

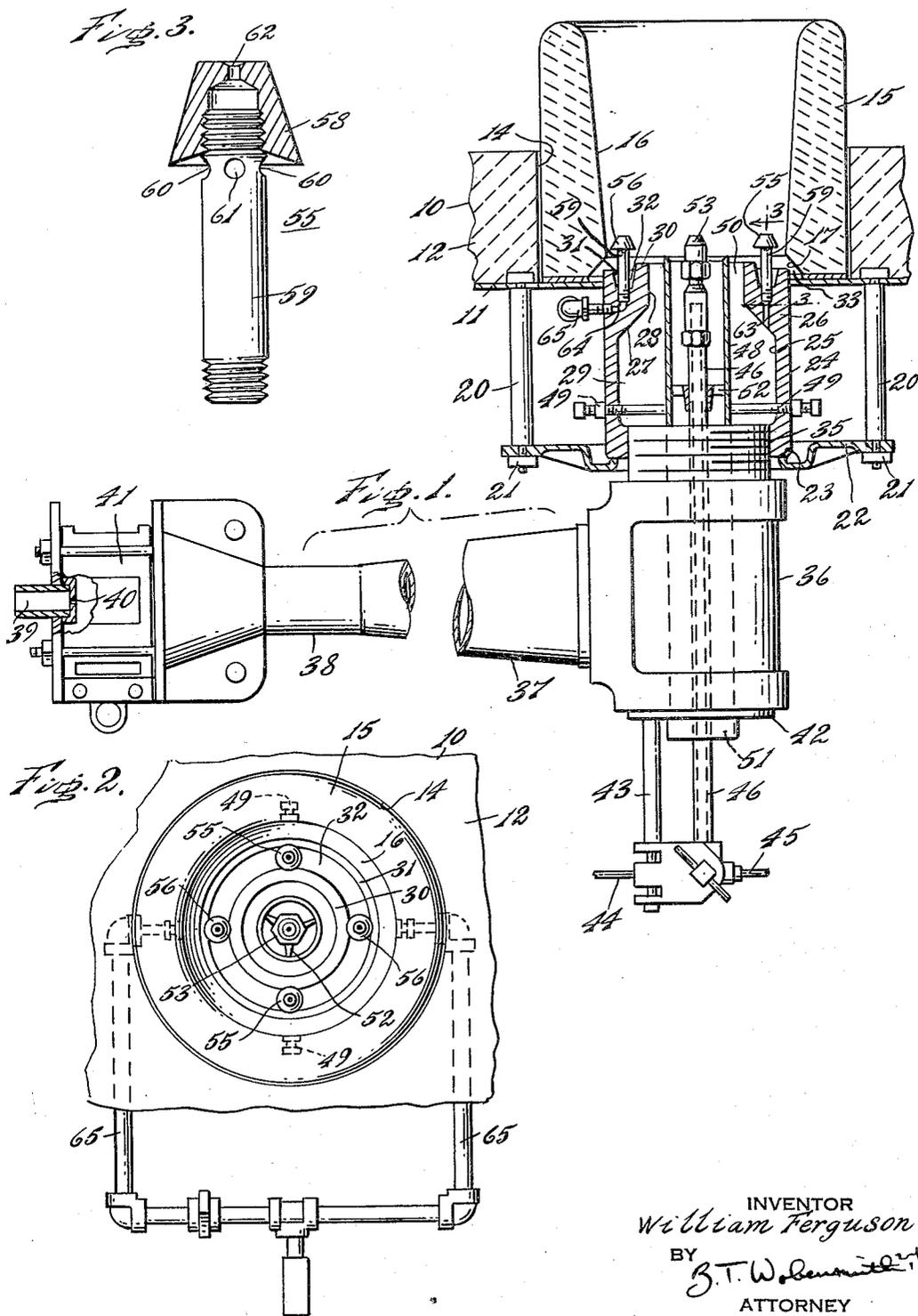
Dec. 29, 1959

W. FERGUSON

2,918,966

BURNERS FOR GASEOUS AND HEAVY LIQUID FUELS

Filed Aug. 7, 1958



INVENTOR
William Ferguson
BY *B.T. Wolbenmittl*
ATTORNEY

1

2,918,966

BURNERS FOR GASEOUS AND HEAVY LIQUID FUELS

William Ferguson, Glenside, Pa., assignor to National Airoil Burner Company, Incorporated, Philadelphia, Pa., a corporation of Delaware

Application August 7, 1958, Serial No. 753,756

12 Claims. (Cl. 158-11)

This invention relates to burners for simultaneous combustion of gaseous and heavy liquid fuels and more particularly to such burners for upfired heater furnaces in petroleum refining, chemical and other plants.

In modern oil refinery practice, upfired furnaces are frequently employed for furnaces, stills, heaters and similar separately fired devices. Upon attempting to burn heavy or residuum oils from oil cracking or refining processes, and particularly the viscous tar like residues included in such oils, difficulties have been encountered. One source of difficulty arises because of coke deposition in the bore of refractory blocks used as part of the burner, and in and around the gas nozzle. Expensive and recurring dismantling of the burner for cleaning, examination and repair was necessary in order that the gas fuel could be burned.

Another source of difficulty arises because of the nature of these heavy or residuum oils when discharged by a burner nozzle. The failure to attain rapid combustion has frequently resulted in dripping of unburned residues. This dripping is objectionable for many reasons and no satisfactory provisions have heretofore been made to reduce and also accommodate the dripping, and complete the combustion of the unburned residues.

The byproduct fuel gases also available for combustion are frequently high in hydrogen content, which may run as much as 90%, so that difficulty is encountered by the relatively high ignition velocity of an air-gas mixture in which the byproduct fuel gas is employed with the result that flashback occurs in the burner and nozzles.

It is the principal object of the present invention to provide an improved burner for burning both heavy or residuum oils and also byproduct fuel gases of high hydrogen content.

It is a further object of the present invention to provide a burner for heavy or residuum oils and byproduct fuel gases of high hydrogen content, with which the heavy or residuum oils are burned in suspension without clogging of the gas nozzle by dripping of the heavy residuum oils.

It is a further object of the present invention to provide an improved burner for heavy and residuum oils and byproduct fuel gases in which the fuel gases supplied to the burner are shielded from any falling particles of heavy or residuum oils and in which additional provisions are made for burning any heavy or residuum oils tending to return from the advancing combustion stream.

It is a further object of the present invention to provide an improved burner for heavy or residuum oils and byproduct fuel gases in which an improved gas nozzle is provided having provisions for catching any unburned oil and effecting the combustion of such unburned oil.

It is a further object of the present invention to provide an improved burner for heavy liquid fuels and byproduct fuel gases having improved provisions for handling any unburned oil from the burner block.

Other objects and advantageous features of the invention will be apparent from the description and claims.

The nature and characteristic features of the invention

2

will be more readily understood from the following description, taken in connection with the accompanying drawings forming part thereof, in which:

Figure 1 is a side elevational view of a preferred form of burner in accordance with the present invention, parts being broken away to show the interior details of construction;

Fig. 2 is a top plan view of the burner shown in Fig. 1; and

Fig. 3 is a vertical sectional view, enlarged, taken approximately on the line 3-3 of Fig. 1.

It should, of course, be understood that the description and drawings herein are illustrative merely, and that various modifications and changes may be made in the structure disclosed without departing from the spirit of the invention.

Like numerals refer to like parts throughout the several views.

Referring now more particularly to the drawings a fragmentary portion of a furnace floor 10 is illustrated, of the character employed in stills, heaters and the like in refineries and other process industries, comprising a horizontal metal floor plate 11 with a horizontal ceramic refractory lining 12 therein.

The floor 10 is provided with an opening 14 within which a burner block 15 is mounted and supported. The burner block 15 is also of ceramic refractory material, extends upwardly above the upper face of the lining 12, and is provided with an interior upwardly diverging frustoconical bore or opening 16. At the lower end of the opening 16 a downwardly diverging frustoconical portion 17 is provided.

Supporting arms 20, carried by the metal floor plate 11 have secured thereto by nuts 21, a mounting plate 22 with an inner circular rim 23. The rim 23 is in supporting engagement with the lower edge of an outer cylindrical nozzle housing 24.

The nozzle housing 24 has an interior face 25 and a thickened upper wall 26 bounded by an inner converging face 27 and an inner cylindrical face 28 of predetermined reduced diameter. An interior space 29 is thus provided bounded by the face 25.

The upper end of the wall is provided with an inner annular upstanding rim 30 and an outer annular upstanding rim 31 with an annular trough 32 therebetween. The inner rim 30 is at a higher elevation than the outer rim 31 to provide a directing and shielding action, as hereinafter explained.

The outer rim 31 is in predetermined spaced relation to the frusto-conical portion 17 of the burner block 15 to provide therebetween a constant secondary air inlet port 33. The nozzle housing 24 at the lower end thereof, has a threaded opening 35 for the connection of a T-fitting 36. At one side of the T-fitting 36, an inspirator 37 of well known type is connected. The inspirator 37 includes a venturi tube 38 through which the combustible gas and air mixed therewith is supplied to the space 29.

The combustible gas is delivered to the inspirator 37 through a fuel supply pipe 39 and through an orifice 40 in the customary manner with gas burners, an air shutter 41 being provided as part of the inspirator 37 which is adjustable in a well known manner for controlling the amount of primary air for mixing with the combustible gas.

The gas delivered to the supply pipe 39 is a byproduct fuel gas of high hydrogen content which may run as much as 90% and can be supplied at a pressure of the order of 1 p.s.i.g. The gas delivered to the supply pipe 39 under certain conditions will be natural gas. The T-fitting 36 is provided with an adapter bushing 42 to which a bracket 43 is connected for supporting an atom-

izing steam supply pipe 44 and a heavy or residuum oil supply pipe 45 for delivery to and through a burner pipe 46.

The adapter bushing 42 has a tube 48 connected thereto and extending inwardly through the space 29. The tube 48 is carried by the bushing 42 at one end and a plurality of centering screws 49 extending through the nozzle housing 24 are provided for centering the tube 48 with respect to the face 28. The space between the tube 48 and the face 28 provides an annular combustible gas-air delivery orifice 50 of predetermined size in accordance with the dimensioning of the tube 48 and the face 28. The annular orifice 50 is relatively large in diameter but small in film like thickness to retard flashback.

The burner pipe 46 extends through the pipe 48 in spaced relation thereto and provides a constant inlet opening 51 for tertiary air within the tube 48 and around the burner pipe 46. The burner pipe 46 can be supported by and centered with respect to the tube 48 by a centering spider 52.

At the outer end of the burner pipe 46 an atomizing nozzle 53 is provided for the delivery of the heavy or residuum oil in finely divided form and in a frusto-conical upwardly directed spray. As previously indicated the heavy or residuum oil can be that resulting from oil cracking or refining processes, has a very low volatile content, high content of solid carbonaceous material, and is viscous and tar-like. The end of the nozzle 53 projects beyond the end of the tube 48.

At a plurality of locations with respect to the trough 32, spaced standpipe assemblies 55 and additional standpipe assemblies 56 are provided, two of each being shown by way of illustration.

The standpipe assemblies are shown in detail in Fig. 3 and preferably each includes a frusto-conical tip 58 and a connecting pipe 59. The connecting pipes 59 are preferably provided with a plurality of discharge ports 60 in a horizontal plane and positioned so as to discharge circumferentially against the bore or opening 16 of the refractory burner block 15. An additional port 61 is provided discharging radially towards the center line of the burner pipe 46.

While it is not essential, an additional and smaller port 62 can be provided in the ends of the tips 58 of the standpipe assemblies 55 and 56 to produce a small flame extending a short distance into the furnace to indicate that the igniters are in operation.

The shape of the tips 58 and the disposition thereof with respect to the connecting pipes 59 prevents any oil from dripping into the radial discharge ports 60 and 61 of the standpipe assemblies 55 and 56. Any clogging of the top hole or orifice 62 is not detrimental and will not adversely affect the performance. The interiors of the standpipe assemblies 55 are connected by fluid connections 63 in the wall 26 of the nozzle housing 24 to the interior space 29 within the nozzle housing 24.

The interiors of the standpipe assemblies 56 are connected by fluid connections 64 provided within the wall 26 of the nozzle housing 24 and to which raw gas supply pipes 65 are connected to a suitable source of supply of raw gas. The raw gas supplied to the pipes 65 is preferably the same kind of gas as is supplied to the supply pipe 39 and may be at a pressure of the order of 5 to 50 p.s.i.g.

The mode of operation will now be pointed out.

The heavy or residuum oil supplied by the pipe 45 to the burner tube 46 is atomized by the steam supplied through the pipe 44 to the pipe 46, the atomization being effected by the nozzle 53 for discharging the atomized material outwardly within the bore or opening 16 of the burner block 15. The burner block 15 in normal operation is, of course, heated and supplies heat for aiding in the ignition of the heavy or residuum oil in atomized form.

Byproduct or natural gas supplied through the pipe 39 and the nozzle 40 is mixed with air admitted through the air shutter 41 to provide a combustible mixture delivered through the inspirator 37 to the T-fitting 36, exteriorly of the pipe 48 and passing to the space 29 and thence through the orifice 50 for discharge into the opening 16 in the burner block 15 for burning in intimate relation with the atomized material from the nozzle 53. The burning of the gas-air mixture discharged through the orifice 50 aids in heating the burner block 15. Primary air is supplied through the air shutter 41 at the inspirator 37, secondary air is inspired through the orifice 33 and tertiary air is inspired through the opening 51.

The gas air mixture delivered through the pipe to the passageway 63 and pipe 59 of the standpipe assemblies 55 is burned with a flame directed in close relation to the trough 32. At the same time raw gas delivered through the supply pipe 65, the passageways 64 and the pipes 59 of the standpipe assemblies is also delivered in intimate relation to the channel 32 at spaced locations with respect to the standpipe assemblies 55.

The combustion of gas at the standpipe assemblies 55 and 56 also aids in heating the refractory block to prevent the deposition of coke from any unburned oil tending to move downwardly within the bore or opening 16. Any oil dripping into the channel 32 from the bore or opening 16 or tending to fall towards the faces provided by the rims 30 and 31 and the channel 32 therebetween will be burned by the heat provided by the combustion at the standpipe assemblies 55 and 56. The upwardly extending rim 30 tends to direct any falling material towards and into the channel 32.

The amount of gas consumed by the standpipe assemblies 55 and 56 will vary with the fuel oil temperature and flash point, the viscosity of the fuel oil as burned, the free carbon or coke content of the heavy or residuum oil, the quality and temperature as well as flow rate of the atomizing steam, the amount of secondary air entering at the orifice 33, the furnace draft and the amount or percentage of excess air introduced through the respective air inlet orifices.

The gas pressure in the standpipe assemblies 55 and 56 will average about 1 p.s.i.g. and will increase and decrease with an increase and decrease in the viscosity of the heavy or residuum oil. While different fuel rates can be employed, it has been found that satisfactory results are attained if the heat value of the fuel supplied to the standpipe assemblies 55 and 56 is of the order of 1% to 5% of the heat value of the heavy or residuum oil.

The air supplied through the tertiary air inlet 51 and passing in contact with the interior of the tube 48 will have a cooling effect, the orifice 50 being relatively large in diameter but relatively small in transverse dimensions so that flashback into the space 29 is greatly retarded. The cooling of the exterior of the nozzle portion 24 by exposure to the atmosphere also aids in retarding flashback.

The length of the orifice 50 is relatively great and further retards the tendency to flashback which might occur with combustible gas having a high hydrogen content.

It will be noted that any material tending to drip against the standpipe assemblies 55 and 56 will be ignited by the combustion occurring at these assemblies and that no locations are provided within the burner block 15 or contiguous to the burner for the collection of coke. Any coke tending to collect will be ignited and burned by reason of the high temperature areas maintained at the trough 32 and within the burner block 16.

An important function of the standpipe assemblies 55 is to maintain or stabilize flame retention of the main flame by producing a small kindling flame in the event that the supply of heavy or residuum oil is cut off and

5

byproduct gas is the only fuel supplied and burned. If the burner assemblies 56 are in operation, the use of the burner assemblies 55 is accordingly not essential to the continued operation of the burner, except as noted.

I claim:

1. Apparatus for burning heavy residuum oils and gas comprising a furnace having a horizontal floor, a burner block mounted in and extending above said floor and having a vertical opening therethrough, a burner housing coaxial with the opening in said burner block and in spaced relation thereto to provide an air inlet opening therebetween, an open ended tube extending through said housing and having its outer surface in spaced relation to an end portion of said housing for providing combustible gas-air discharge therebetween, an inspirator connected to said burner housing exteriorly of said tube and having a gas delivery connection thereto and an air inlet therein for admitting air for admixture with the gas from said connection, a burner tube extending interiorly of said first named tube and in spaced relation thereto, the space between said burner tube and said first named tube providing an air inlet passage, the inner end of said burner tube having a nozzle thereon disposed within the opening in said burner block, connections for supplying residuum oil and atomizing fluid to said burner tube, said burner housing having in outwardly spaced relation with respect to said first named tube a body portion provided with an inner rim and an outer rim with a trough therebetween, and auxiliary means including burners disposed along said trough and within said burner block for supplying auxiliary flames for combustion of unburned residuums falling within said burner block.

2. Apparatus for burning heavy residuum oils and gas as defined in claim 1 in which certain of said auxiliary burners have connections for the independent supply of gas thereto.

3. Apparatus for burning heavy residuum oils and gas as defined in claim 1 in which certain of said auxiliary burners have connections in communication with the interior of said burner housing for the supply of combustible gas and admixed air thereto.

4. Apparatus for burning heavy residuum oil and gas as defined in claim 1 in which said auxiliary burners each include pipes extending upwardly from said trough and end tips of frusto-conical shape, said auxiliary burners having gas discharge openings below and protected by said tips.

5. Apparatus for burning heavy residuum oils and gas comprising a furnace having a horizontal floor, a burner block mounted in and extending above said floor and having a diverging opening therethrough, a burner housing coaxial with the opening in said burner block and in spaced relation to said burner block at the inlet end thereof to provide an air inlet opening therebetween, supporting members carried by said floor for supporting said burner housing, an inspirator connected to said burner housing and having a gas delivery connection thereto and an air inlet therein for admitting air for admixture with the gas from said gas delivery connection, an open ended tube extending through a portion of said inspirator and through said burner housing and having its outer surface in spaced relation to an end portion of said burner housing for the discharge of combustible gas-air from said inspirator, a burner tube extending interiorly of said first named tube and in spaced relation thereto, the inner end of said burner tube having a nozzle thereon disposed within the opening in said burner block, connections for supplying residuum oil and atomizing fluid to said burner tube, the space between said burner tube and said first named tube providing an air inlet passage, said burner housing having spaced inner and outer rim portions extending into said burner block with a trough therebetween, the exterior diameter of said burner housing being in excess of the minimum interior diameter of

6

said burner block, and auxiliary means including burners disposed along said trough and within said burner block for supplying auxiliary flames for combustion of unburned residuums falling within said burner block.

6. Apparatus for burning heavy residuum oils and gas as defined in claim 5 in which certain of said auxiliary burners have connections for the independent supply of gas thereto.

7. Apparatus for burning heavy residuum oils and gas as defined in claim 5 in which certain of said auxiliary burners have connections in communication with the interior of said burner housing for the supply of combustible gas and admixed air thereto.

8. Apparatus for burning heavy residuum oil and gas as defined in claim 5 in which said auxiliary burners each include pipes extending upwardly from said trough and end tips of frusto-conical shape, said pipes having gas discharge openings below and protected by said tips.

9. Apparatus for burning heavy residuum oils and byproduct gas of high hydrogen content comprising a furnace having a horizontal floor, a burner block mounted in and extending above said floor and having a diverging frusto-conical opening therethrough, a burner housing coaxial with the opening in said burner block and in spaced relation to said burner block at the inlet end thereof to provide an air inlet opening therebetween, supporting members carried by said floor for supporting said burner housing, an inspirator connected to said burner housing with a delivery portion coaxial with said burner housing and having a byproduct gas delivery connection thereto and an air inlet therein for admitting air for admixture with the gas from said gas delivery connection, an open ended tube extending through said delivery portion of said inspirator and through said burner housing in coaxial relation thereto and having its outer surface in spaced relation to an end portion of said housing for the discharge of combustible gas with admixed air from said inspirator, members carried by said burner housing for centering said tube with respect to the burner housing, a burner tube extending interiorly of said first named tube and in spaced coaxial relation thereto, the inner end of said burner tube having a nozzle thereon disposed within the opening in said burner block, connections for supplying residuum oil and atomizing fluid to said burner tube, the space between said burner tube and said first named tube providing an air inlet passage, said burner housing having spaced inner and outer rim portions extending into said burner block opening with a trough therebetween, the inner rim extending into said burner block opening to a greater extent than said outer rim, the exterior diameter of said burner housing at said outer rim being in excess of the minimum interior diameter of said burner block, auxiliary means including burners disposed along said trough and within said burner block for supplying auxiliary flames for combustion of unburned residuums falling within said burner block, and fuel supply connections for said auxiliary burners.

10. Apparatus for burning heavy residuum oils and byproduct gas as defined in claim 9 in which certain of said auxiliary burners have connections for the independent supply of byproduct gas of high hydrogen content thereto.

11. Apparatus for burning heavy residuum oils and byproduct gas as defined in claim 9 in which certain of said auxiliary burners have connections in communication with the interior of said burner housing for the supply of combustible gas and admixed air thereto.

12. Apparatus for burning heavy residuum oil and byproduct gas as defined in claim 9 in which said auxiliary burners each include pipes extending upwardly from said trough and end tips of frustoconical shape, said auxiliary burners having gas discharge openings below and protected by said tips.