis. This construction aids in bringing about a more uniform distribution of fuel around the interior of pipe 14. Moreover we have found that the vanes reduce the pressure drop through the burner, thus permitting the fan which supplies the primary air to operate with less power consumption.

For convenience in manufacture and adjustment, the passages for fuel and primary air are constructed of several parts, as shown particularly in Fig. 1. An annular member 45 is bolted to the casing 18, and the receiving head 35 is attached to this member by suitable fastening means, such as cap screws 46. It is to be noted that these cap screws do not pass through both of the connected parts, but are merely screwed into the receiving head 35. Each cap screw has a washer 48 beneath its head, and this washer overlaps the member 45, and is clamped thereagainst by tightening the screw. This construction permits the receiving head and inlet pipe 36 to be revolved about the axis of the burner to the most convenient angle for connection with the fuel supply pipe. It will be apparent that this adjustment is in no way affected by the spacing between adjacent screws 46. As shown, the receiving head may be made symmetrical about the line 3—3, so that it may be reversed if desired to cause the fuel to revolve in the opposite direction. A closing plate 50 is mounted on the outer side of the receiving head. Each vane 40 is provided with an ear 52, and this ear is spot welded to the interior of pipe 14. This pipe is held in place in the member 45 by a set screw 54, and this construction permits the pipe to be rotated about its axis to vary the relation of the vanes 40 to the fuel inlet pipe 36.

In order to throw outward the fuel stream issuing from the nozzle 14 and increase the turbulent effect, we provide adjacent the end of the nozzle an improved fuel spreading device 56. This spreader comprises a large number of substantially radial vanes 57, each arranged at an angle to the general direction of the stream flow so as to whirl the primary air and fuel. We have found it advisable in a majority of instances to provide for opposite rotation of the fuel and secondary air, as this tends to increase the mixing effect and the turbulence. However, these directions of rotation may be made the same if desired by reversing the louvers 16. The spreader 56 may be conveniently constructed of a single circular piece of sheet metal, cut radially at a number of equally spaced points, the resulting vanes being suitably twisted to an acute angle with the plane of the sheet and shaped generally like the blades of one form of an air propelling fan, as illustrated. This construction provides a number of spaced thin vanes, presenting long edges extending substantially the full width of the fuel stream,

so that the fuel is caused to flow from the entire extent of said long edges in the form of thin sheets which are directed outwardly and distributed into the secondary air. A further advantage results from the use of our improved spreader in that the coarser particles of fuel are thrown by centrifugal force to the outside of the issuing fuel stream, where they are brought quickly into intimate contact with the secondary air and are exposed to heat reflected from the adjacent refractories. This is very important, for obviously the coarse particles require a longer time for complete combustion, and in order to obtain a short flame it is essential that they start to burn immediately on leaving the nozzle.

The spreader 56 is shown attached by a nut 58 to the inner end of a small pipe or tube 60 arranged concentric with the pipe 14. This pipe 60 is slidably mounted in a boss 62 on the plate 50, a screw 64 being used to hold it in any desired position. By this construction the spreader 56 may be adjusted along the axis of the burner as desired, thus varying the angle of flare of the plane and controlling the position of the flame in relation to the furnace wall 10. At no position of adjustment does the spreader seriously obstruct the flow of primary air and pulverized fuel.

The pipe 60 has a straight and unobstructed passage therethrough and it may be provided with a cap 65 on its outer end, held in place by a screw 66. This cap may have a small opening 68 therein for use as a peep hole, through which a clear view may be obtained of the flame interior. By removing cap 65, an oil burner or other suitable device may be inserted through the pipe 60 to initially light the issuing fuel stream. An inspection door 70 (Fig. 3) may be provided in the casing 18 to permit observation of the flame, or to ignite the oil burner which may be inserted through pipe 60.

The operation of our invention will now be apparent from the above disclosure. Pulverized fuel is delivered to the inlet pipe 36 on a current of primary air. This fuel may come directly from a suitable pulverizer of the unit type, or it may come from a storage bin. The fuel because of its tangential entry, whirls rapidly in the chamber 35, about the axis of the burner, and is uniformly distributed around the circumference of the nozzle pipe 14. This even distribution is aided by the series of guide vanes 40. The issuing fuel stream is given an outward whirling motion by the vanes 57 on the fuel spreader 56. Secondary air is delivered from a suitable fan to the chamber formed by casing 18, the pressure therein being controlled by dampers 20. This secondary air passes inward between the louvers 16, and is thereby evenly distributed, and given a rapid rotary

motion. The secondary air contacts with the fuel inside the flaring opening 12, and the refractory surfaces of this opening reflect heat from the furnace directly on the fuel stream. A very high degree of turbulence is obtained, and the result is rapid combustion and a flame only a few feet in length. When starting up with a cold furnace, suitable combustible materials, such as oil contained in a hand torch, may be inserted through pipe 60 to bring about ignition. By loosening screw 64, the pipe 60 and spreader 56 may be longitudinally adjusted to position the flame as desired.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. A burner for pulverized fuel comprising a central pipe having an enlarged portion substantially circular in shape adjacent to its intake end, said enlarged portion being provided with a tangential inlet for pulverized fuel and primary air, deflecting vanes arranged around the interior of said pipe in the path of fuel passing out of the enlarged portion, each vane being inclined with respect to a radius extending thereto, and means for introducing secondary air uniformly around the discharge end of the pipe.

2. A burner for pulverized fuel comprising a central pipe having at its intake end a substantially circular enlarged portion, means for introducing fuel and primary air tangentially into said enlarged portion, deflecting vanes arranged around the interior of said pipe in the path of the fuel, each vane being inclined with respect to a radius extending thereto, and means for introducing secondary air around the discharge end of the pipe.

3. A burner for pulverized fuel comprising a straight central imperforate burner pipe having an open discharge end, an inlet conduit for a stream of pulverized fuel and primary air arranged tangentially to said burner pipe and communicating therewith by imperforate connections so as to cause the entire stream of fuel and air to pass longitudinally through the burner pipe as a mass whirling about the axis of the pipe, and air admission means including an arrangement of louvres surrounding the central pipe for introducing secondary air uniformly around the burner pipe adjacent to its discharge end and into the whirling stream of fuel in the combustion zone beyond the burner pipe.

4. A burner for pulverized fuel comprising a straight central imperforate burner pipe having an open discharge end, an inlet conduit for a stream of pulverized fuel and primary air arranged tangentially to said burner pipe and communicating therewith by imperforate connections so as to cause the entire stream of fuel and air to pass longitudinally

through the burner pipe as a mass whirling about the axis of the pipe, said imperforate connections being shaped to provide a substantially circular chamber larger in diameter than the central pipe and coaxial therewith, and air admission means including an arrangement of louvres surrounding the central pipe for introducing secondary air uniformly around the burner pipes adjacent to its discharge end and into the whirling stream of fuel in the combination zone beyond the burner pipe.

5. A burner for pulverized fuel comprising a central pipe arranged to deliver directly into a furnace a stream of pulverized fuel carried by a current of air, means for introducing all of the secondary air into the furnace uniformly around the discharge end of the pipe, and a spreading device mounted axially of the pipe and at the discharge end thereof, which has a number of spaced thin vanes, each vane extending outwardly and being fixed at an angle to the general direction of the stream flow, and the vanes presenting long edges extending substantially the full width of the fuel stream so that the fuel is caused to flow from the entire extent of said long edges and is thrown outwardly therefrom and distributed into the secondary air.

6. A burner for pulverized fuel comprising a central pipe arranged to deliver directly into a furnace a stream of pulverized fuel carried by a current of air, means for introducing all of the secondary air into the furnace uniformly around the discharge end of the pipe, a spreading device mounted axially of the pipe and at the discharge end thereof which has a number of spaced thin vanes, each vane extending outwardly and being fixed at an angle to the general direction of the stream flow, the vanes presenting long edges extending substantially the full width of the fuel stream so that the fuel is caused to flow from the entire extent of said long edges and is thrown outwardly therefrom and distributed into the secondary air, and means to distribute the fuel substantially uniformly about the axis of the central pipe and cause it to be whirling when it strikes the deflecting vanes, thereby insuring proper distribution of the fuel into the secondary air.

7. A burner for pulverized fuel comprising a central pipe arranged to deliver directly into a furnace a stream of pulverized fuel carried by a current of air, means for introducing secondary air into the furnace uniformly around the discharge end of the pipe, a spreading device mounted axially of the pipe and at the discharge end thereof which has a number of deflecting vanes, each vane extending outwardly and at an angle to the general direction of the stream flow to throw the fuel outwardly into the surrounding secondary air, and an inlet conduit for pul-

verized fuel and air arranged tangentially to said central pipe and communicating therewith by imperforate connections so as to cause the entire stream of fuel and air to pass longitudinally through the central pipe as a mass whirling about the axis of the pipe, said imperforate connection being shaped to provide a substantially circular chamber larger in diameter than the central pipe and coaxial therewith.

8. A burner for pulverized fuel comprising a pipe arranged to deliver into a furnace a stream of pulverized fuel carried by a current of air, a spreading device mounted axially of the pipe and adjacent to the discharge end thereof which has a number of deflecting vanes, each vane extending substantially radially and at an angle to the general direction of the stream flow so as to throw the pulverized fuel outwardly, means for adjusting the spreading device along the axis of the pipe from a position within the pipe to a position beyond the end thereof, and means for introducing secondary air uniformly around the discharge end of the pipe and into the deflected fuel stream.

9. A burner for pulverized fuel comprising a pipe arranged to deliver into a furnace a stream of pulverized fuel carried by a current of air, a tube smaller in diameter than the pipe and mounted within the pipe and coaxial therewith, a spreading device mounted on the tube adjacent to the discharge end of the pipe, said spreading device having a number of deflecting vanes and each vane extending substantially radially and at an angle to the general direction of the stream flow so as to throw the pulverized fuel outwardly, and means for introducing secondary air uniformly around the discharge end of the pipe and into the deflected fuel stream, said tube having a straight and unobstructed passage therethrough to permit igniting material to be introduced to the whirling fuel stream and a view to be obtained of the flame interior.

Signed at Worcester, Mass., this 18th day of January, 1927.

OLLISON CRAIG.
L. V. ANDREWS.