Jan. 29, 1957 J. S. ZINK ET AL 2,779,399

FLARE STACK GAS BURNER

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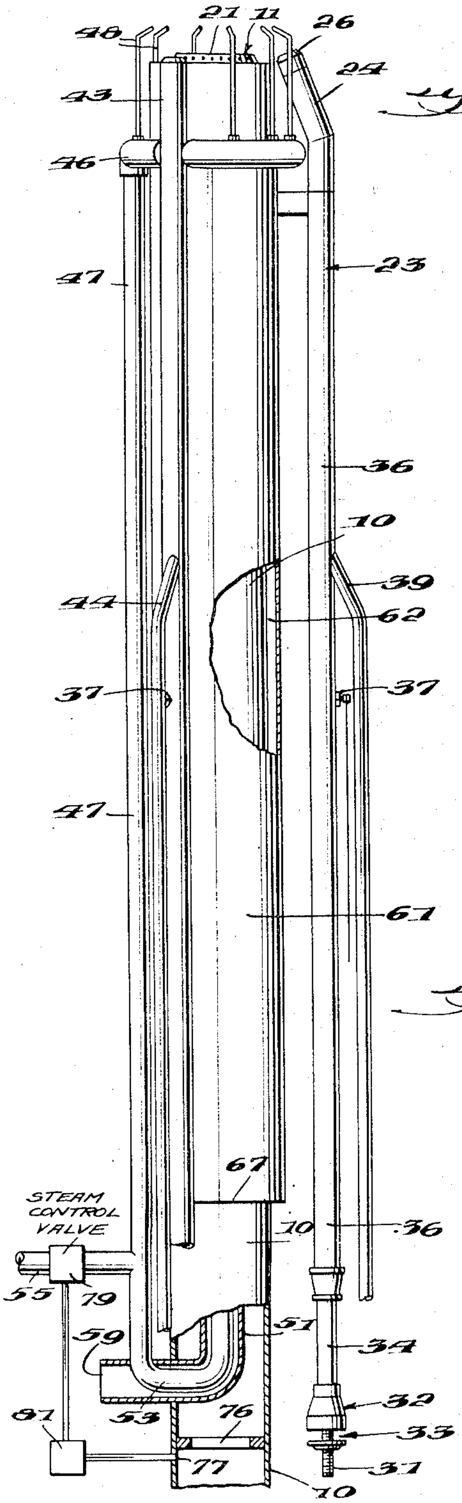
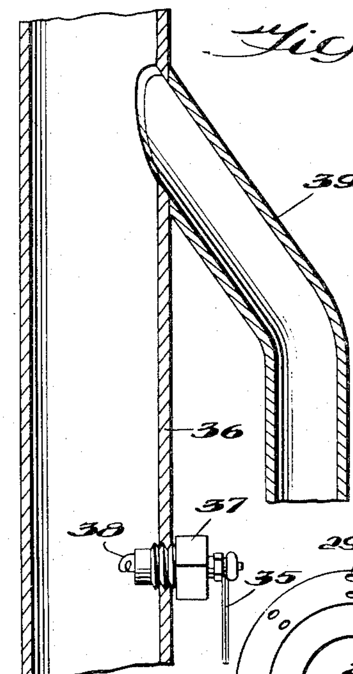


Fig. 1.

Fig. 4.



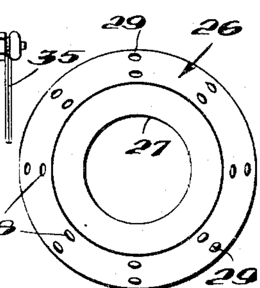
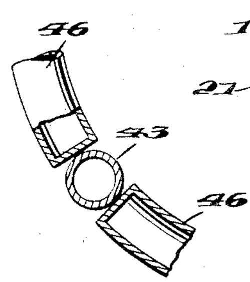
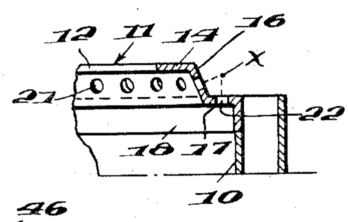


Fig. 8.

Fig. 5.

Fig. 6.





INVENTORS
JOHN S. ZINK,
ROBERT D. REED,

BY [illegible]

ATTORNEY

FLARE STACK GAS BURNER

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Fig. 2.

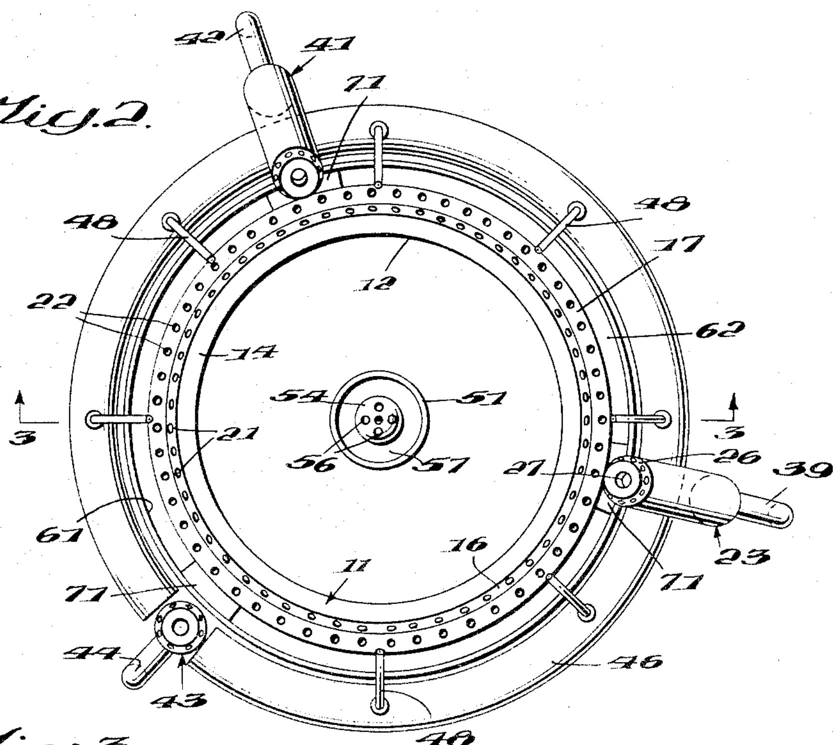
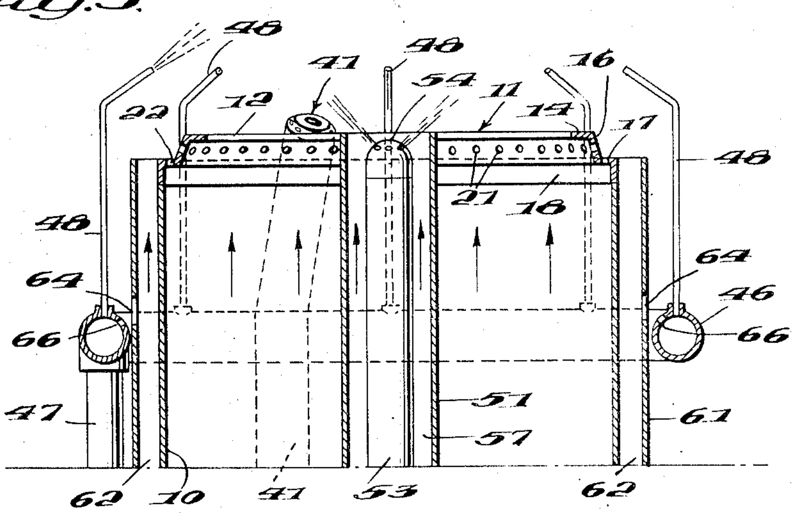


Fig. 3.



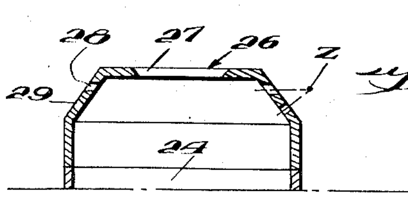


Fig. 7.

INVENTORS
JOHN S. ZINK,
ROBERT D. REED,
BY
Lloyd P. Shank
ATTORNEY

United States Patent Office

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FLARE STACK GAS BURNER

John S. Zink and Robert D. Reed, Tulsa, Okla., assignors, by direct and mesne assignments, to John Zink Company, Tulsa, Okla., a corporation of Delaware

Application February 29, 1952, Serial No. 274,142

10 Claims. (Cl. 158—115)

The present invention relates to a burner structure for dump-gases often referred to as flare stacks for use in connection with the petroleum industry and chemical plants where hydrocarbons and other inflammable raw materials are handled or processed and at intervals excessive quantities of combustible gases must be disposed of by burning.

In recent years and because of anti-smoke ordinances in effect in many communities such industries have been confronted with the necessity of burning huge volumes of inflammable materials without smoke. The combustion of such dump-gases is desirably accomplished in the atmosphere and in such a manner as to avoid the escape of unburned materials. The combustion must also take place under extremely stable conditions and the apparatus should be such as to avoid extinguishment of the burning operation as a result of wind currents or other factors to remove the possibility of releasing toxic or inflammable gases into the atmosphere. The burner structure must also meet the requirement for quickly purging the manufacturing equipment of the materials being processed under emergency conditions such as power or utility failure. Under such circumstances, the materials being processed must be rapidly burned and the combustion must take place in such a manner that there must be no escape of any unburned material.

Earlier devices for burning such materials have not been entirely successful. They have been almost prohibitively expensive from the standpoint of original cost and the operating costs in order to provide smokeless combustion has been extremely high. The prior equipment for consuming dump-gases has deteriorated rapidly in service as a result of the fantastically huge quantities of heat released by the burning gases and the high temperature conditions existing in the burning zone. Many of the devices employed in the past have been designed around the use of heat-resistant metals lined with refractory materials to protect the parts where combustion takes place. Wind currents tend to extinguish the burning of the gases in prior burners so as to render their operation generally unsatisfactory since the extinction of the flame is hazardous. The extinction hazard has resulted in the design of prior waste gas burners so as to discharge the gases for burning at a very low velocity to avoid the phenomena of "blowoff" associated with the discharge of gases for burning at substantial velocities. The low velocity discharge allows the burning gases to be blown by wind currents and the flame is often blown back onto the flare stack structure to further overheat the parts and promote deterioration. On the downwind side of the flare stack structure a low pressure area is set up by wind currents and the flame from the burning of gases is accordingly drawn into the low pressure zone to further accelerate overheating and destruction of the burner parts.

An object of the present invention is to provide a flare stack burner for dump-gases which is capable of burning large volumes of inflammable gases in the presence of

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wind currents and to provide a burner wherein the waste gases are burned so completely as to be smokeless and to provide a burner wherein the gases are discharged at a relatively high velocity without the loss of ignition to thereby prevent the return of the flame to parts of the flare stack structure and accordingly avoid rapid destruction of the burner parts.

Another object of the invention is to discharge the dump-gases at a relatively high velocity so that the kinetic energy of the discharged gas draws secondary air into the combustion zone so as to create a condition of turbulence to assist in the mixture of air with the burning gases to thereby reduce the production of smoke.

A further object of the invention is to move the waste gases from the burner at such a high velocity as to avoid cracking of the hydrocarbons and the consequent delay in combustion which provides for the production of free carbon from the hydrocarbons being burned and the release of free carbon which produces smoke.

Another object of the invention is to provide a plurality of pilots in association with a flare stack for burning dump-gases to insure ignition of the flare gas regardless of the wind direction and in the absence of a shield between the wind and the flare gas tip.

A more detailed object of the invention is to provide a plurality of small converging high velocity streams of gases at circumferentially spaced points around a flare gas stack burner tip and in sufficient quantity so as to continue to burn despite the effects of wind and a high velocity of the discharged dump-gases and to provide burner structures around the pilots so as to maintain ignition of the pilot gas mixtures to thereby maintain ignition of the flare gas at the main burner tip.

A still further object of the invention is to provide means for the discharge of dump gases at substantially high velocities without loss of ignition in combination with means for injecting a mixture of steam and air at a plurality of points into the gas stream in combination with a plurality of pilots to assure ignition of the flare gas regardless of the wind direction so that the water vapor provided by the steam combines with the incandescent carbon of the dump-gases to form carbon monoxide and hydrogen both of which burn smokeless and thereby promote the production of smokeless burning of the flare gases.

A still further object of the invention is to provide means for controlling admission of steam to the presence of the gases being burned in accordance with the volume of the dump-gases being supplied to the burner.

Other objects and features of the invention will be appreciated and will be more apparent to those skilled in the art as the present disclosure proceeds and upon consideration of the accompanying drawings and the following detailed description wherein a typical embodiment of the invention is disclosed.

In the drawings:

Fig. 1 is a side elevational view partly in section showing the upper end portion of a flare stack burner embodying the invention.

Fig. 2 is a plan view on a larger scale.

Fig. 3 is a sectional view of the upper end portion of the burner structure taken on the line 3—3 of Fig. 2.

Fig. 4 is an enlarged fragmentary sectional view of one of the ignition devices and a portion of the tube structure for one of the pilots.

Fig. 5 is a sectional view of one of the pilot tubes and adjacent portions of the steam manifold.

Fig. 6 is a fragmentary sectional view of the upper end of the main gas burner tip on an enlarged scale.

Fig. 7 is an enlarged sectional view of one pilot burner tip.

Fig. 8 is a plan view of the pilot burner structure shown in Fig. 7.

A flare stack tube is shown at 10 which is adapted to be erected in a substantially vertical position so that the upper end thereof is arranged above the height of the neighborhood buildings or the like. Auxiliary parts are mounted on the tube 10 which may be maintained in an erect position in any suitable manner. The dump-gases or waste gases are supplied into the lower end of the pipe 10 and move upwardly therein. A main gas burner tip 11 is mounted at the upper end of the flare gas tube 10. The structure of the dump-gas burner tip is more clearly shown in Figs. 2, 3 and 6 and is in the form of an annular member having a relatively large central opening 12 defined by the inner edge of a horizontal flange 14. A frustro-conical wall 16 extends downwardly from the periphery of the horizontal flange 14. A further horizontal flange 17 and a depending skirt 18 complete the main burner tip which is secured to the upper end of the flare gas tube 10. The annular member 11 is preferably formed of heat resistant metal.

A plurality of circumferentially spaced discharge openings 21 are provided in the conical wall 16. A series of similarly circumferentially spaced discharge openings 22 are provided in the horizontal flange 17. The openings 21 and the openings 22 are in radial alignment as shown in Fig. 2. The axis of each opening 21 is such that the gas issuing therefrom impinges on the jet of gas issuing from each of the openings 22 at a point indicated at X in Fig. 6. Such a confluence of the gas jets takes place throughout the circumference of the burner tip 11. The dump-gases moving through the relatively large central opening 12 at a high velocity upon being ignited is surrounded by stably burning gas which is discharged through the ports 21 and 22 so that the main stream of gas continues to burn despite the effects of wind currents passing over the burner tip and despite the high velocity of the escaping flare gas. In other words the inductive effect of the large stream of gas flowing through the central opening 12 draws the flames from the gas burning after emergence from the angularly disposed ports 21 and 22 into the main stream flowing through the central opening. Thus super-heated gas the temperature of which is substantially above the kindling point of the dump-gas is drawn into the dump-gas flowing through the central opening. Thus permanence of ignition and complete burning of the dump-gas takes place despite any radiation from the main flame as a result of the wind currents and regardless of the unusually high velocity of the discharge of the gas through the main central opening 12 and despite rain or a heavy water spray directed onto the burner tip.

Another feature of the invention provides for insured ignition of the dump-gases to be burned upon release from the flare stack. A plurality of pilots are circumferentially spaced around the main or dump-gas burner tip 11 so as to maintain ignition in case of interruption of the flame of the flare burner. A circumferential disposition of the pilots insures re-ignition and initial ignition regardless of the direction of the wind in relation to the flare stack. One of the pilots is shown at 23 which includes a relatively long pipe extending upwardly along the flare stack as shown in Fig. 1. The upper end portion 24 is angularly disposed so that the pilot tip 26 is directed inwardly towards the flare burner tip 11. The tip 26 for the pilot is shown more clearly in Figs. 7 and 8 and is provided with a relatively large central discharge orifice 27. A series of circumferentially spaced ports 28 are arranged in the conical wall of the burner. An equal number of discharge ports 29 are provided in the conical wall. The axes of the ports 28 are arranged perpendicularly to a central axis of the main opening 27. The axes of the ports 29 are arranged at an acute angle with reference to the axis of the orifice 27 so that the jets of gas discharged from the ports 28 and 29 will intermingle at Z in Fig. 7.

A mixture of gaseous fuel and air is supplied into the lower end of the pilot structure and the main portion of the fuel flows through the central orifice 27. Upon ignition the flame developing by the fuel discharged through the orifice 27 draws the fuel after emergency from the ports 28 and 29 into the main stream. Thus super-heated gases supplied at temperatures above the kindling point of the fuel are drawn into the main flame to maintain kindling of the pilot. The structure of the pilot tip 26 is based on the theory that a high velocity stream of gas surrounded by stably burning gases in sufficient quantities will tend to burn despite the relatively high velocity of the fuel issuing from the pilot.

The pilot 23 is supplied with gaseous fuel and connected to a suitable source by a pipe connection 31. The gas is discharged into a mixing device 32 wherein primary air enters in the direction of the arrow 33. A short pipe 34 of relatively small diameter extends from the gas mixing device 32 and is connected to the larger diameter pipe 36. The pipe 36 provides a materially larger cross sectional conduit for the gaseous-air-mixture between the mixing device 32 and the pilot tip 26 where combustion takes place. The pipe 36 avoids the possibility of any linear pressure drop in the conduit guiding the gaseous-air mixture to the pilot burner tip and the mixing device 32 is located below the top of the flare stack so as to avoid the heat developed by the dump-gas burner.

One arrangement for igniting the fuel mixture in the pilot tube structure includes an electrically heated glow-plug 37 (Fig. 4) provided with a filament 38 which may be rendered operable by low voltage supplied through the conductor 35. The glow-plug 37 is mounted in and grounded to the wall of the pipe 36 at an intermediate position in its length and is thus removed from the heat developed at the upper end of the flare gas burner. Another advantage of the glow-plug is that it has a long operating life and may be energized at all times to insure reignition. The glow-plug is capable of igniting the gas and air mixture within a period of about ten seconds after the gaseous air mixture flows upwardly in the pipe 36. Thereafter the cooling action of the fuel mixture reduces the temperature of the glow-plug filament 38 below the kindling temperature of the fuel but the cooling action of the gas and air mixture prolongs the life of the glow-plug.

It is common practice in the operation of the dump-gas burning devices to pay little attention to the apparatus after it is in operation. Under ordinary circumstances, the failure of the pilot gas supply will extenguish the pilot without the extinction being noted which is a serious hazard in dump-gas burners. Under such circumstances an interruption fo the flow of the gas and air mixture over the glow-plug 37 will result in the filament 38 being heated to a high temperature. Thus if the flow of gas is reduced for a few seconds the glow-plug 37 regains a sufficiently high temperature to rekindle; when the pilot gas supply is restored the pilot will be immediately rekindled. An important safety feature is thus incorporated in the pilot burner.

Additional means is incorporated in the apparatus for insuring kindling of the pilot. A flame-front tube 39 of relatively small diameter is connected to the pipe 36 as shown particularly in Figs. 1 and 4. This tube is connected to the pipe 36 above the glow-plug and is of such length so as to extend downwardly and terminate near the ground. A gas and air mixture may be supplied into the tube 39 at its lower end and may be ignited by any suitable means when there is a failure of the electrical supply serving the glow-plug 37. The air and gas mixture in the tube 39 may be kindled by means of a blank cartridge or the like fired in the tube 39 so as to cause a burst of flame to occur in the gas-air mixture in the lower end portion of the tube **39**. Once kindled the flame moves at a relatively high speed through the tube **39** to its upper end where it enters the pipe **36** and kindles the air-gas mixture in the pilot pipe **36**. It will be observed that the small tube **39** functions to kindle the gas-air mixture in the pipe **36** at a substantial distance from the zone where the dump-gas is being burned. Thus heat-damage to the tube **39** is avoided and kindling of the pilot flame is assured regardless of wind conditions and because the pilot gas mixture is kindled inside the pipe **36** where external factors, such as wind, water, or the like have no influence on the ignition of the air-gas mixture.

A plurality of pilots of the type described in connection with the pilot designated at **23** are employed in connection with the main burner. Another of such pilot structures is indicated at **41**. The pilot **41** includes a flame front tube **42** to provide auxiliary ignition of the gas-air mixture for the pilot **41** in the event of an electric supply failure. The burner tip for the pilot **41** is similar to that shown in Figs. 7 and 8. Another pilot of the type previously described is shown at **43**. The pilot **43** does not turn inwardly at its upper end but is substantially straight throughout its length. The burner tip at the upper end of the pilot **43** is constructed and arranged like that shown in Figs. 7 and 8. The pilots are equally spaced about the circumference of the main burner.

Another feature of the invention pertains to the introduction of a smoke retardant such as steam and air into the dump-gas stream discharged from the upper end of the flare gas tube **10**. A manifold **46** surrounds the flare-gas burner near the upper end thereof as shown in Fig. 1. Steam is supplied to the manifold through a conduit **47** which extends upwardly along the flare stack structure and is connected to the manifold **46**. A plurality of nozzles **48** are in open communication with the manifold **46** and extend vertically therefrom to positions above the discharge end of the main burner tip. The nozzles **48** then extend inwardly at angles to the vertical. The nozzles **48** discharge steam radially inwardly into dump-gas flame. The jets of steam entrain large volumes of air which is mixed with the steam. The steam and air mixtures move at relatively high velocity as they enter the flare-gas. A mixture of dump-gas and the smoke retardant material is thus produced. The steam and air contains substantial quantities of water vapor which combines with the incandescent free carbon in the flame to produce carbon monoxide and hydrogen both of which burn with a smoke free flame.

In order for the smoke retardant to properly serve its purpose it is necessary for the jets of steam and air to thoroughly permeate to the dump-gas escaping through the opening **12**. The upward velocity of the dump-gas stream tends to turn the jets of steam and entrained air upwardly after issuing from the nozzles **48**. In order to insure proper penetration of the steam and air into the dump gas means is provided at the center of the flare-gas burner tip **11** for adding steam and air to the central portion of the dump-gas escaping through the opening **12**. A relatively large tube **51** is arranged concentric with the axis of the flare-gas tube **10** as shown in Figs. 2 and 3. The upper end of tube **51** is preferably flush with the flange **14** of the burner tip **11** as shown in Fig. 3. The lower end of the tube **51** is in open communication with the atmosphere below the burning zone as shown at **59** (Fig. 1).

A tubular member **53** is arranged within the tube **51** and supplied with steam from a suitable source such as the supply pipe **55** which feeds the manifold **46**. A tip **54** closes the upper end of the tubular member **53**. A plurality of discharge orifices **56** are provided in the tip **54**. These discharge orifices are at an angle to the axis of the dump-gas stream flowing through the annular space surrounding the tube **51**. Jets of steam are thus discharged from the orifices **56** and pick up air from the annular space **57**. A mixture of air and steam is thus forcibly injected into the dump-gas stream flowing through the annular space between the periphery of the tube **51** and the inner edge of the flange **14** of the main burner. Thus a smoke retardant is introduced into the interior of the gas stream as well as into the exterior and smoke is effectively suppressed.

A sleeve **61** of larger diameter than the tube **10** surrounds the upper end thereof in spaced relation as shown particularly in Fig. 3. The sleeve **61** provides an annular passage **62** between the flare-gas tube **10** and the sleeve **61**. The steam manifold **46** may be mounted in close proximity to the periphery of the sleeve **61**. A plurality of circumferentially spaced openings **64** are provided in the sleeve **61** adjacent the manifold **46**. Discharge openings **66** are provided in the manifold **46** in radial alignment with the opening **64**. Thus small jets of steam issuing from the openings **66** enter the annular space **62** through the openings **64**. These jets are directed upwardly so that the steam and entrained air moves rapidly upward in the annular space **62**. The lower end **67** of the sleeve **61** is in open communication with the atmosphere. Thus the rising currents in the annular passage **62** induces an upward current of air to cool the flare-gas burner structure and the upper portion of the tube **10**. A plurality of baffles **71** are arranged to close the upper end of the annular space **62** adjacent the pilots. These baffles serve to prevent interference with the kindling of the dump-gas by the pilots as a result of air rising in the annular space **62**. The baffles **71** deflect the cooling medium away from the ends of the pilots.

Another feature of the invention pertains to control of the steam supplied to the manifold **46** and to the tubular member **53** in accordance with the volume of the flare-gas moving upwardly in the tube **10**. Such control of the steam also provides for variations in the forced cooling of the burner parts. A reduction in the steam supplied to the manifold **46** reduces the jet action of the steam passing upward into the annular space **62**. An increase in the volume of steam increases the volume of the cooling air. Thus the cooling of the burner parts is varied with the volume and the flare-gas being burned and in accordance with the needs for cooling in accordance with the heat produced by the main gas burner. Any suitable means may be provided for varying the admission of the steam to the conduit **47** and the tubular member **53**. In the embodiment illustrated a restricted orifice **76** (Fig. 1) is provided in the tube **10** so that the gas moving therein creates pressure changes at **77**. The steam supply pipe **55** is provided with a control valve **79** the position of which is controlled by changes in pressure adjacent the area **77** by means of a control mechanism shown diagrammatically at **81**. As the volume of flare-gas increases in the tube **10** the valve **79** is progressively opened. As the volume of dump-gas moving through the restricted orifice **76** decreases the valve **79** is moved to a position to limit the admission of steam to the pipes **47** and **53**.

In operation the dump-gas moving upwardly in the tube **10** escapes through the relatively large central opening **12** in the burner tip **11**. The gas escapes from the burner tip at relatively high velocity. The dump-gas is ignited by the burning gas and air mixture moving upwardly in any one of the pilots **23**, **41** or **43**. The dump-gas escaping through the opening **12** is ignited regardless of the direction of the wind sweeping over the upper end of the flare stack. The gas escaping through the discharge ports **21** and **22** is drawn into the main flame to thereby provide superheated gases surrounding the main flame in spite of the high velocity of the dump-gas and wind currents which would otherwise tend to reduce the kindling temperature. The small ports **28** and **29** surround each of the pilot burner tips and also serve to maintain ignition of the gas and fuel mixture moving upwardly in the pilot pipes. In case of power failure the pilots may be reignited by utilizing the flame front tubes. Steam is admitted to the manifold **46** and the tubular member **53** in accordance with the volume of the dump-gas moving upwardly in the tube 10. Thus the quantity of the steam released by the nozzles 48 and the discharge openings 56 is varied in accordance with the volume of the flare-gas being burned. In a like manner the forced cooling of the burner parts varies in relationship with the volume of dump-gas being burned and in accordance with the need for cooling as required by the amount of heat produced.

While the invention has been described with reference to a particular structural arrangement and various details, changes may be made in the elements as well as alterations in the overall assembly. Such modifications and others 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 apparatus for burning dump-gases, an elongated vertically disposed tube, a burner tip at the upper end of said tube, a plurality of pilots including supply pipes circumferentially spaced around said burner for igniting the dump-gases at the burner tip, a sleeve inside said supply pipes surrounding an upper portion of said tube in spaced relationship to provide an annular passage between the sleeve and the periphery of the tube, said sleeve being in open communication with the atmosphere at its lower end, means creating a forced upward flow of cooling air in said passage, means varying the flow of cooling air in accordance with changes in the volume of the dump-gases being burned, and a plurality of circumferentially spaced baffles closing portions of said annular space with one baffle adjacent each pilot deflecting the cooling air away from the associated pilot.

2. In apparatus for burning dump-gases, an elongated vertically disposed tube, a burner tip at the upper end of said tube, a sleeve surrounding an upper portion of said tube in spaced relationship to provide an annular passage between the sleeve and the periphery of the tube, said sleeve being in open communication with the atmosphere at its lower end, means for injecting steam from a plurality of points into the dump-gases as combustion takes place at the burner tip, means injecting steam into said annular passage to provide for a forced movement of cooling air in said passage, and means controlling the steam admitted to the last two means in accordance with the volume of dump-gases moving upwardly in said tube.

3. In a flare stack burner, an elongated vertically disposed tube for guiding combustible gases upwardly therein for combustion adjacent the upper end thereof, a sleeve surrounding an upper portion of said tube in spaced relationship to provide an annular passage between the sleeve and the periphery of the tube, said sleeve being in open communication with the atmosphere at its lower end, a second tube extending upwardly within the first tube and terminating adjacent the upper end thereof with a lower portion open to atmosphere, a tubular member extending upwardly within said second tube and of smaller diameter providing an annular passage between the periphery of the tubular member and said second tube, and means creating forced upward flow of air within both of said annular passages.

4. In a flare stack burner, an elongated vertically disposed tube for guiding gaseous materials upwardly therein for combustion at the upper end thereof, a sleeve surrounding an upper portion of said tube in spaced relationship to provide an annular passage between the sleeve and the periphery of said tube, a lower portion of said sleeve being in open communication with the atmosphere, a tubular member extending upwardly within the first tube, an upper end of said tubular member being adjacent the upper end of the first tube, means closing the upper end of the tubular member and having discharge orifices therein, means for supplying water vapor under pressure into and upwardly within said annular passage and into said tubular member, and said discharge orifices being positioned to direct the water vapor upwardly and radially outwardly from the upper end of the tubular member.

5. In a flare stack burner, a vertically disposed tube for guiding combustible gases upwardly therein for combustion adjacent the upper end thereof, a tubular member extending upwardly within the first tube, means closing the upper end of the tubular member adjacent the upper end of the first tube and having discharge orifices therein, a plurality of nozzles circumferentially spaced about the upper end of the first tube having end portions directed radially inward with respect to the first tube, and means for supplying water vapor under pressure into said nozzles and into said tubular member for discharge into the gases being burned adjacent the upper end of the first tube.

6. In a flare stack burner, an elongated vertically disposed tube for guiding gases upwardly therein, means igniting said gases for combustion adjacent an upper end of said tube, a manifold embracing said tube adjacent the upper end thereof, a plurality of circumferentially spaced nozzles supported by said manifold in open communication therewith, means for suppyling steam into said manifold for escape through said nozzles, and upper ends of said nozzles extending radially inward with respect to said tube above the upper end thereof to discharge jets of steam from a plurality of points into the gases as combustion takes place at the upper end of said tube.

7. In a flare stack burner, an elongated vertically disposed tube for guiding combustible gases upwardly therein for combustion adjacent an upper end thereof, a sleeve surrounding an upper portion of said tube in spaced relationship to provide an annular passage between the sleeve and the periphery of said tube, said sleeve being in open communication with the atmosphere at its lower end, a manifold embracing said sleeve adjacent an upper end thereof, a plurality of circumferentially spaced nozzles supported by said manifold and in open communication therewith, means for supplying steam into said manifold for escape through said nozzles, upper ends of said nozzles extending radially inward to discharge jets of steam radially inwardly of said tube, said sleeve having a plurality of openings therein adjacent said manifold, said manifold having openings therein for permitting steam to enter said annular passage through said first openings, and said openings being disposed for upward movement of steam in the annular passage.

8. In a flare stack burner, an elongated vertically disposed tube for guiding gaseous mediums upwardly therein for combustion adjacent an upper end thereof, a manifold arranged circumferentially about said tube adjacent an upper end thereof, a plurality of circumferentially spaced nozzles supported by said manifold in open communication therewith, means for supplying steam into said manifold for escape through said nozzles, upper ends of said nozzles extending radially inwardly above an upper end of said tube, and means for controlling the volume of the steam supplied to said manifold in accordance with the volume of gases moving upwardly in said tube.

9. In a flare stack burner, an elongated vertically disposed tube for guiding gaseous mediums upwardly therein for combustion adjacent an upper end thereof, a plurality of circumferentially spaced nozzles supported around an upper end of said tube, means for supplying steam into said nozzles, upper ends of said nozzles extending radially inward above an upper end of said tube, a second tube extending upwardly within the first tube and terminating adjacent the upper end thereof with a lower portion open to atmosphere, a tubular member extending upwardly within said second tube of smaller diameter providing an annular passage between the periphery of the tubular member and the second tube, means closing the open end of the tubular member having discharge orifices therein, means for supplying steam into said tubular member for escape through said discharge orifices, and said orifices being so disposed as to direct the steam radially outward with respect to the first tube.

10. In a flare stack burner, a vertically disposed tube

for guiding gases upwardly therein for combustion adjacent an upper end of said tube, a plurality of circumferentially spaced nozzles supported adjacent the upper end of said tube, means supplying water vapor under pressure into said nozzles for escape therefrom, the ends of said nozzles extending radially inward above the upper end of said tube to discharge jets of water vapor into the gases as combustion takes place at the upper end of said tube, a tubular member disposed within said tube, means in the vicinity of the upper end of said tube closing said tubular member and having discharge orifices therein, means supplying water vapor under pressure into said tubular member, and said discharge orifices directing jets of water vapor radially outward into the gases as combustion takes place adjacent the upper end of said tube.

References Cited in the file of this patent

UNITED STATES PATENTS

160,785	Neff	Mar. 16, 1875
1,561,848	Green	Nov. 17, 1925
2,433,463	Lampe	Dec. 30, 1947
2,480,230	Elster	Aug. 30, 1949
2,537,091	Rodman	Jan. 9, 1951

FOREIGN PATENTS

191,309	Germany	Nov. 5, 1907