

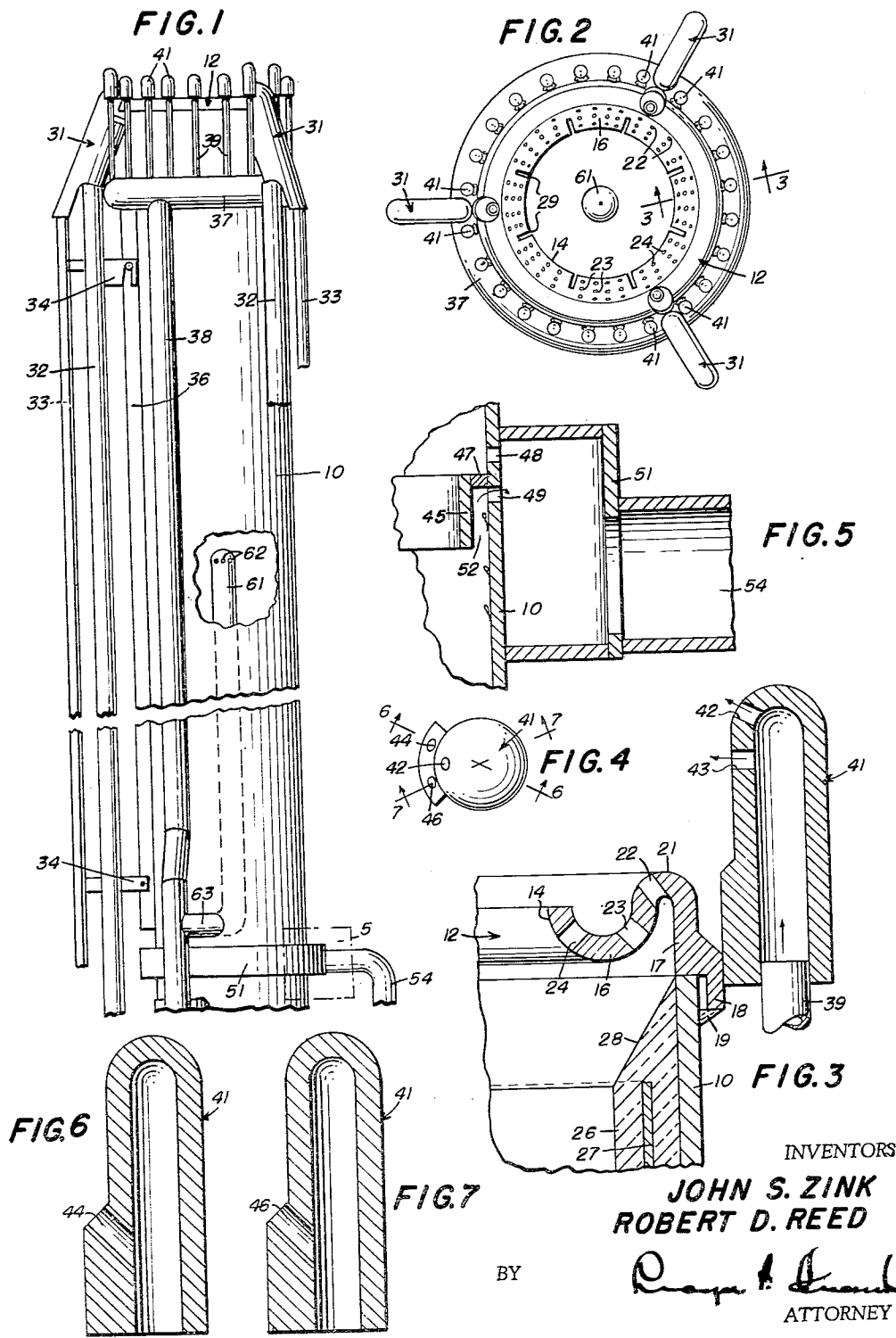
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FLARE STACK GAS BURNER ASSEMBLY

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3,134,424
FLARE STACK GAS BURNER ASSEMBLY
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The present invention relates to a burner structure for gases which are released from chemical or petroleum plants where hydrocarbons and other inflammable materials are handled and processed and such structures are often referred to as flare stack burners which function to provide for the combustion of gases at significant elevations above the surrounding terrain. The invention pertains to improvement in the flare stack burner disclosed in the Zink and Reed Patent 2,779,399.

An object of the present invention is to provide improvements in the tip structure of such a flare stack burner so as to shield the kindling ports and the main discharge opening from wind currents which sweep over the upper end of the stack structure to reduce the tendency of air to enter the kindling ports and the main discharge opening when the pressure within the upper portion of the stack is below that exteriorly thereof as developed at the upwind side of the stack structure to cause burning of the gas within the upper end stack.

Another object of the invention is to provide improvements in the distribution of steam into the presence of the gas flowing from the main discharge opening and to provide steam dispersion means which sets up a barrier moving at high velocity and which intercepts any gas that is driven by the wind after it escapes from the stack and turns such gas back towards the axis of the burner and to provide steam distribution means which will serve to suppress smoke with smaller quantities of steam.

Another object of the invention is to provide means within the upper end portion of the flare stack protecting the metal of which the flare stack is formed from corrosive attack and to provide guide surfaces on such protective means directing a portion of the gas to a position for escape through the kindling ports.

A further object of the invention is to provide means on the flare stack burner assembly for the entrapment and removal of condensed combustible materials as they tend to creep upwardly along the inner surface of the stack structure and to prevent such materials from reaching the burner tip and thereby avoid the development of coke or carbon at the burner tip.

Other objects and features of the invention will be appreciated and become apparent to those skilled in the art to which the invention pertains as the present disclosure proceeds and upon consideration of the accompanying drawing and the following detailed description wherein an embodiment of the invention is disclosed.

In the drawing:

FIG. 1 is a fragmentary side elevational view of a flare stack burner assembly exhibiting the invention.

FIG. 2 is a plan view.

FIG. 3 is an enlarged fragmentary sectional view taken on the line 3—3 of FIG. 2.

FIG. 4 is a plan view of one of the steam distribution devices.

FIG. 5 is an enlarged section taken in the area indicated at 5 in FIG. 1.

FIG. 6 is a sectional view of a nozzle taken on the line 6—6 of FIG. 4.

FIG. 7 is a sectional view of the same nozzle taken on the line 7—7 of FIG. 4.

Referring to the drawing there is shown at 10 a tube which is adapted to be erected in a substantially vertical

position so that the upper end thereof is positioned above any adjacent buildings or the like and at a significant elevation above the surrounding terrain. The tube 10 may be formed of sections and the stack structure may be of any desired height. Auxiliary elements of the assembly are mounted on the tube 10 which may be maintained in an erect position by suitable bracing. The gas such as dump or waste gases are supplied into the lower end of the tube 10 and moved upwardly therein.

One of the features of the invention pertains to the structure at the upper end of the tube 10 for the escape of the gas and the arrangement and disposition of the kindling ports. This structure forms a burner tip indicated at 12 and the structural characteristics thereof will be appreciated upon consideration of FIGS. 2 and 3. The burner tip is in the form of an annular member having a relatively large central opening 14 defined by the inner edge of a web 16 having an undulating shape as viewed in section. The annular member includes a depending flange 17 having an inner diameter substantially flush with the inner surface of the tube 10. An offset ferrule 18 carried by the flange 17 extends below the upper end of the tube 10 in surrounding relationship and may be welded to the tube 10 as indicated at 19 in FIG. 3.

The depending annular flange 17 merges with the web 16 to provide an annular lip 21 which is convex shaped as viewed in section and constitutes the most elevated extremity of the burner tip. A row of discharge ports 22 are provided in the web 16 as shown in FIG. 2 and the exit ends of the discharge ports 22 terminate immediately below the annular lip 21 as shown in FIG. 3. The axis of each discharge port 22 is disposed at an angle of approximately thirty degrees with respect to the vertical. A second row of discharge ports 23 and a third row of discharge ports 24 extend through the web 16. The exit ends of the discharge ports 23 and 24 terminate at the upper surface of the undulating web and within an annular concave recess which is below the annular lip 21. The discharge ports 22 and the discharge ports 23 and the discharge ports 24 are all protected from wind currents by the annular lip 21 regardless of the direction at which wind induced air currents move over the upper end of the flare stack and the tendency of wind driven air to be forced into kindling ports is reduced to a minimum. The axis of the discharge ports 23 are desirably disposed at an angle of approximately forty-five degrees with respect to the vertical and the axis of the discharge ports 24 are disposed at a similar angular relationship. The axes of the ports 23 and 24 converge toward each other in proceeding upwardly. The exit end of the opening 14 for the escape of the major portion of the gas is below the annular lip 21.

A ceramic lining 26 is provided within the tube 10 covering the upper inner surface of the tubular structure. The ceramic liner may be held in position by suitable retaining means 27 which is anchored at spaced intervals (not shown) to the tube 10. The upper end of the ceramic liner 26 is chamfered as indicated at 28 to permit the gas to move to all of the kindling ports and in quantity sufficient to maintain kindling combustion around the perimeter of the burner tip 12. The web 16 is provided with radially disposed slots 29 (FIG. 2) circumferentially spaced therearound to allow expansion and contraction of the burner tip structure as a consequence of temperature changes. The slot arrangement permits movement of one segmental portion of the burner tip structure 12 with respect to other portions in response to a high localized temperature.

A plurality of pilot burners 31 are arranged at circumferentially spaced location adjacent the upper end of

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the flare stack assembly. The pilot burners 31 may be of the type disclosed in the Zink Patent 2,869,631 and have their upper ends directed inwardly to ignite the gas escaping through the main central opening 14 and through the kindling ports. Each pilot burner is supplied with a mixture of gas and air through a pipe 32 and each pilot burner is provided with a flame front pipe 33. The pilot burners are supported by these pipes which are in turn secured to the stack structure by means of brackets attached to vertically disposed ribs 36. The pilot burners 31 are of the type which burn stably in varying weather conditions.

An annular conduit 37 surrounds the tube 10 near the upper end thereof and may be supported on the stack structure in any suitable manner. This annular conduit is supplied with steam through a tube 38 so that it serves as a steam manifold. A plurality of pipes 39 extend upwardly from the manifold at circumferentially spaced locations. A nozzle structure 41 is carried by the upper end of each pipe 39 and in open communication therewith. Each nozzle is provided with a plurality of discharge apertures as shown in FIGS. 3, 4, 6 and 7. The axis of each discharge aperture 42 and 43 is disposed in a radial direction towards the axis of the tube 10. The axis of the aperture 43 is in a horizontal plane whereas the axis of the aperture 42 is inclined upwardly in proceeding to the exit end at an angle of approximately thirty degrees with respect to the horizontal. Two additional steam discharge apertures 44 and 46 are provided in a lower portion of each nozzle 41. The axis of each of these apertures 44 and 46 is inclined to the vertical at an angle of about forty-five degrees. The axes of the apertures 44 and 46 diverge from each other in proceeding away from the nozzle at an included angle of approximately thirty degrees as shown in FIG. 4.

The majority of the steam nozzles 41 are located at the same elevation and with the exit ends of the apertures 44 and 46 substantially at the level of the uppermost extremity of the annular lip 21 as shown in FIG. 3. The steam nozzles 41 at each side of each pilot burner 31 are disposed at a higher elevation so that the pilot burners are not affected by the low pressure zone developed adjacent the steam nozzles as a consequence of the discharge of the steam at a high velocity. The nozzles 41 immediately adjacent the pilot burner 31 are positioned thereabove so that stable operation of the pilot burners is retained.

If the gas to be burned is a hydrocarbon having molecular weight in excess of fifty there is a tendency for such gaseous materials to go to the dew-point along the inner surface of the tube 10. If such a hydrocarbon moves upwardly in the stack the burner tip structure 12 is "wetted" with the hydrocarbon causing the formation of coke or carbon. This tends to obstruct the kindling ports and if the accumulation of the coke is great enough it may break away and fall to the ground while burning. The structure shown in FIGS. 1 and 5 is for the purpose of preventing this undesired condition and a ring 45 is mounted within the tube 10 and it has an inner diameter smaller than that of the tube 10. A baffle 47 supports the ring 45 and closes the upper end of the annular area between the exterior of the ring 45 and interior of the tube 10. A row of holes 48 is provided through the wall of the tube 10 above the baffle 47. Another row of holes 49 is provided through the wall of the tube 10 below the baffle 47. The area of the opening within the ring 46 is less than the area of the tube 10. Thus the flow of any given quantity of gas through the tube 10 provides a pressure below the ring 45 which is greater than the pressure thereabove. There is communication between these two pressure zones through the openings 49 and the interior of an annular housing 51 and through the openings 48. The ring 45 also provides an annular depending lip below the baffle 47 and droplets moving upward along the inner surface of the tube 10 will enter the annular

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space 52. These droplets are thus delivered into the chamber within the annular housing 51 and are returned to a grade level through a pipe or conduit means 54. This structure provides the advantage of entrapment of the condensate without the disadvantage of excessive pressure drop within the flare stack.

Steam may be supplied into the presence of the gas within the flare stack. A pipe 61 extends upwardly along the axis of the tube 10. It is provided with a nozzle having discharge apertures 62 therein. The pipe 61 is supplied with steam from the main supply pipe 38 through a conduit connection 63 which extends through the side wall of the tube 10. The discharge apertures 62 are preferably arranged with their axes disposed to discharge the steam in radial directions substantially at right angles to the axis of the tube 10. The steam supplied to the gas below the burner tip 12 is for the purpose of injecting quantities of steam in addition to those quantities which is possible to inject from the nozzles 41. The discharge apertures 62 may have their axes inclined upwardly in proceeding outwardly from the nozzle without materially altering the quantity of the steam injected into the gas prior to its release from the tip structure 12.

In operation gas supplied into the lower end of the tube 10 moves upwardly and is guided for discharge through the main opening 14. Some of the gas by reason of the chamfered end 28 of the ceramic lining 26 moves into position for escape through the kindling ports 22 and 23 and 24. The extremity of the web 16 defining the main central opening 14 is disposed below the annular lip 21 and the exit ends of all of the kindling ports are disposed below the annular lip 21. Thus even when there is a small volume of gas moving upwardly in the tube 10 the tendency of air at wind induced pressures to enter the main central opening 14 and the kindling ports is reduced and burning inside the burner tip is virtually eliminated. The ceramic lining 26 protects the metal structure of the tube 10 adjacent the upper end of the stack in the event there is some burning of gas within the upper end of the stack structure.

The steam supplied into the pipe 38 passes into the manifold 37 and is distributed to the steam nozzles 41. Each nozzle 41 is provided with four discharge apertures and they discharge the steam in different directions. The steam escaping through the apertures 42 and 43 is discharged radially inward in two directions to the center of the gas stream. The steam escaping through the discharge apertures 44 and 46 in the lower portion of each nozzle portion 41 is discharged upwardly at an angle of approximately forty-five degrees with respect to the vertical and at an angle of approximately fifteen degrees to either side of a radial line which intercepts the center of the tube 10 and the axis of the associated nozzle 41. This angular discharge of the steam causes entry of the steam into outer portions of the stream of gas escaping through the central opening 14. Thus both the center of the stream of gas and the outer portions of the stream of gas receive direct injection of steam. The steam escaping through the discharge apertures 44 and 46 is at high velocity and sets up an annular barrier which moves at high velocity and converges inwardly towards the stream of gas flowing from the central opening 14. This steam barrier intercepts any gas that may be driven by the wind and forces the gas back towards the center of the stream of gas flowing from the main discharge opening 14.

While the invention has been described with reference to a particular type of stack structure and burner assembly it will be appreciated that changes may be made in the overall organization as well as in the various elements. The steam supplying equipment may be omitted and the flame retention characteristics of the burner tip function to maintain ignition even when there is a high discharge velocity of the gaseous medium. Such and other modifications may be made without departing from

the spirit and scope of the invention as set forth in the appended claims.

What we claim and desire to secure by Letters Patent is:

1. In a flare stack burner, an elongated vertically disposed tube for guiding a gaseous medium upwardly therein, a burner tip including an annular flange supported on the upper end of said tube, said burner tip including a generally horizontally disposed web extending inwardly from said flange, said web having an undulating shape viewed in section providing an annular concave recess at the upper face thereof, said web at its inner extremity defining a central opening for the escape of the gaseous medium, said undulating web having a plurality of annular rows of kindling ports therethrough with exit ends thereof within said annular recess discharging minor quantities of said gaseous medium upwardly around said central opening, inner rows of said kindling ports converging towards each other providing for impingement of the gaseous medium flowing therefrom above the exit ends thereof with the resultant streams moving substantially parallel to the gaseous medium escaping through said central opening, the axes of an outer row of said kindling ports converging towards an extension of the axis of said central opening, and said flange where it merges with the perimeter of said web providing an annular lip disposed at a greater elevation than exit end of said central opening and the exit ends of said kindling ports.

2. In a flare stack burner, an elongated vertically disposed tube for guiding a gaseous medium upwardly therein, a burner tip structure including a vertically disposed annular flange supported on the upper end of said tube, a generally horizontally disposed web extending inwardly from said flange, said web having a central opening therein for the escape of the gaseous medium, said web having annular rows of kindling ports therethrough discharging minor quantities of said gaseous medium upwardly around said central opening, said flange where it merges with the perimeter of said web providing an annular lip disposed at a greater elevation than exit end of said central opening and the exit ends of said kindling ports, a plurality of nozzles arranged in circumferentially spaced relationship around the burner tip structure, means for supplying steam into said nozzles, each nozzle having a plurality of discharge apertures at different vertical locations above said annular lip discharging steam radially inwardly towards the axis of the tube, and each nozzle having additional discharge apertures substantially at the level of said annular lip discharging steam upwardly and inwardly in angular relationships to a radius of said central opening which intersects each nozzle.

3. In a flare stack burner, an elongated vertically disposed tube for guiding a gaseous medium upwardly therein, a burner tip structure including a vertically disposed annular flange supported on the upper end of said tube, a generally horizontally disposed annular web extending inwardly from said flange, said web having an annular concave recess at the upper face thereof, said web at its inner extremity defining a central opening for the escape of the gaseous medium, said web having kindling ports therethrough discharging minor quantities of the gaseous medium upwardly around said central opening, said flange where it merges with the perimeter of said web providing an annular lip disposed at a greater elevation than exit end of said central opening and the exit ends of said kindling ports, a ceramic layer covering the inner surface of the upper end portion of said tube, and said ceramic layer being chamfered adjacent the upper end of the tube facilitating flow of the gaseous medium to said kindling ports.

4. In a flare stack burner, an elongated vertically disposed tube for guiding a gaseous medium upwardly there-

in, a burner tip structure including a vertically disposed annular flange supported on the upper end of said tube, a generally horizontally disposed web extending inwardly from said flange, said web having a central opening therein for the escape of the gaseous medium, said web having annular rows of kindling ports therethrough discharging minor quantities of said gaseous medium upwardly around said central openings, said flange where it merges with the perimeter of said web providing an annular lip disposed at a greater elevation than exit end of said central opening and the exit ends of said kindling ports, a plurality of nozzles arranged in circumferentially spaced relationship around the burner tip structure, means for supplying steam into said nozzles, each nozzle having a plurality of discharge apertures at different vertical locations discharging steam radially inwardly towards the axis of the tube, each steam nozzle having additional discharge apertures substantially at the level of said annular lip discharging steam upwardly and inwardly, an interior nozzle within said tube below the upper end thereof and positioned substantially at the axis of said tube, said interior nozzle having apertures therein with their axes disposed substantially at right angles to the axis of said tube, and means for supplying steam into said interior nozzle for discharge through said apertures in directions generally transversely of the movement of the gaseous medium within said tube.

5. In a flare stack burner, an elongated vertically disposed tube for guiding a gaseous medium upwardly therein, a burner tip including an annular flange supported on the upper end of said tube, said burner tip including a generally horizontally disposed web extending inwardly from said flange, said web having an undulating shape viewed in section providing an annular concave recess at the upper face thereof, said web at its inner extremity defining a central opening for the escape of the gaseous medium, said undulating web having annular rows of kindling ports therethrough with exit ends thereof within said annular recess, said flange where it merges with the perimeter of said web providing an annular lip disposed at a greater elevation than exit end of said central opening and the exit ends of said kindling ports, and said web having radially disposed slots accommodating temperature changes in the tip.

6. In a flare stack burner, a vertically disposed tube having an annular wall for guiding a gaseous medium upwardly therein, a burner tip structure supported at the upper end of said tube, means carried by the burner tip structure for maintaining ignition of the gaseous medium discharged through the burner tip structure, a ring providing an annular constriction within said tube reducing the cross section thereof including baffle means supporting the ring on said tube, said ring having a lip extending below the baffle means and providing an annular space between the exterior of the ring and the interior of the tube, said tube having holes through said wall below and above said baffle means, a housing surrounding the exterior of the tube encasing said openings, and conduit means in communication with said housing extending downwardly therefrom.

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