

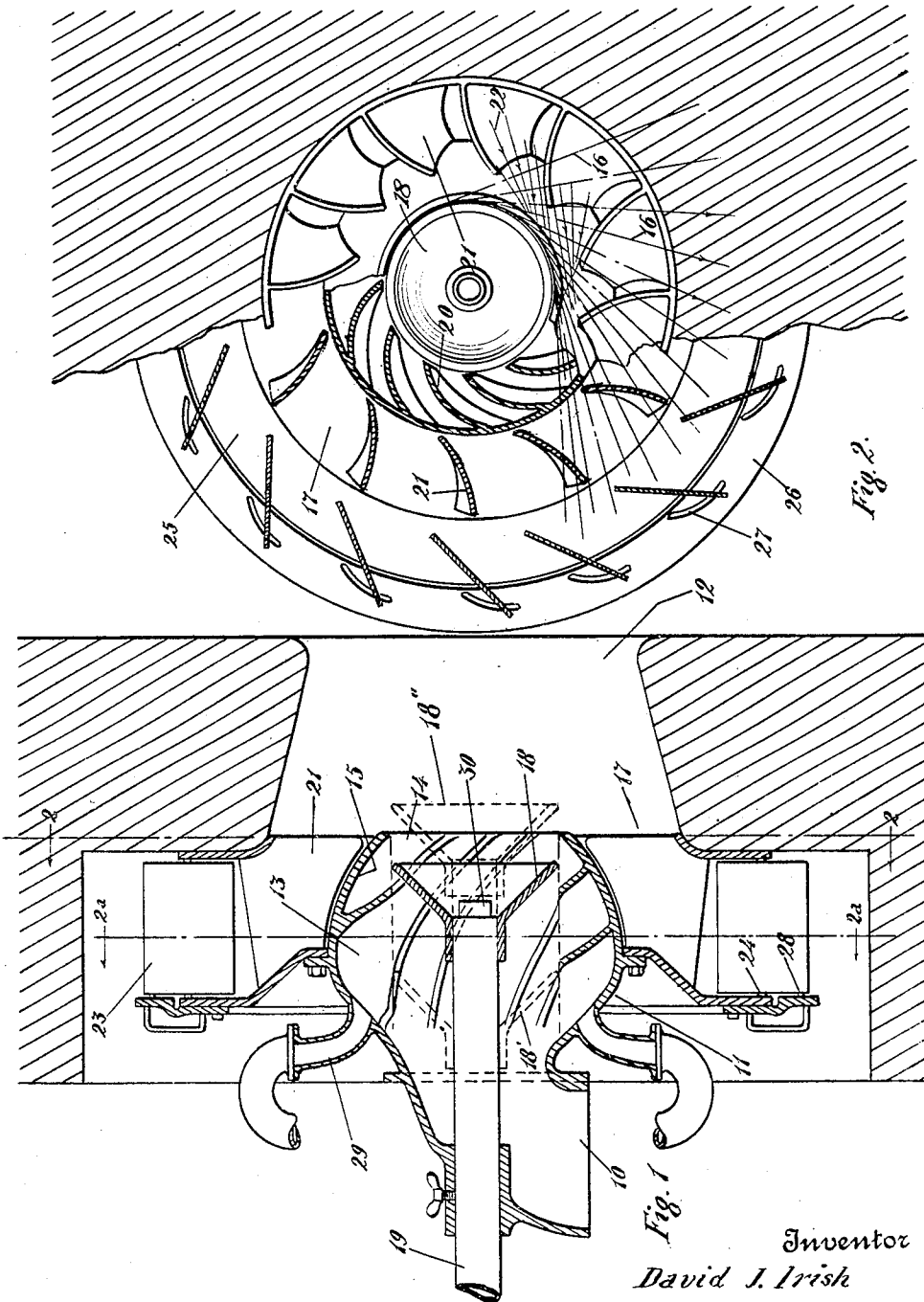
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AIR MIXING BURNER

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AIR-MIXING BURNER

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This invention relates to fuel burners and more particularly refers to an improved type of burner for pulverized fuel, insuring a thoroughly intimate mixture between the fuel and the air supporting combustion due to the peculiar arrangement of the burner itself.

The primary object of this invention is to provide a pulverized fuel burner of a novel and improved type adapted by virtue of its own design to automatically cause spreading of the fuel issuing therefrom in a substantially cone shaped spray directly in the path of the air admitted through a suitable register or inlet.

Another object of this invention is to provide, in combination with a burner adapted for use in connection with pulverized fuel and adapted by virtue of its own design, to cause outward spreading of the fuel issuing therefrom in a substantially cone shaped spray, creating a tendency in the same to whirl in a certain direction, an air inlet, creating a tendency in the air admitted therethrough to cross the path of and to whirl in the direction intersecting that of the whirling tendencies of the fuel; the result being an immediate and thorough mixing of the fuel particles with the air supply, insuring complete and efficient combustion.

A further object is to provide an improved type of burner for pulverized fuel, in which opposite whirling tendencies are created in the fuel and air issuing therefrom, in a manner calculated to insure thorough mixing of the elements necessary to combustion, said burner being provided with simple and reliable means for regulating the quantity of fuel issuing therefrom.

A still further object is to provide a burner of the character described, adapted to be selectively or collectively used in connection with a liquid fuel burner, associated therewith in a manner insuring absolute freedom from interference in the operation of each one of the burners by the other.

Other objects and advantages will more fully appear as the description proceeds and will be set forth and claimed in the appended claims.

In the use of pulverized fuel for the firing of boilers and like purposes, it is essential that an ample supply of air be provided for the combustion of the fuel, and it is equally important that the mixture between the fuel and the air be as thorough and intimate as possible.

In practice, however, it has not always been found possible to obtain ideal conditions of aeration of the fuel due to difficulties pertinent to the nature of the fuel itself, and also due to the necessity often found of admitting to the combustion zone, an excessive quantity of air in order to insure satisfactory combustion.

In burners of ordinary design, the pulverized fuel is generally admitted to the combustion chamber in a continuous jet issuing under pressure from the burner's nozzle, and the pressure impelling the fuel particles is relied upon to cause outward spreading of the same as they leave the nozzle.

A spray is thus produced which does to a certain extent intermingle with the surrounding air, but as a general rule the combustion of the fuel is but imperfectly obtained, unless excessive pressures are used and unless an excessive quantity of air is admitted to the combustion chamber.

The main object of my present invention is to produce a novel type of burner whereby a good air fuel mixture is automatically assured without the necessity of using abnormal pressures at the same time using a relatively small quantity of air.

This object is attained principally by introducing various features in the design of the burner, the main feature residing broadly, in employing means within the nozzle co-acting with the fuel under pressure insuring a better spray than would be obtainable if only the velocity and buoyancy of the fuel particles were relied upon to produce the spreading effect thereof.

These means comprise an outwardly spreading conical surface, placed in the path of the fuel on its way to the nozzle causing a positive outward spreading of the fuel particles which produces a spray of a much greater range than would be obtainable under

ordinary conditions. This spray which is substantially conical in shape reaches right across the air register or inlet which generally extends around the nozzle, concentrically thereto, so that a greater proportion of fuel particles has a chance to be completely surrounded by air, and combustion conditions are accordingly improved.

The conical surface is preferably mounted so as to be axially adjustable in order to be used as a valve regulating the quantity of fuel delivered to the nozzle.

However, if only a cone valve of the ordinary type is used, the directions of the fuel particles when issuing from the nozzle, coincide with the generatrices of the cone shaped surface and due to their decreased momentum, said particles tend to be deflected downwardly before the cone spread has attained a sufficient and desirable diameter. The air admitted to the fire zone through the air register is inwardly directed transversely to the direction of the fuel particles and helps in inwardly deflecting the spray produced thereby, without intermingling with the fuel particles as thoroughly as would be desirable.

The result is a fuel spray which is comparatively poor in air in the inner zone, a good proportion of the air remaining unmixed in the outer zone. A correction of these conditions obtained by an increase in the pressure at which the fuel is delivered to the burner, or in the quantity of air admitted to the combustion chamber, or both, would entail an increase in the cost of operation, as well as a decrease in the operating efficiency of the burner.

I have succeeded in increasing the range of the fuel spray by so designing the burner nozzle, that the fuel delivered thereto, gradually and naturally acquires a tendency to issue in the form of an outwardly directed spray from the burner without losing its momentum or speed.

This is obtained by providing the inner surface of the nozzle with inwardly projecting vanes directed at an angle to the generatrix of said nozzle. These vanes form passages for the fuel dividing the fuel supply in a number of streams outwardly directed and inclined towards the front of the burner. The totality of these streams, which in issuing from the burner under pressure, become individual sprays of minute particles, form a conical spray which extends outwardly considerably more than a spray issuing from a burner provided with a conical spreading surface only, under the same pressure conditions; this being due to the speed and definite direction imparted to the fuel particles by the arrangement mentioned, substantially without any impact loss.

In the preferred embodiment of this feature, the vanes are spirally directed, preferably with a decreasing pitch or increasing

angle in relation to the axis of the burner from the inside towards the outside. Such an arrangement adds to the spreading tendency of the spray, due to a spiral whirling motion induced thereby in the fuel particles as they issue from the burner; the effect thus obtained being comparable to the effect obtained in maintaining the speed and direction of a bullet issuing from a rifle by the use of spiral grooves with decreasing pitch in the inner surface of the barrel.

The direction imparted to the elementary sprays by the sides of the vanes, which is substantially in line with the direction of said surfaces at the point of issue, is further preferably modified by inwardly curving the inner surface of the nozzle itself, so as to impart to the fuel particles a tendency to follow a curved trajectory leading the fuel particles towards the annular space in the immediate vicinity of the mouth of the nozzle where the inrush of air takes place.

At this point therefore where both the fuel particles and the air streams are impelled by their respective velocities, the mixture therebetween will occur under the most favorable conditions. The mixing conditions are still further improved by admitting the air to the combustion chamber through a circumferential series of passages all around the nozzle formed by a number of vanes disposed all around the annular air inlet surrounding the nozzle.

These vanes are preferably curved so as to induce a whirling tendency in the streams of air issuing therefrom, the direction of their curved surfaces being such that the air streams are directed right across the individual fuel sprays issuing from the turbine like passages of the nozzle. The result is a cross impact between streams of spread out fuel particles and streams of air having tendencies to whirl in different or cross directions, so that the fuel particles are whirled around by the air and carried further out towards the outer zone of the combustion chamber, further increasing the ultimate range of the fuel air spray.

It is obvious that by combining all these features in the same burner, practically each fuel particle will finally be surrounded in the spray by an air cushion providing an ample supply of combustion supporting medium therefor.

In practice, it is desirable to provide means for regulating the intensity of the flame and to this end, I provide arrangements whereby both the quantity of fuel admitted to the nozzle and the quantity of air admitted to the air inlet may be increased or decreased.

A typical embodiment of my invention is illustrated in the drawings in which:

Fig. 1 is a side sectional view in elevation through my improved burner; and

Fig. 2 is a fragmentary front sectional view

of the same from the nozzle end, partly through line 2—2 of Fig. 1 and partly through the line 2^a—2^a of Fig. 1.

Referring to said drawings 10 designates the inlet through which the pulverized fuel under pressure is admitted to the nozzle 11. The nozzle proper, which is axially directed towards the mixing chamber 12 has a larger diameter at its intermediate portion 13 than at its outlet 14, and is formed with an inwardly curved surface 15 extending from said intermediate portion to said outlet.

The inner surface of the nozzle is formed with a plurality of vanes 20 disposed all around the axis of the nozzle, having their cross section eccentric in relation to said axis, as shown in Fig. 2. Said vanes extend from the rear towards the front and up to the outlet of the nozzle, forming spiral passages for the fuel, extending from the inner to the outer part of the nozzle and preferably progressing with a gradually decreasing pitch.

The result of this arrangement is that those portions of the pulverized fuel stream which become enchanneled through these spiral passages and impelled by the pressure of the fuel towards the outlet, gradually assume a spiral direction, which causes them to issue from the outlet of the nozzle at a tangent to the curved surface leading to said outlet in an outwardly spreading direction inclined towards the combustion chamber. These individual streams or sprays therefore will combine into a substantially conical spray, which is composed of individual elements diagrammatically represented at 16 in Fig. 2, said elements being as stated, substantially tangential to the curved surface in proximity of the outer circumference of the nozzle outlet, and being inclined away from the nozzle towards the combustion chamber.

The quantity of fuel issuing from the nozzle may be regulated by means of an outwardly spreading conical valve 18 mounted on an auxiliary adjustable stem 19. Said conical valve may be moved to or from the nozzle outlet and set at any desired position, coacting with the inner surface 15 of the nozzle the diameter of which gradually increases inwardly from the outlet in forming annular passages for the fuel, gradually increasing in section as the conical valve is moved away from said outlet.

One of the advantages of the conical surface of the valve, as explained before, is to deflect the fuel particles towards the annular passage provided therefor; and this also tends to separate them from one another, facilitating their subsequent intermingling with the air in the mixing chamber.

The fuel particles which are thus deflected and directed against the surface of the nozzle at an inclination corresponding to the inclination of the cone are further deflected in stream line fashion when they strike at an

angle against the spiral side surfaces of vanes 20, so that the successive changes in their direction due to the combined action of the cone and the vanes take place easily and gradually.

Furthermore, the fuel delivered to the nozzle through inlet 10 is already mixed with a certain quantity of air, air under pressure being the conveying agent used throughout the system; so that said fuel already has a certain buoyancy which causes a portion thereof to be forced directly through the spiral passage between vanes 20. These portions of the fuel therefore will acquire their speed and direction solely by virtue of the surfaces of said vanes and surface 15 of the front part of the nozzle.

The supply of air is ordinarily admitted to the mixing chamber through an annular series of inlets, surrounding the nozzle outlet; so that the outwardly spreading individual sprays 16 of the fuel, due to their direction and velocity will extend up to and directly in front of the inlets through which the inrush of air takes place.

In order to further improve the mixing conditions obtained by this arrangement, I provide the air inlet with a series of curved vanes 21, the curvature of which is such as to direct the air streams issuing therethrough, directly across the path of the elementary fuel sprays projected in front of said air inlets; the air streams thus directed being diagrammatically represented by arrows 22 in Fig. 2.

By means of this arrangement, I create a condition where both the fuel sprays and the air streams have individual tendencies to whirling motion along paths transverse to one another, with the fuel particles impelled by a velocity and directness sufficient to carry them right across the annular air inlet.

A thorough mixture of the two elements thus takes place and is then projected towards and through the combustion chamber, where due to the good aeration of the fuel particles a perfect combustion occurs with a minimum expenditure of air.

As stated before, it is customary and desirable to provide means for regulating the intensity of the flame and also for individually regulating the supply of air and fuel. The supply of fuel is regulated by means of valve 18 in the manner heretofore explained, said valve being movable from a position to the front where it entirely blocks outlet 14, to an extreme position in the rear shown in dotted lines at 18' corresponding to the maximum fuel output or to the position forwardly of the outlet shown in dotted lines at 18'' in which the fuel is deflected outwardly.

The supply of air may be regulated in any well known manner, for instance, by providing a circumferential series of shutters such as shown at 23, all around the annular series of air inlets 17, said shutters being pivotally

mounted as shown at 24 and being operated by a floating pin and slot arrangement, causing the same to be tilted more or less about their pivots, so as to more or less close or open the passages 25 admitting air to the air inlets. The simultaneous operation of said shutters may be obtained by means of a ring 26, provided with a number of eccentric slots 27, one for each shutter, within which project pins such as 28 outwardly extending from the front end of the shutters.

It is apparent from the drawing that if ring 26 is angularly displaced in a clockwise direction, the shutters will be caused to tilt about their pivots so as to enlarge the air passages and if the ring is angularly displaced in a counter clockwise direction, the shutters will be tilted in the closing direction.

My improved burner may be used for either forced or natural draft, and if desired, air can also be admitted directly to the nozzle through passages such as indicated in dotted lines at 29. Such an arrangement is particularly suitable when a forced draft is employed.

The stem 19 on which valve 18 is mounted may be a tubular member adapted to receive an oil burner 30. By virtue of such an arrangement, the device becomes a combination oil and pulverized fuel burner which may be used in connection with either fuel or by the simultaneous use of both fuels. I have found this to be a most efficient combination due on one hand to the high flame intensities obtainable by the combined use of both fuels and on the other hand to the great flexibility and adaptability of the resulting structure.

Such a combination provides a power plant which can be run either on pulverized fuel or oil, according to the supply available, or both. It also provides a means for quickly increasing the flame intensity of a burner where pulverized fuel is normally used without altering the pressure or other conditions under which the fuel is delivered to the burner, merely by starting the oil burner whenever convenient or desirable. This is a very convenient feature for instance, when firing boilers, in order to quickly get up steam, also when forced runs are required of the boilers during certain periods.

The combination of means for burning oil or pulverized fuel or both in a single boiler however, is not specifically claimed here because it is in a broad sense a different and independent invention from the type of burner forming per se, the object of the present invention.

It will be observed that the peculiar arrangement described also permits of spreading the fuel particles in what might be termed a double spray, that is, the range of the spray may be increased not only in a radial, but also in an axial direction.

In the manner of operation described, it has been assumed that the cone valve is movable from the nozzle outlet to an extreme position to the rear in order to regulate the fuel supply. It is also possible however, to carry the valve beyond the nozzle outlet to positions such as indicated in dotted lines at 18''.

When this new type of relative arrangement between the movable and the stationary part of the nozzle is resorted to, the fuel instead of issuing from the nozzle at directions and velocities which are a result of the combined effect of the surfaces of the vanes and nozzles, will issue in practically two sprays, axially spaced one from the other within the mixing chamber. One spray is due to the tangential streams issuing from the nozzle outlet, due to the action of the spiral vanes; the other spray is produced by that central portion of the fuel column which does not come in actual contact with the inner surface of the nozzle, by the deflecting and spreading out action of the surface of the cone valve, upon the fuel particles thereof, said fuel particles moving in an axial direction against the surface of the valve and being then deflected to form a conical spray in the ordinary manner.

Given a certain quantity of fuel issuing from the nozzle therefore, this arrangement permits of spreading the fuel practically throughout the entire depth of the mixing chamber. This arrangement is particularly useful when an abnormal quantity of fuel is admitted to the firing zone, in order to generate a great amount of heat.

My improved burner is therefore capable of inducing thorough mixing and efficient combustion of the fuel under a great variety of conditions such as may arise in practice; so that besides affording the practical and economical advantages which may be derived by an efficient combustion of the fuel, the same also affords the advantages of a remarkable flexibility and adaptability under practically all conditions.

The drawings are intended for illustrative purposes only, because various details of construction may obviously be altered without departing from the inventive idea; therefore, I reserve myself the right to carry my invention into practice in any way or manner which may enter fairly into the scope of the appended claims.

I claim:

1. In a fuel burner, a nozzle provided with vanes inwardly projecting from the inner surface of the nozzle, spirally directed in relation to the axis thereof, said vanes forming spiral passages for the fuel issuing from said nozzle, said passages having a gradually decreasing pitch as they progress towards the outlet of said nozzle.

2. In a burner for pulverized fuel, a nozzle

provided with a fuel inlet and a fuel outlet, having an enlarged section in its intermediate portion gradually decreasing towards the outlet thereof, the inner surface of said nozzle being provided with inwardly projecting helical vanes, forming helical passages through said enlarged section for the fuel issuing from said nozzle, and an outwardly spreading cone shaped member, coaxial and adapted to register with said outlet capable of axial displacement in relation thereto.

3. In a burner for pulverized fuel, a nozzle provided with a fuel inlet and a fuel outlet, having an enlarged section in its intermediate portion gradually decreasing towards the outlet thereof, the inner surface of said nozzle being provided with inwardly projecting helical vanes, forming helical passages through said enlarged section for the fuel issuing from said nozzle, said passages having a decreasing pitch as they progress towards the outlet of said nozzle, and an outwardly spreading cone shaped member coaxial and adapted to register with said outlet, capable of axial displacement in relation thereto.

4. In a burner for pulverized fuel, a nozzle provided with a fuel inlet and a fuel outlet, having an enlarged section in its intermediate portion gradually decreasing towards the outlet thereof, the inner surface of said nozzle being provided with inwardly projecting helical vanes, forming helical passages through said enlarged section for the fuel issuing from said nozzle, and means for regulating the amount of fuel issuing from said nozzle.

5. In a device of the class described, a nozzle provided with a fuel inlet and a fuel outlet, having an enlarged section in its intermediate portion gradually decreasing towards the outlet thereof, the inner surface of said nozzle being provided with inwardly projecting helical vanes, forming helical passages for the fuel issuing from said nozzle, an annular air inlet coaxial with said nozzle provided with a plurality of spaced vanes helically directed in relation to the axis thereof, the inclination of said vanes being in the opposite direction to that of the nozzle vanes, and means for controlling the direction of said fuel stream from said nozzle.

6. In a device of the class described, a nozzle provided with a fuel inlet and a fuel outlet, having an enlarged section in its intermediate portion gradually decreasing towards the outlet thereof, the inner surface of said nozzle being provided with inwardly projecting helical vanes, forming helical passages through said enlarged section for the fuel issuing from said nozzle, an annular air inlet coaxial with said nozzle provided with a plurality of spaced vanes helically directed in relation to the axis thereof, the inclination of said vanes being in the opposite direction

to that of the nozzle vanes said air inlet being inclined inwardly towards the axis of said nozzle, and an outwardly spreading cone shaped member coaxial and adapted to register with said outlet capable of axial displacement in relation thereto.

7. In a burner for pulverized fuel, a nozzle provided with a fuel inlet and a fuel outlet, having an enlarged section in its intermediate portion gradually decreasing towards the outlet thereof, the inner surface of said nozzle being provided with inwardly projecting helical vanes, forming helical passages for the fuel issuing from said nozzle, an annular air inlet coaxial with said nozzle provided with a plurality of vanes helically directed in relation to the axis thereof, the inclination of said vanes being in the opposite direction to that of the nozzle vanes, an outwardly spreading cone shaped member coaxial and adapted to register with said outlet, and means for moving said cone-shaped member axially through said nozzle to control the spread of gases delivered therefrom and the quantity of gases delivered.

8. A burner of the type described which comprises a furnace throat opening, an annular air supply channel, helically directed vanes in said channel, a central fuel and air feeding passage, said passage being enlarged immediately in advance of its delivery outlet, helical vanes in said central passage, the inner edges of said vanes being aligned with the edge of the delivery outlet to form a cylindrical unobstructed space, and a conical plate movable axially through said passage.

9. A burner of the type described which comprises a fuel and air supply passage having an enlarged portion converging to an outlet, vanes in the enlarged portion of said passage to direct fluid passing therethrough into a helical path, a plate movable axially of said passage, the inner edges of said vanes extending to the periphery of the cylindrical surface generated by said plate in its axial movement, and means for supplying a rotating annular sheet of fluid encircling said passage.

10. A burner of the type described which comprises an annular air supply passage, a central passage having a bulging wall forming the inner wall of said annular passage and narrowing to an outlet opening, vanes in said annular and in said central passages for conducting fluids therethrough in opposite whirling paths, and a deflector slidable axially within said central passage and through said outlet opening.

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