July 7, 1936. O. F. CAMPBELL 2,046,767

COMBUSTION APPARATUS

Filed May 25, 1932 2 Sheets-Sheet 1

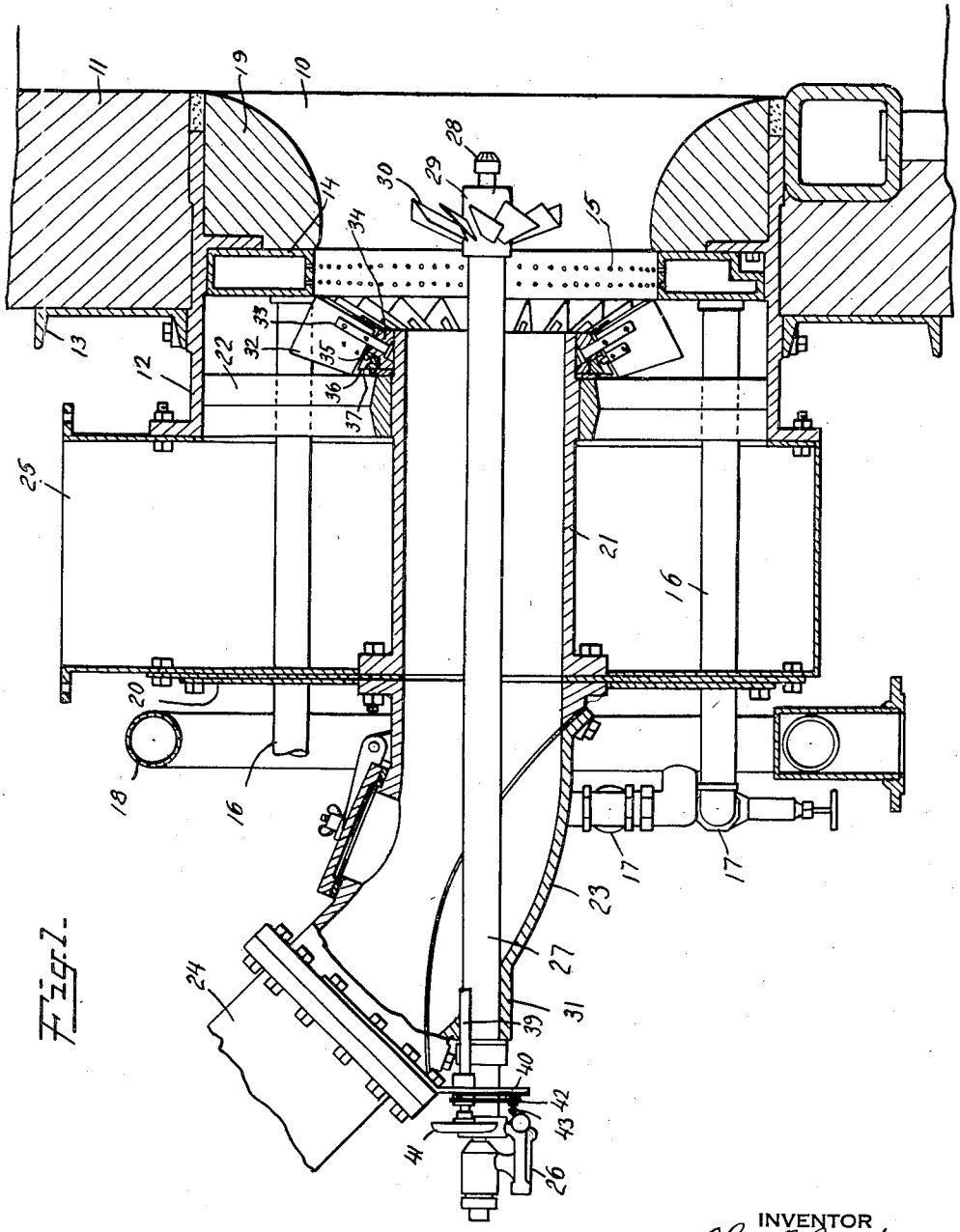


Fig. 2.

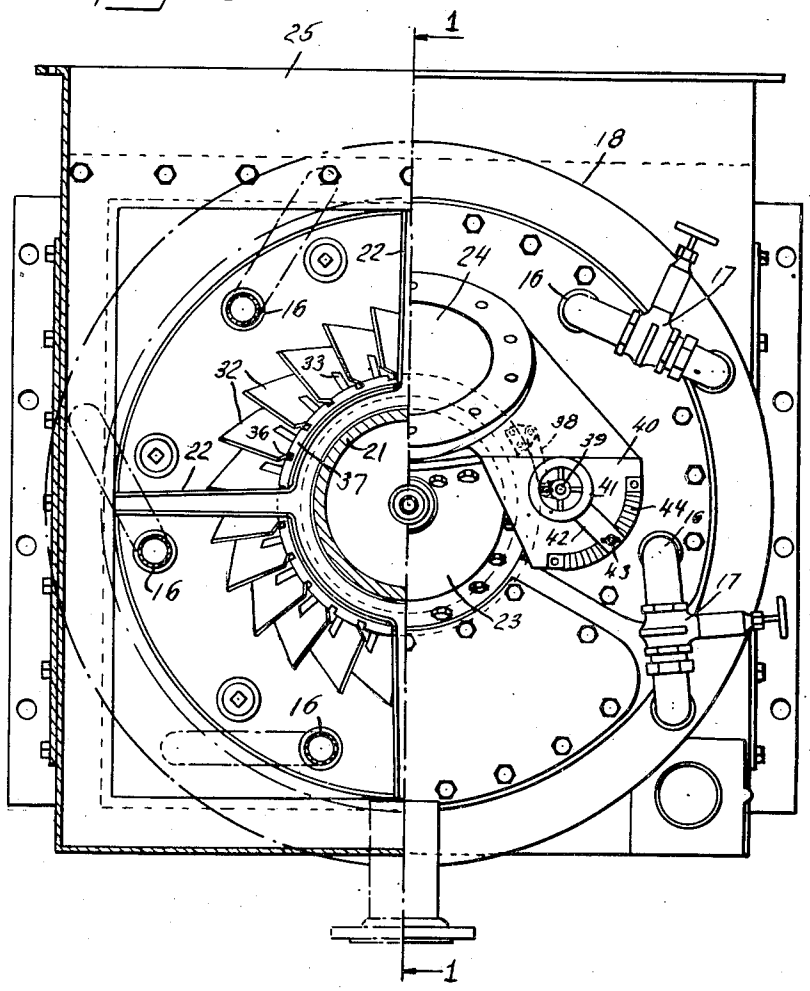
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Fig. 2.



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COMBUSTION APPARATUS

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2 Claims. (Cl. 110—22)

This invention relates to the burning of pulverulent, gaseous, or liquid fuels in boiler furnaces and similar combustion chambers and is concerned more particularly with a novel burner for delivering fuel into such a chamber and supplying air for combustion under regulated conditions, such that ignition of the fuel as it enters the combustion chamber is assured and the deflagrating fuel is thoroughly mixed with air so that it is completely consumed and a high combustion efficiency results. The burner is constructed to deliver a plurality of different fuels, either one at a time or simultaneously.

In the burning of pulverulent solid fuels, it is the practice to introduce the fuel into the combustion chamber mixed with a quantity of primary air which is insufficient for combustion, and to supply additional or secondary air to the chamber at the same time. In order to deliver the fuel-air mixture into the furnace satisfactorily, the stream has to be maintained at a velocity of 40 feet per second or more and this makes it difficult to obtain ignition of the solid particles in the case of low volatile fuels, such as certain petroleum cokes, which have a flame propagation velocity as low as 5 feet per second. When a mixture of such a fuel and primary air is introduced into the furnace chamber along a rectilinear path, it is apparent that the forward movement of the solid particles is greater than the speed of flame propagation and accordingly, the particles may pass through a considerable portion of their path through the chamber from the point of fuel admission to the exhaust gas exit before ignition of the particles occurs. To obtain best combustion results, the fuel should be ignited and begin burning as soon after it enters the combustion chamber as possible, and this earily ignition is not obtained with the methods of supplying fuel now commonly in vogue.

Proper burning of low volatile fuels also requires a more intimate mixing of the fuel and air within the combustion chamber than is required with fuels of high volatility, and an increased mixing action is likewise required for good combustion as the furnace temperature decreases.

The present invention is directed to the provision of a burner adapted to deliver fuel and air into a combustion chamber in such a way as to obtain early ignition of the particles and the proper mixing of the particles with air, these desirable results being secured by controlling the manner in which the secondary air is introduced into the chamber. In the operation of the improved burner of the present invention, the fuel to be consumed is admitted into the chamber in a stream and the secondary air is introduced in the form of an envelope which encloses the stream. Just before the envelope comes into contact with the stream, it is given a rapid whirling movement and this causes the fuel particles to change direction so that their rate of forward advance into the combustion chamber is greatly reduced and a more intimate mixture of fuel and air is effected. By proper regulation of the rotational velocity of the envelope, the fuel particles may be advanced so slowly that they are ignited shortly after they enter the furnace and the degree of mixing of the fuel and the air may also be varied as may be required for good combustion of fuels of different kinds.

The principles of the invention may be practiced by means of burners of various forms, dependent to some extent in their construction on the kinds of fuel to be burned. For purposes of illustration, a form of the new burner capable of supplying pulverulent, gaseous, and liquid fuels will be described in detail though it is to be understood that the advantages from utilizing the new burner are not limited to the burning of two or more fuels simultaneously.

A burner constructed in accordance with the invention for the purpose referred to includes a tube for delivery of the pulverulent solid fuel mixed with primary air and leading to an opening in the furnace wall, a plurality of burner openings for gas, these openings lying close to the end of the tube and preferably formed in a ring of greater diameter than the tube, and a nozzle for supplying atomized liquid fuel, which may be mounted on the end of an oil pipe which extends through the tube and terminates beyond the end of the latter. Secondary air for combustion is supplied by a wind box and is discharged through an annular outlet surrounding the fuel tube, the air from the box flowing through the gas ring and around the liquid fuel nozzle into the combustion chamber. The secondary air thus envelops the stream of pulverulent fuel and primary air and it is given a rapid whirling motion just before it contacts with the stream so that it entrains the solid particles therein and causes them to change direction and to advance into the furnace along a helical path. The particles thus enter the zone of combustion much more slowly than would otherwise be the case and the whirling movement of the secondary air produces a better mixing of the fuel and air which results in improved combustion conditions with ignition

of the solid particles continuously maintained, even though those particles may be of a fuel of low volatile content.

For a better understanding of the details of the invention, reference may be made to the accompanying drawings, in which

Fig. 1 is a view of the burner in longitudinal section on the line 1—1 of Fig. 2; and

Fig. 2 is an end view of the burner with certain parts removed.

Referring now to the drawings, one form of the new burner is illustrated as mounted in an opening 10 through the wall 11 of a combustion chamber, the burner being placed for horizontal delivery of the fuel, although it may be used for vertical delivery if desired. The burner comprises a casing 12 secured in place in any convenient manner, as by means of beams 13, and provided at one end with a hollow ring 14 having a plurality of jet openings 15 formed in its inner surface. The ring 14 receives a supply of gaseous fuel through pipes 16 connected through control valves 17 to a gas manifold 18. In the burner illustrated, there is a single sectional gas ring with two rows of jet openings but additional gas rings may be employed and the arrangement of the jet openings in the ring may be varied as desired. Within the opening and beyond the gas ring is a flaring ring of refractory material 19 protecting the inner end of the casing 12 and defining the wall of the opening 10.

A tube 21 abuts the wall 20 of the casing and surrounds an opening therein. The inner end of the tube 21 terminates on the outer side of the gas ring 14 so that the outer surface of the tube and the inner surface of the gas ring define an annular discharge outlet from the casing. The tube 21 is supported at its inner end in a spider 22, the legs of which contact with the casing wall, and at its outer end, the tube is connected by an elbow 23 to a transport line 24. The tube delivers a mixture of fuel and primary air and the secondary air for combustion is supplied to the casing through an opening 25 to which leads an air duct (not shown). The casing thus serves as the wind box for secondary air.

Liquid fuel is supplied through a main connection 26 and through pipe 27 which extends through the tube 21 and terminates in an atomizing nozzle 28. The pipe 27 projects beyond the end of the tube and through the gas ring and at its inner end it may carry a collar 29 provided with deflecting blades 30 which lie in front of the outlet end of the tube and in the path of the stream of primary air and fuel issuing therefrom. The pipe 27 projects through a boss 31 formed in the wall of the discharge elbow 23 and suitable means (not shown) are provided for controlling the supply of liquid fuel issuing from the nozzle.

The secondary air issuing through the annular discharge outlet from the wind box is given a rapid whirling or spiraling motion by means of a plurality of vanes 32 mounted on pivot pins 33 which pass through openings in a ring 34 secured on the end of the tube 21. The pins on which these vanes pivot are slightly inclined so that the inner edges of the vanes extend from the ring 34 to the adjacent edge of the gas ring 15 and each vane carries a stud 35 which is received in a slot or recess 36 in a movable ring 37 which lies in a circumferential channel behind the ring 34. A link 38 is attached to the movable ring at one point and leads to a crank on a shaft 39, the shaft being mounted in a bearing formed, for example, in one of the arms of the spider 22. The shaft projects out through the front wall of the casing 12 and its outer end is supported in a bracket 40 attached to the discharge elbow 23. The shaft carries a hand wheel 41 by which it may be rotated to cause an angular movement of the ring 37 and as the ring moves, it causes the vanes to swing on their pivots. The shaft 39 carries an arm 42 provided with a pin 43 which cooperates with a notched segment 44, the pin and segment permitting the shaft to be locked in any position of adjustment, this in turn locking the vanes in the desired adjusted position.

With the construction described, the primary fuel and air mixture issuing from the burner tube 21 and the stream of atomized liquid fuel are surrounded by an envelope of rapidly whirling secondary air which entrains the streams and changes the direction of the fuel particles therein, so that the particles advance more slowly into the zone of combustion and an intimate mixture of fuel and air is obtained. The deflecting blades 30 on the end of the liquid fuel pipe may be omitted, if desired, but when used, they break up the stream of solid fuel and air and thus further assist in creating turbulence and an intimate mixing action.

In effect, the secondary air is admitted through radial slots defined by the vanes with the inclination of the walls of the slots such as to create the desired spiral movement. The nearer the vanes are to being completely closed, the greater will be the angular movement of the secondary air. The mixing action increases with the angular movement of the secondary air, and, since the degree of mixing desirable increases with a decrease in the volatility of the fuel and of the furnace temperature, it will be apparent that by adjustment of the vanes, a mixing action can be obtained which is appropriate for fuels of varying kinds and for different combustion conditions.

Another advantageous feature of the new burners is that the rotary movement is imparted to the secondary air at the point of delivery of fuel into the furnace, and the whirling stream thus has little chance to straighten out before coming into intimate contact with the fuel. This insures that the rotational movement will be fully effective and because of the better mixing of fuel and air thus obtained, there is a greater heat release per unit of furnace volume.

The new burner is capable of burning various fuels one at a time or simultaneously, as, for example, petroleum coke, coal, sawdust, acid sludge, gas, oil, etc. and the burner may be used to especial advantage at oil refineries where these different fuels are produced, such of the fuels being consumed as are available at any time.

What I claim:

1. In a burner, the combination of a tube for delivering a stream of mixed pulverulent fuel and primary air, a hollow ring member disposed beyond the discharge end of said tube and provided with gas ports in its inner side, means for supplying gas to said hollow ring member, a pipe extending through said tube and terminating in a nozzle, means for supplying liquid fuel to said pipe, a wind box having an annular discharge outlet surrounding said tube and adapted to deliver secondary air in the form of an envelope enclosing said stream and the fuel issuing through said nozzle, said secondary air flowing through said ring member and between said ring

member and the end of the tube, means including a plurality of vanes positioned at the end of said tube and pivotally mounted on axes lying in radial planes and disposed approximately perpendicular to the axis of said tube and extending substantially across said annular discharge outlet for imparting spiral movement to said envelope, and means for adjusting said vanes rotatively about said axes.

2. In a burner, the combination of a tube for delivering a stream of mixed pulverulent fuel and primary air, said tube having an open discharge end, a wind box having an annular discharge outlet surrounding said tube for delivering secondary air in the form of an envelope enclosing said stream, a hollow ring member having ports in its inner side, said ports lying beyond the discharge end of said tube, said secondary air passing through said ring member and between said ring member and the end of said tube, means for supplying gaseous fuel to said hollow ring member, means for imparting spiral movement to said envelope including a plurality of vanes pivotally mounted on axes lying in radial planes and disposed approximately perpendicular to the axis of said tube and extending substantially across said annular discharge outlet, said means being disposed close to the point where said secondary air contacts with said stream, and means for adjusting said vanes rotatively about said axes.

OLIVER F. CAMPBELL.