Nov. 7, 1961 J. A. TE NUYL ET AL 3,007,512

BURNER FOR THE BURNING OF REGENERATOR FLUE GAS

Original Filed Oct. 28, 1955 2 Sheets-Sheet 1

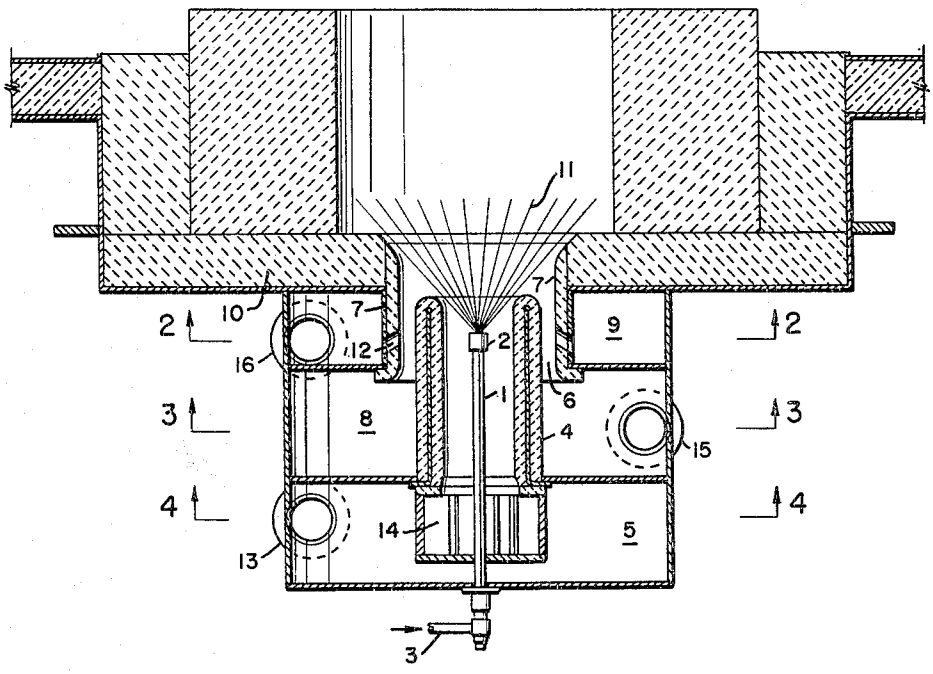


FIG. 1

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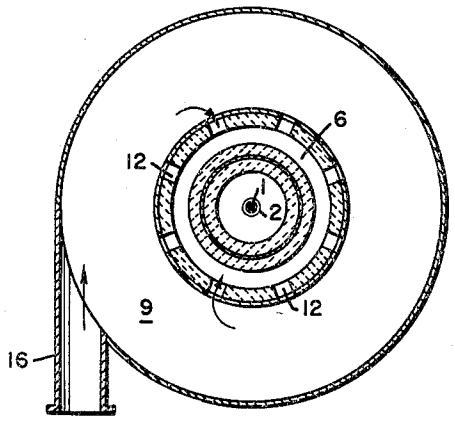


FIG. 2

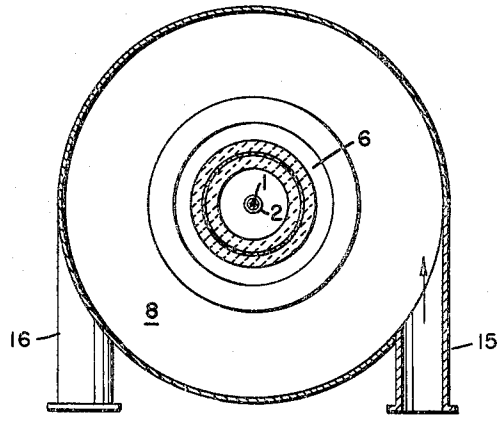


FIG. 3

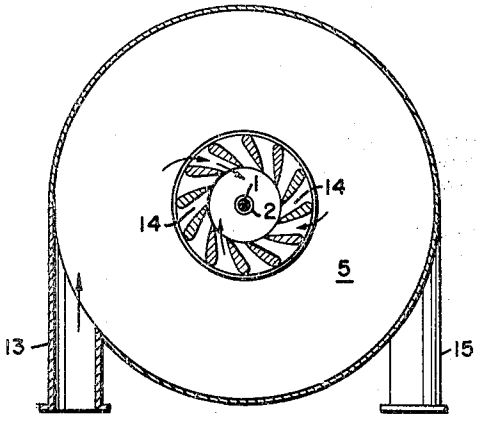


FIG. 4

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BURNER FOR THE BURNING OF REGENERATOR FLUE GAS

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Original application Oct. 28, 1955, Ser. No. 543,343, now Patent No. 2,952,310, dated Sept. 13, 1960. Divided and this application Dec. 24, 1959, Ser. No. 1,836

2 Claims. (Cl. 158—11)

This invention relates to the burning of flue gas, and especially flue gas from the regenerator of a catalytic cracking operation, and to a burner therefor.

In the catalytic cracking of hydrocarbon oils the catalyst is continuously regenerated by burning off carbonaceous matter under controlled temperature conditions and under conditions of essentially complete utilization of the oxygen in the air supplied for the combustion. This operation results in a large quantity of so-called regenerator gas, or regenerator flue gas, at a temperature between about 500 and 650° C. This gas is normally discharged to the atmosphere. While this gas consists chiefly of inert materials such as nitrogen, water vapor and carbon dioxide, it normally contains some carbon monoxide (e.g., 5–10% by volume) and has a combustion value of the order of 150 to 300 Cal. per cubic meter.

It has been proposed to recover some of the sensible heat of these lean gases to form low pressure steam in a heat economizer and this has been done to a limited extent. It has also been proposed to recover the heat of combustion as well as the sensible heat but this has been difficult to accomplish in reasonable apparatus and in a practical way. According to one scheme use is made of a catalyst mass which promotes the combustion of the lean gas. This is effective but requires costly apparatus. According to another scheme this lean gas is fed into a furnace in which combustion is already maintained by means of conventional gas or oil burners so that the regeneration gas is also burnt in the hot atmosphere formed by this combustion. In this latter method the combustion is not concentrated as desired for boilers of the usual type, but takes place in a large volume so that special furnaces of different construction are necessary.

The object of the invention is to provide apparatus for the burning of lean gases, and more specifically catalytic cracking regenerator gas, whereby the combustion is concentrated in a small space and consequently may be effected efficiently in steam boilers or furnaces of the usual construction. This object, broadly speaking, is attained by supplying the lean gas pre-mixed with combustion air annularly through a conical flame which is maintained by the combustion of a liquid fuel. This is done in such a manner that the gas mixture is rapidly raised to the combustion temperature (800° C. to 1000° C.) and burns together with the liquid fuel in a small space.

A specific burner designed to allow the combustion of catalytic cracking regenerator gas according to the invention is illustrated in FIGURES 1 to 4 of the accompanying drawings. While the burner illustrated is specifically designed for this operation, it may be modified in certain particulars as will be apparent to those skilled in this art after considering the following description of its operation.

FIGURE 1 of the drawing is a plan view in section of the burner mounted in the front wall of a conventional boiler. FIGURES 2, 3, and 4 are elevations in section taken through the planes 2—2, 3—3, and 4—4, respectively.

Referring to the drawings, 1 is a tube to which liquid fuel is supplied by line 3 and which carries an atomizing

nozzle 2 at its front end. This nozzle may be, for example, a vortex chamber atomizer or any other type of nozzle which atomizes the liquid fuel in the shape of a cone 11. Cone 11 preferably has a wide angle, e.g. about 90°. The tube 1 is surrounded by a cylinder 4 which is constructed preferably of a heat-resisting material. The back end of the cylinder 4 is attached to and opens into an air chamber 5 provided with an air inlet duct 13. Within the air chamber and connected to the cylinder 4 is a means for distributing the air and imparting to it a rotating motion as it enters tube 4. In the particular apparatus illustrated this means 14 consists essentially of a cage provided with fins which impart to the incoming air the desired rotating motion. An annular slot 6 is provided around the front end of cylinder 4. This slot is bounded on the inside by cylinder 4 and on the outside by the wall of cylinder 7 which latter is fitted to the furnace wall 10. The cylinder 7 is likewise constructed of or lined with a heat-resistant material.

In front of the air chamber 5 and surrounding in part cylinder 4 is a gas chamber 8 communicating with the slot 6 and provided with an inlet duct 15 for the lean gas to be burned. The regeneration gas supplied by duct 15 enters the chamber 8 and then passes through the slot 6 to the combustion zone. In front of gas chamber 8 and surrounding in part the cylinder 7 is a third chamber 9 supplied by an air duct 16. The cylinder 7 is provided with a number of slotted openings 12 providing communication between the air chamber 9 and the annular slot 6. These openings or slots 12 enter the annular passageway 6 somewhat back of the end of the cylinder 4, as illustrated, and are preferably inclined somewhat in the direction of flow of flue gas through slot 6.

In operation a liquid fuel is supplied by line 3 to the tube 1 and nozzle 2 by which it is sprayed into the combustion zone in the form of the cone 11. Air for the combustion, introduced by duct 13, passes into the outer chamber 5 and then through the distributor 14 wherein it is given a rotatory motion. The swirling air passes forward through the cylinder 4 around tube 1 to the combustion zone. A further quantity of air introduced through duct 16 passes to the forward or front chamber 9 and from there through the slots 12 into the annular passageway 6. Regenerator flue gas introduced through duct 15 passes to the intermediate chamber 8 which is between the gas chambers 5 and 9 and from it through the slot 6. In passing through the slot 6 the regenerator flue gas is pre-mixed with the air required for its combustion and the mixture is forced to pass through the cone 11. When this mixture of gas and air meets the flame formed by the liquid fuel it rapidly reaches the necessary combustion temperature and burns together with the liquid fuel in a single flame in a very short time.

By effecting the combustion of the flue gas in the manner described the size of the flame thus obtained is not much greater than that of the flame which would be obtained if only liquid fuel were burnt in the quantity which would produce the same amount of heat. Thus, the invention enables liquid fuel to be substituted by regeneration gas in a boiler or furnace of conventional design intended to produce a given amount of heat with liquid fuel. This allows considerable saving to be made in the cost of fuel without resort to boilers of furnaces of special construction.

With the burner illustrated it is an easy matter to mount a number of such burners on a furnace wall and in such case the chambers 5, 8 and 9 may be enlarged to accommodate several burners. The regenerator flue gas, as pointed out, normally is at a fairly high tempera-

ture, e.g., between 500° C. and 600° C. With the burner illustrated the heat which this gas imparts to the walls of the gas chamber is not lost in view of the position of this gas chamber between the two air chambers.

It has been found that the amount of liquid fuel required to cause the combustion of regenerator flue gas is relatively small. An amount of gas can be burned with an amount of liquid fuel, the total combustion value of which is approximately 50% of the combustion value of the gas. This means that only about 0.01 ton of liquid fuel is required to burn one ton of regenerator gas.

It has also been found that the described method of burning regenerator flue gas has a favorable effect on the course of combustion of very heavy fuels such as liquid asphalt.

It will be noted that the burner used according to the invention is one in which a gaseous fuel and a liquid fuel are supplied at the same time with separate streams of combustion air. The burner is preferably mounted in the furnace wall such that the part of the furnace which directly surrounds the combustion zone has no cooled walls such as are formed, for example, by a part of the boiler surface. The free flame formation should not, however, be obstructed by the presence of wall sections especially arranged to promote ignition. The front edge of the cylinder 4 and the edge of the cylinder 7 are preferably so positioned that they closely approach the cone of atomized fuel 11 since when the cone passes close to the top edges of these cylinders the most favorable mixing is obtained between the mixture of gas and air and the burning mass formed from the liquid fuel. As illustrated, it is advantageous to direct the mixture of regenerator gas and air in a direction approximately parallel to the central line of the burner.

This application is a division of application Serial No. 543,343, filed October 28, 1955, now Patent No. 2,952,310.

We claim as our invention:

1. A burner for burning lean fuel gases which comprises a tubular wall, an open-ended cylinder coaxial with said wall and spaced radially inwardly therefrom to define an annular channel, the forward edge of said cylinder being set back from the forward edge of the wall and the rear edge of the cylinder extending beyond the rear edge of the wall, means forming a forward annular gas chamber surrounding said tubular wall, said tubular wall having passage means distributed about the circumference thereof interconnecting said gas chamber and said channel intermediate of the ends thereof, means forming an intermediate annular gas chamber surrounding said cylinder and in communication with the rear end of said channel, means forming a rear gas chamber in communication with the rear end of said cylinder through a gas-rotating means, means forming an inlet for introducing combustion air to the forward and rear gas chambers, means forming an inlet for introducing lean fuel gas to the intermediate gas chamber, a fuel pipe with an atomizing head to atomize liquid fuel in the form of a cone, said head being situated within said cylinder and positioned and arranged to emit a spray cone which grazes the forward edges of said cylinder and tubular wall.

2. The burner according to claim 1 wherein said interconnecting passage means is inclined for the flow of air into said annular channel in a forward direction.

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