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Desty et al.

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[54] FLARE-STACK

[75] Inventors: **Denis Henry Desty**, Weybridge; **Christopher John Young**, Horton, both of England

[73] Assignee: **The British Petroleum Company Limited**, London, England

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[52] **U.S. Cl.** **431/202**, 431/328

[51] **Int. Cl.** **F23d**

[58] **Field of Search** 431/202, 328, 5

[56] **References Cited**

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Primary Examiner—Carroll B. Dority, Jr.

Attorney, Agent, or Firm—Morgan, Finnegan, Durham & Pine

[57] **ABSTRACT**

A flare-stack suitable for burning off waste gases comprises:

a. a honeycomb burner element on supports

b. flare-stack walls projecting vertically upwards from the edges of the burner element, the flare-stack walls and burner element being enclosed by

c. a draught fence around the base of the flare-stack walls. During operation of the flare-stack, air flows through the draught fence, below the flare-stack walls and into the combustion air tubes of the burner.

2 Claims, 4 Drawing Figures

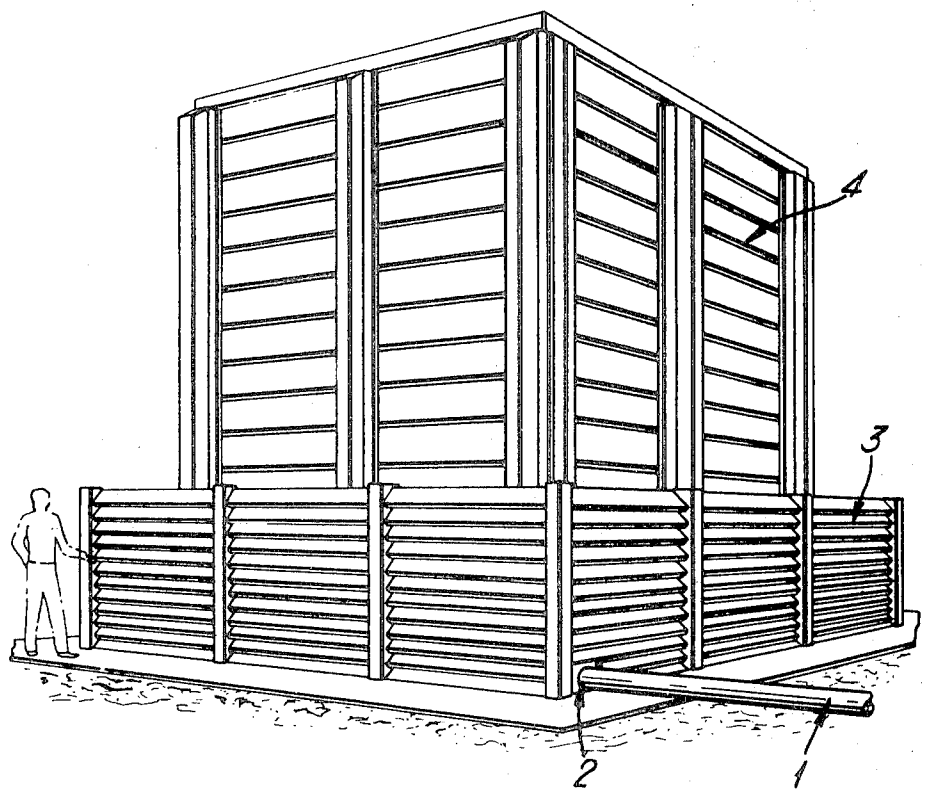
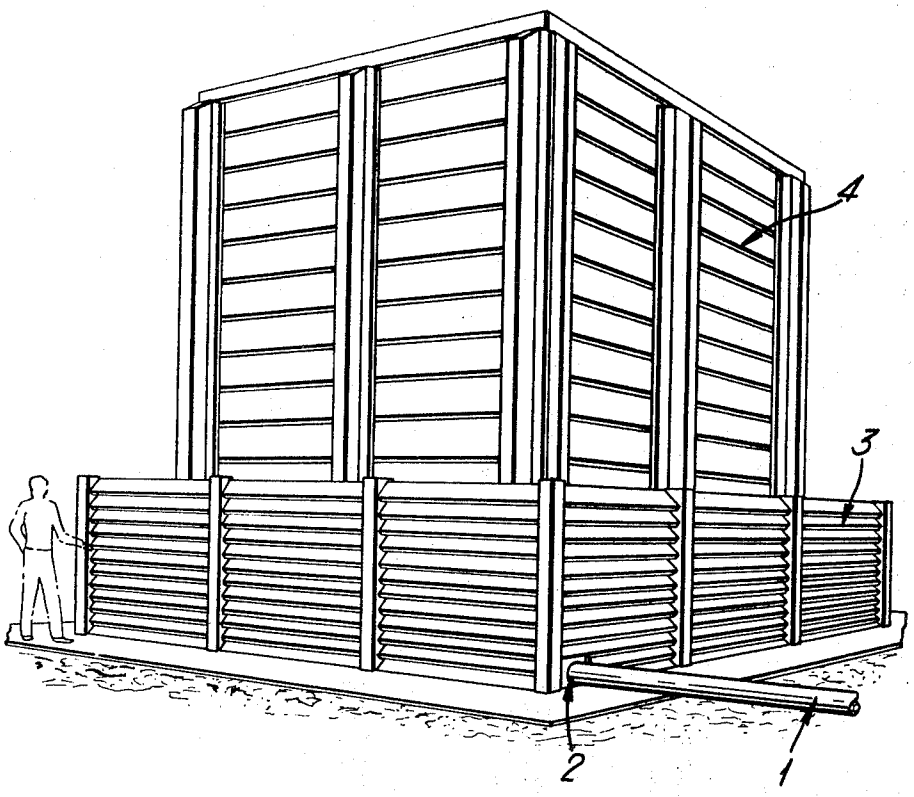


Fig. 1.



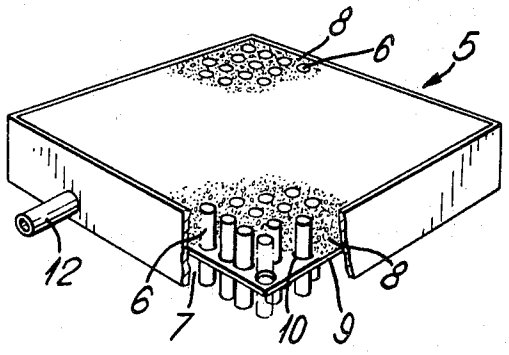


Fig. 2.

Fig. 3.

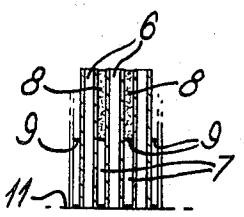
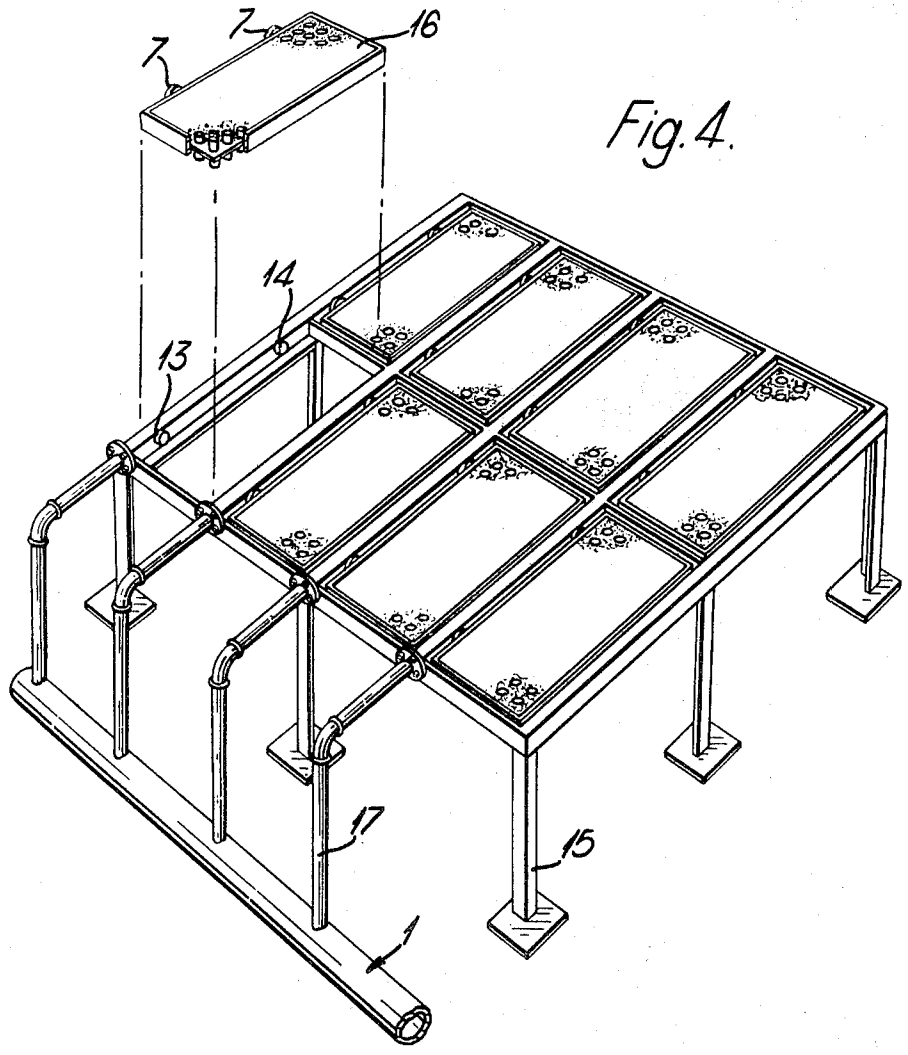


Fig. 4.



FLARE-STACK

This invention relates to a flare stack for disposing of waste combustible gases and in particular relates to the disposal of waste gases from refineries and chemical plant.

In the refining of crude petroleum there are usually produced and/or separated from the oils, gases comprising hydrocarbons e.g. butane, propane. It is not always possible to sell or otherwise make use of these combustible gases at low pressure and it is customary to burn them off in a flare stack. In the case of 'sour' gases, i.e., containing sulphur, ground level flaring is impractical and an elevated flare stack is used to aid the dispersion of any oxides of sulphur that may be formed during combustion.

During emergency flaring, very large quantities of combustible gases, often of the order 200 tons/hour have to be dealt with. It is always desirable and frequently essential, because of legislation, to minimise and if possible to eliminate the amount of smoke emitted by a flare. To reduce the amount of smoke emission under these conditions, steam injection into the flare stack may be used to improve combustion.

A similar problem occurs in oil fields where the oil produced often has associated with it large quantities of hydrocarbon gases. Any excess of gas is dealt with, as in the case of refineries by 'flaring-off' the gas. A suitable flare stack for this purpose is described in our co-pending British Patent application No. 12068/71.

However for steady state flaring of 'sweet gases', factors of cost, and the noise and visibility of the flares render the steam injected flare stacks less suitable for this purpose and it is therefore normal to provide an enclosure for flaring which is mounted at ground level.

According to the invention a burner element for use in a ground fired flare stack comprises a plurality of combustion air tubes adapted to convey combustion air to the combustion zone, each combustion air tube has a cross-sectional area of not less than 1.0 cm^2 where it opens into the combustion zone and the bores of the combustion air tubes account for at least 25 percent of the area adjacent to the combustion zone, the tubes passing through a fuel chamber divided into:

a. a fuel outlet space which communicates with the combustion zone and which contains packing which provides a high resistance to the flow of gaseous fuel, and

b. a fuel inlet space which is adapted for connection to a fuel supply and which contains no packing material so that it provides a low resistance to the flow of fuel, whereby, during the use of the burner, air flows through the combustion air tubes into the combustion zone where it reacts with the fuel which flows through the inlet and outlet spaces and finally into the combustion zone.

Preferably the combustion tubes are of 1 inch diameter and spaced at 1¼ inch separation of centres and of length 4 inches.

The burner element described in the last preceding paragraph has the special property that it can burn a wide variety of gases, e.g., butane, methane and liquids, e.g., liquid petroleum gas, by a diffusion flame mechanism. Also, the low back pressure created by the burner is an advantage in situations where the gas is only available at low pressures.

For gaseous fuels, the fuel outlet space provides a resistance to flow which is high in comparison with the resistance of the unpacked spaces. (This implies that no low resistance channels are left, e.g., around the combustion air tubes in the packed spaces). This high resistance serves to retain gas in the fuel inlet space while even fuel distribution is achieved. The packing is preferably a porous material, e.g., sand whose particle size and particle density is such as to produce the required high resistance to fuel flow.

The packing is conveniently supported on a plate which extends across the fuel chamber and which plate permits passage of fuel. Examples of such plates include gauzes, perforated plates and plates which provide an annular fuel passage around each of the combustion air tubes. In certain cases the packing may have sufficient mechanical cohesion to render the use of a plate unnecessary.

The invention also includes a gaseous fuel burner element as described above which also incorporates one or more pilot tubes which terminate in the fuel outlet space, the pilot tubes being so sized that, during use, they supply enough fuel to provide a pilot flame for reignition.

Preferably the pilot tube, or each pilot tube when there is more than one, terminates near the boundary between the fuel outlet space and the adjacent unpacked zone.

In the case of liquid fuel combustion, the fuels used are those having boiling points at or below room temperature. Heat transfer from the surrounding air via the tube bank heat exchanger formed by the combustion air tubes enables the liquid fuel to be vaporised, the fuel then passing through the packing as described previously for gaseous fuels.

The following two constructions are particularly suitable for use at the inlet end of the combustion air tubes:-

CONSTRUCTION A

The combustion air tubes are secured in fluid tight manner into holes in an air inlet zone plate which forms one wall of the fuel inlet space.

CONSTRUCTION B

The combustion air tubes have a conformable polygonal crosssection, e.g., equilateral triangles, square or regular hexagons and, at the inlet end of the combustion air tubes, the walls of the tubes are secured to one another in fluid tight manner.

The burner element can form part of flare stacks used for the burning off of residual gases.

According to another aspect of the invention there is provided a flare stack suitable for burning off waste gases comprising

a. a diffusion flame burner element (as described above) on supports

b. flare stack walls projecting vertically upwards from the edges of said burner element, the flare stack walls and burner element being enclosed by

c. a draught fence around the base of the flare stack walls whereby during operation of the flare stack air flows through the draught fence, below the flare stack walls and into the combustion air tubes of the burner element.

Preferably the length of a side of the total burner element is not less than 5′ or greater than 30′. Burner ele-

ments having dimensions smaller than this are unsuitable for flaring off refinery waste gases as they are not capable of dealing with the quantities generally used. Burner elements greater than about 30' in length give rise to constructional difficulties.

Preferably the height from the ground to the burner element is one-fourth to one-third of the length of a side of the total burner element. This enables an adequate supply of air to be maintained to the burner element to enable smoke-free combustion of the fuel.

In a preferred embodiment of the invention the flare stack walls are constructed from steel reinforced refractory concrete, and the draught fence is a slat arrangement constructed from glass fibre reinforced concrete.

Preferably the diffusion flame burner element is of a modular construction, i.e., the element is made up of a suitable number of small units. This gives advantages in assembling the stack and in the manufacture of the burner element.

According to another aspect of the invention there is provided a method for disposing of low pressure residual gases or volatile liquids which comprises burning off the gases in a flare stack as hereinbefore described in the Specification by passing the gases through a burner element fitted with a plurality of combustion air tubes adapted to convey combustion air to the combustion zone, each of which tubes has a cross-sectional area of not less than 1.00 cm^2 where it opens into the combustion zone and the bores of the combustion air tubes account for at least 25 percent of the area adjacent to the combustion zone, the tubes passing through a fuel chamber divided into:

a. a fuel outlet space which communicates with the combustion zone and which contains packing which provides a high resistance to the flow of gaseous fuel, and

b. a fuel inlet space connected to a fuel supply and which contains no packing material so that it provides a low resistance to the flow of fuel,

air flowing through the combustion air tubes into the combustion zone where it reacts with the fuel which flows through the inlet and outlet spaces and finally into the combustion zone.

The invention will now be described by way of example, with reference to the diagrammatic drawings accompanying this specification in which:

FIG. 1 is front view of the ground fired flare stack.

FIG. 2 is a perspective view, with part cut away of the burner unit of the flare according to the preferred embodiment of the invention.

FIG. 3 is a vertical cross-section through the burner element shown in FIG. 2.

FIG. 4 is a perspective view of the burner element showing the method of construction from modules.

A front view of a flare stack is shown in FIG. 1. The fuel is fed into the stack by means of a fuel inlet pipe 1 which passes through the draught fence 3 via a hole 2 and is piped into the burner element. Air passes through under the flare stack walls 4 into the combustion zone (not shown). The burnt gases then pass to the atmosphere along the flare stack walls 4.

The burner element shown in FIGS. 2 and 3 comprises a fuel chamber 5 through which a plurality of combustion air tubes 6 pass. The fuel chamber is divided into a fuel inlet space 7 and a fuel outlet space 8 which is packed with porous material, preferably sand to increase its flow resistance, said packing being supported by means of a partition 9. Each of the combustion air tubes 6 passes through a hole in the partition 9 and the size of the hole is such that an annular fuel duct 10 is formed around each of the combustion air tubes.

In the use of the burner element, fuel enters the fuel inlet space 7 via the fuel supply line 12 and it passes through the interstices of the combustion air tubes 6. From the fuel inlet space 7 the fuel passes through the packed fuel outlet space 8 into the combustion zone. Since the packing offers a relatively high resistance to the fuel flow and the interstitial space of the fuel inlet space 7 offers a relatively low resistance the construction encourages a uniform supply of fuel into the combustion zone.

FIG. 4 shows a cross-section of a flare stack incorporating modular burner elements 16. In use, the fuel enters the fuel inlet pipe 1 and branches off via module feed pipes 17. Fuel then enters each burner element module through suitably arranged inlets 13 and 14. The total burner element stands on supports 15.

A flare stack using a burner as described above was tested using butane and propane as the fuel. The burner element comprised combustion air tubes each having a diameter of 1 inch, the overall dimensions of the burner element being 12 foot square by 4 inches deep. It was fitted with a perforated plate and the top 1 inch was packed with coarse sand. The burner element was incorporated in a flare stack. The stack walls were constituted of steel reinforced refractory concrete and the draught fence of glass fibre reinforced concrete. The height from the burner element to the top of the stack was 15 feet.

What we claim:

1. A flarestack for burning waste gases, comprising:

A plurality of modular burner elements constituting a burner unit;

each of said burner elements having a plurality of combustion air tubes adapted to convey combustion air to a combustion zone, each of said combustion air tubes having a cross-sectional area of not less than 1.0 $cm.^2$ where it opens into said combustion zone and the bores of said combustion air tubes accounting for at least 25 percent of the area adjacent to said combustion zone, said combustion air tubes passing through a fuel chamber divided into

a fuel outlet space which communicates with said combustion zone and which contains packing to provide a high resistance to the flow of gaseous fuel, and

a fuel inlet space adapted for connection to a fuel supply and which contains no packing material to provide a low resistance to the flow of fuel;

flarestack walls projecting vertically upwardly from the edges of said burner unit;

the length of a side of said burner unit being not less than 5 feet or greater than 30 feet;

the height from the ground to said burner unit being a quarter to a third of the length of a side of said burner unit; and

a draught fence enclosing the base of said flarestack walls and said burner unit, whereby during operation of said flarestack, air flows through said draught fence, below said flarestack walls and into said combustion air tubes of said burner unit.

2. A flarestack as claimed in claim 1, wherein each of said combustion air tubes has a cross-sectional area of 5.0 $cm.^2$ where said tube opens into said combustion zone.

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