Nov. 16, 1943. O. F. CAMPBELL 2,334,314

FUEL BURNER

Filed April 21, 1941 2 Sheets-Sheet 1

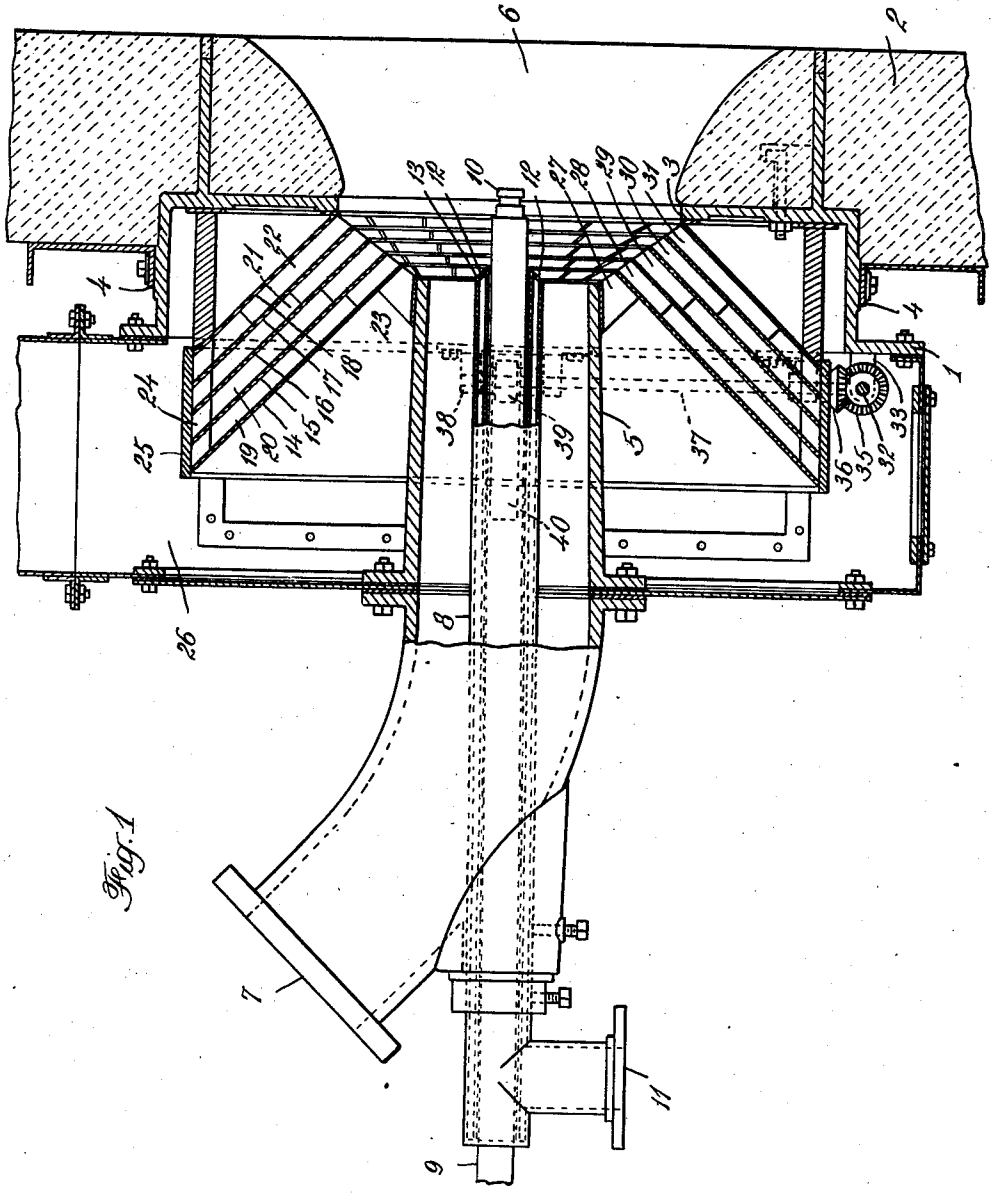


Fig. 1

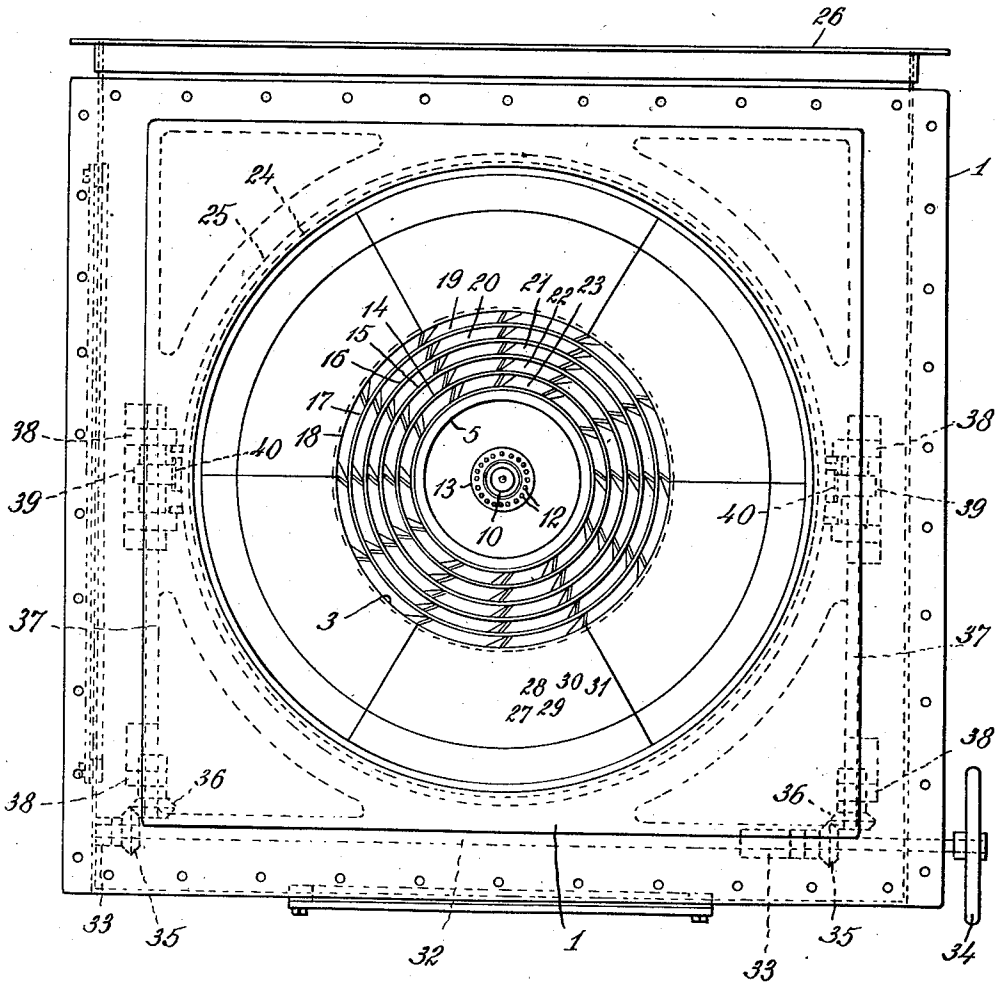
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Fig. 2.



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FUEL BURNER

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4 Claims. (Cl. 158—1.5)

This invention relates to fuel burners and more particularly relates to an improved burner capable of operating efficiently over an unusually broad range of capacities. The invention is applicable to the burning of gaseous, liquid or pulverized solid fuel or mixtures thereof.

In the burning of these fuels by conventional type burners the fuel and air for supporting combustion thereof are injected into the combustion zone in proportions which are usually to some extent controllable by regulation or adjustment of the burner. For efficient operation it is essential that the relative proportions of fuel and air be kept at an optimum value and that the fuel and air be intimately admixed upon entering the combustion zone.

Some of these fuel burners are adapted to operate only at a given capacity or at a capacity which cannot be changed while the burner is in operation. The capacity of other conventional burners may be changed at will over a limited range by varying the amount of fuel and combustion air injected thereby into the combustion zone. In the latter type of burner, when it becomes desirable to increase the rate of heating of a boiler, for instance, the rate at which fuel is supplied to the combustion zone by the burner, is increased and, when a lower rate of heating is desired, the rate at which the fuel is supplied is decreased.

If efficient operation is to be maintained over a range of heating rates, these variations in the rate of fuel supply must be accompanied by an appropriate change in the amount of air supplied by the burner. However, it is not alone sufficient that the optimum proportions of fuel and air be maintained. It is also essential to efficient combustion that the fuel and air be properly mixed, that the fuel be highly dispersed in the combustion air.

One of the major defects of conventional burners has been their failure to accomplish proper mixing of the fuel and air except when operating within a rather narrow range of capacities. Usually such burners depend to a considerable extent upon turbulence caused by the velocity of the incoming air to effect proper mixing of the air and fuel. In conventional burners the ducts through which the air passes to the combustion zone are usually of a fixed size and, while effective mixing may be obtained within fixed limits, when the burner is operating at lower capacity the velocities are too low to accomplish adequate mixing, and poor combustion results. If an attempt is made still further to decrease the capacity of such burners, a lower limit is soon reached beyond which ignition cannot be maintained.

Burners having air ducts of fixed cross-sectional area may, of course, be designed for low capacity operation. However, if one attempts to operate such low capacity burners at considerably higher capacities either sufficient air cannot be supplied for efficient combustion or the velocity of the air stream is apt to be so great as to extinguish the flame.

Numerous attempts have been made to overcome the capacity range deficiency of conventional fuel burners. For instance, it has been proposed to increase the flexibility of the burners with respect to capacity range by providing mechanical means for varying the cross-sectional area of the air duct at the point where it enters the mixing zone. Thus when decreased volumes of air are required, the cross-sectional area of the air duct exit would be decreased so as to maintain velocity and turbulence of the air stream at the point where it meets with the fuel stream. One of the primary difficulties with previously proposed arrangements has been the necessity of having moving parts located within the zone of high temperature where they soon cease to function and another has been their inability to sufficiently extend the range of efficient operating capacities.

In accordance with my invention, the difficulties heretofore experienced are eliminated by providing a plurality of air ducts of annular cross-section concentrically positioned with respect to the fuel injection means and with respect to each other and means without the high temperature zone for causing air to pass through a greater or less number of these ducts as the firing rate is increased or decreased, respectively.

The air-injection means of my improved burner consists in general of a plurality of concentric converging ducts surrounding the fuel inlet conduit and so positioned with respect to the burner as to direct the stream or streams of air emerging therefrom in paths converging toward the stream of fuel entering the combustion zone, thus effecting thorough mixing of the air and fuel.

In operation, air may be passed through one or more of these ducts, depending upon the rate at which fuel is being supplied and consequently upon the amount of air required. When the burner is operating at maximum capacity all of the ducts may be employed and, when operating at reduced capacity, a proportionately less number of ducts may be used. At minimum capacity only one duct need be in use; for example, the innermost air duct.

By thus varying the number of air ducts employed in accordance with the operating capacity and consequently with the amount of air being supplied, the velocity of the entering air may be maintained at the optimum value for producing the amount of turbulence to give most satisfactory mixing and highest burner efficiency.

Furthermore, in accordance with my invention, the regulation of the amounts and velocities of

air supplied is accomplished without the necessity of adjustable parts within the zone of high temperatures. Also, where the burner is of the type illustrated in the appended drawings, which is adapted to the burning of various fuels, the amount of air and degree of turbulence best suited to the burning of a particular fuel under particular operating conditions may readily be obtained over a wide range of capacities wholly independently of the regulation of the fuel stream.

The mixing of the air and fuel may with advantage be further promoted in accordance with my invention by providing these air ducts with suitable vanes so as to impart to the air a whirling motion as it leaves the respective ducts. Advantageously, the innermost duct is used when operating at minimum capacity and accordingly the angle or pitch of the vanes in this innermost duct is preferably such as to impart the maximum whirling motion to the air passing therefrom so as to obtain the maximum turbulence commensurate with the reduced volume of air being supplied.

My invention will be further described with reference to the accompanying drawings which illustrate a specific embodiment of my invention in a combination burner adapted to the burning of either gas, liquid or pulverized solid fuel or mixtures thereof. In these drawings, Figure 1 represents conventionally and partly in section a side view of the burner and Figure 2 is an end view thereof.

In these drawings the burner housing 1 is shown attached to the wall 2 at the firing port 3 of a firebox by means of the brackets 4. Within the burner housing and supported thereby is the conduit 5 through which pulverized solid fuel, when used, is passed to the combustion zone 6. The pulverized solid fuel is delivered to conduit 5 through the inlet 7 from any convenient source in suspension in a gaseous medium such as air by conventional propulsion means not shown. When not in use this pulverized solid fuel conduit may be closed off so as to prevent the passage of air therethrough into the combustion chamber or may be used for the introduction of a portion of the air for combustion of the liquid or gaseous fuel.

Extending through the conduit 5 is the annular conduit 8 and coaxially arranged within conduit 8 is a pipe 9 which terminates at the nozzle 10. Where a liquid fuel such as fuel oil is being burned, it is supplied through pipe 9 from any convenient source, not shown, under sufficient pressure to insure proper atomization in passing through nozzle 10 into the combustion zone 6.

When a gaseous fuel is being burned, it is supplied from any conventional source and under suitable pressure through the gas inlet 11 to the annular space within conduit 8 surrounding pipe 9 and it issues therefrom through the gas ports 12. These gas ports are shown in the drawing as openings in the shoulder 13 at the inner end of conduit 8. These gas ports may, if desired, be slotted instead of round holes, as shown in the drawings.

Coaxially positioned with respect to the fuel supply conduits 5, 8 and 9 are a plurality of stationary coaxially arranged truncated cones 14, 15, 16, 17 and 18 so positioned with respect to each other as to provide annular air ducts 19, 20, 21 and 22 between the surface of one cone and the next adjacent cone. The innermost cone 14 also forms the outer wall of the air duct 23 lying between said cone and the outer wall of conduit 5. These cones are supported at their outer perimeter by a perforated cylindrical collar 24 adapted to permit the free passage of air into the ducts 19 to 22, inclusive, and may be supported at their inner end, i. e., at their base nearest the firebox, by the conduit 5 by means of staybolts or the like, not shown, so as to offer a minimum interference with the passage of air through these ducts.

Surrounding the perforated collar 24 is a cylindrical sleeve or damper 25 adapted to be moved toward and away from the furnace end of the burner so as to permit the passage of air to a greater or less number of the annular air ducts 19 to 22, inclusive. When this cylindrical damper 25 is in the position shown in the drawings, no air is permitted to pass to any of the annular air ducts 19 to 22, inclusive. As this damper is moved toward the furnace, air is permitted access first to air duct 19 and then successively to air ducts 20, 21 and 22 as the damper 25 is moved further to the right. By regulating this damper 25, for instance, according to the amount of fuel being supplied to the burner, a greater or less number of the air ducts are put into service and the quantity and velocity of the air passing to the combustion zone thus controlled.

The arrangement shown is a simple and effective means for controlling the passage of air through the respective ducts. However, it will be understood that the passage of air through the several ducts may be separately controlled by individual dampers.

When the burner is operating at minimum capacity, the air ducts 19 to 22, inclusive, will normally be closed and the reduced air requirements supplied solely through air duct 23, which is shown in the drawings as opening into the air chamber or wind box 26 which chamber also surrounds the cylindrical damper 25. When operating under forced draft conditions, air for combustion may be supplied to the air chamber 26 by conventional means, not shown, under suitable pressure and in the optimum quantity for efficient combustion of the fuel being supplied by the burner. When operating with a natural draft the wind box 26 may be left open to the atmosphere and the amount of air permitted to enter controlled by auxiliary dampers of any suitable type.

In the specific arrangement shown in the drawing, the sides of the co-axial truncated cones 14 to 18, inclusive, form an angle of approximately 45 degrees with the axis of the burner. This arrangement gives very satisfactory mixing of the fuel and air under ordinary conditions. However, it will be understood that this angle may be varied over a considerable range for different sizes and types of burners and for different firing conditions.

The converging air passages formed by the above-described co-axial arrangement of the truncated cones direct the incoming air for combustion in a converging stream or streams into the stream of fuel leaving the burner and thus assure thorough mixing of the fuel and air. When the burner is operating at minimum capacity, the reduced volume of air required is injected into the fuel stream as the optimum velocity through the throat of air duct 23. By introducing the air through this innermost duct 23, as shown, when the minimum quantity of air is being supplied, maximum advantage is derived

from the velocity thereof in the mixing of the air and fuel.

In order to insure even greater turbulence and thus better mixing of the fuel and air, the ducts 19 to 23, inclusive, may be provided with vanes designed to impart a whirling motion to the stream of air emerging therefrom. These vanes are shown in the drawings at the points indicated by the reference numerals 27, 28, 29, 30 and 31. They may extend throughout the air duct; however, they are shown in the drawing as extending only part-way through the duct. The angle or pitch of these vanes may vary over a considerable range depending upon the desired degree of whirling to be imparted to the incoming air. I have found it advantageous to place these vanes at different angles in the respective air ducts so as to provide greater turbulence at the center of the fire than at the outer portion thereof. This arrangement also has the advantage of providing the maximum turbulence when only the innermost air duct is being used.

For example, the vanes 27 and 28 in the two innermost ducts 19 and 23 may be placed at an angle of 45 degrees and vanes 29, 30 and 31 in ducts 20, 21 and 22 may be placed at an angle of 35 degrees, 25 degrees and 15 degrees, respectively.

The cylindrical damper 25 may be manually operated or it may be automatically controlled, for instance, responsive to fluctuations in the fuel supply. Automatic control devices suitable for this purpose are well understood in the art and need not be here described.

In the attached drawings, one means for manually operating the cylindrical damper 25 is shown. This means consists of a shaft 32 supported by the burner housing by means of bearings 33 and adapted to be rotated by means of a hand-wheel 34. Rigidly fastened on shaft 32 near opposite ends thereof are bevelled gears 35 designed to cooperate with bevelled gears 36 rigidly attached to shafts 37, also supported by the burner housing by means of bearings 38. Rigidly attached to shafts 37 are pinion gears 39 adapted to cooperate with the racks 40 attached to opposite sides of the cylindrical damper 25. Thus, by rotating the hand-wheel, the damper 25 may be moved to the desired position so as to open or close off a greater or less number of the air ducts. Instead of the particular type of damper specifically illustrated, independent dampers for opening and closing the entrance to the several air ducts may be used.

The rate at which fuel is supplied to the combustion zone by the burner may be controlled in the conventional manner; for instance, by regulating the pressure under which the fuel is supplied to the burner.

While I have shown in the drawings only five annular air ducts, it will be understood that a greater or less number may be used, depending upon the desired flexibility of the burner. It will also be understood that the invention is applicable to burners designed to burn only one type of fuel as well as to the type illustrated which is adapted to the burning of different fuels. The invention is likewise applicable to burners of any size including not only large-capacity burners but also domestic burners such as the cone-type, rotary-cup-type and pressure-atomizing-type burners.

I claim:

1. In a fuel burner having means for injecting a stream of fuel into a combustion zone, the improvement comprising a plurality of air ducts of annular cross-section each coaxially arranged with respect to and converging toward the fuel stream in the direction of the combustion zone, a damper removed from the combustion zone for controlling the passage of air through the several ducts said damper being adapted to permit the inward passage of air first to the innermost duct only and progressively to additional successive outer ducts as the damper is moved from the closed to the open position and vanes within said ducts adapted to impart a whirling motion to the air emerging therefrom, the pitch of the vanes in the respective ducts being such as to impart more vigorous whirling motion to the air emerging from the inner ducts than that emerging from the outer ducts.

2. An improved fuel burner adapted to the burning of gas, liquid or pulverized solid fuels comprising coaxially arranged conduits adapted respectively for the passage of liquid, gaseous and pulverized solid fuel suspended in a gaseous carrying medium to a combustion zone, a plurality of air ducts of annular cross-section, each coaxially arranged with respect to said conduits and converging toward the common axis of said conduits in the direction of the combustion zone, and a damper removed from the combustion zone for controlling the passage of air through the several ducts.

3. An improved fuel burner adapted to the burning of gas, liquid or pulverized solid fuels comprising coaxially arranged conduits adapted respectively for the passage of liquid, gaseous and pulverized solid fuel suspended in a gaseous carrying medium to a combustion zone, a plurality of air ducts of annular cross-section, each coaxially arranged with respect to said conduits and converging toward the common axis of said conduits in the direction of the combustion zone and a damper removed from the combustion zone for controlling the passage of air through the several ducts, said damper being adapted to permit the inward passage of air first to the innermost duct only and progressively to additional successive outer ducts as the damper is moved from the closed to the open position.

4. In a fuel burner having means for injecting a stream of fuel into a combustion zone, the improvement comprising a plurality of truncated cones coaxially arranged with respect to the fuel injection means and spaced apart so as to form a plurality of ducts of annular cross-section converging toward the fuel stream in the direction of the combustion zone, means for passing air through said ducts to the combustion zone, a damper removed from the combustion zone for controlling the passage of air through the several ducts, said damper being adapted to permit the inward passage of air first to the innermost duct only and progressively to additional successive outer ducts as the damper is moved from the closed to the open position and vanes within said ducts adapted to impart a whirling motion to the air emerging therefrom, the pitch of the vanes in the respective ducts being such as to impart more vigorous whirling motion to the air emerging from the innermost duct than that emerging from the outer ducts.

OLIVER F. CAMPBELL.