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(54) Flare for high velocity gas

(57) Flare for and method of flaring high velocity (sonic order) gas involves burning (at outlets 114) a low pressure, low velocity gas to produce a flame large enough and energetic enough to establish continuous ignition of the main sonic gas flare from pipe 110, so preventing blow out following a large degree of flare lift-off. The low pressure gas is typically released at less than half sonic velocity and may be derived (111) from the high velocity flare (eg. as 5 - 10% by volume), from a separate source or from both.

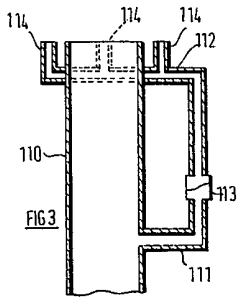

FIG 3

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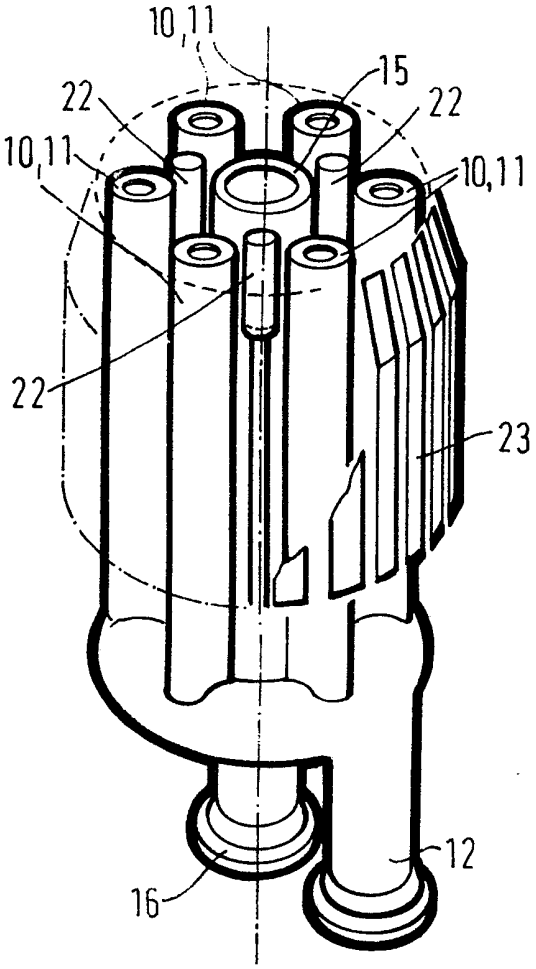

FIG.2.

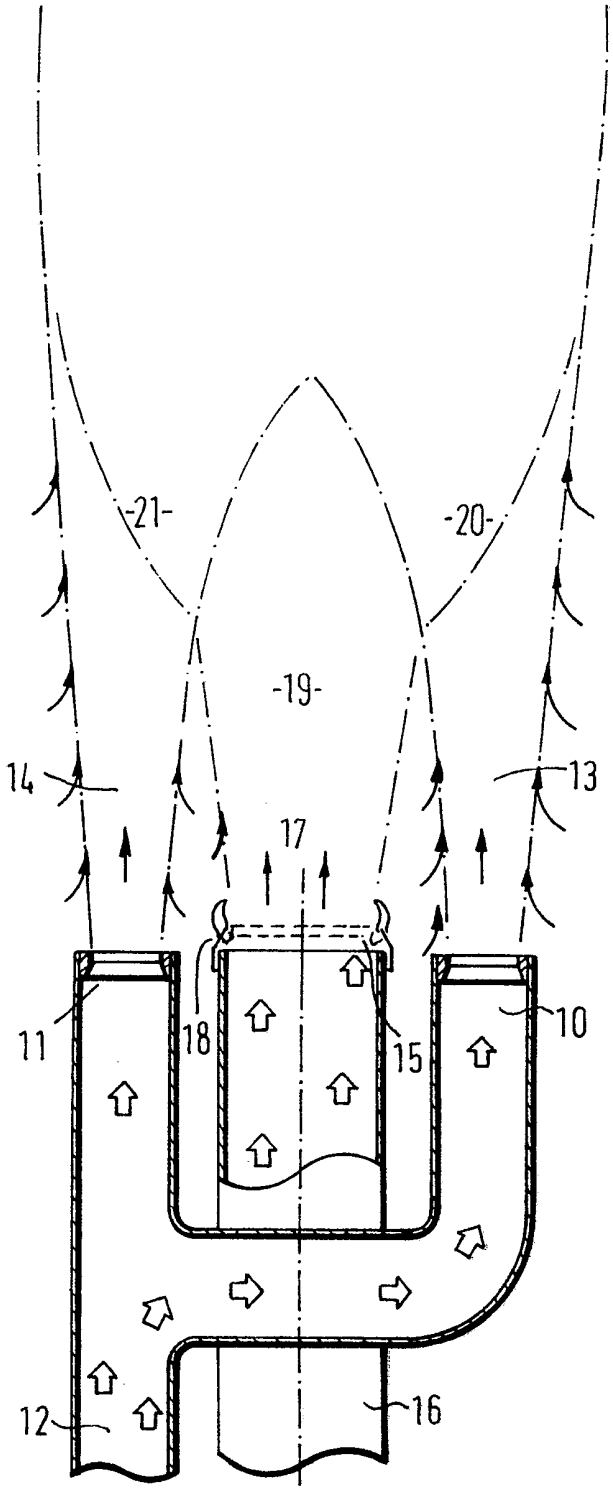

FIG.1.

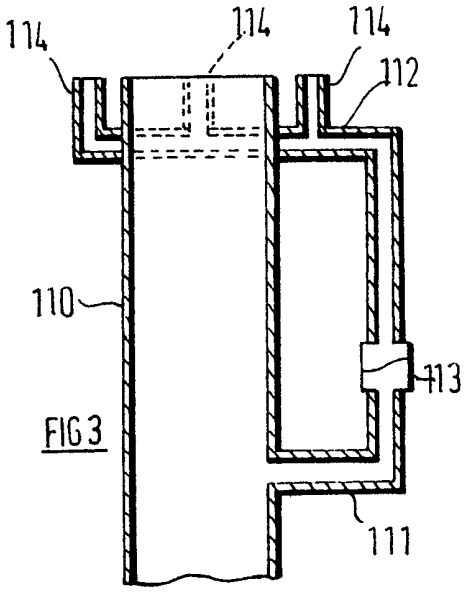

FIG 3

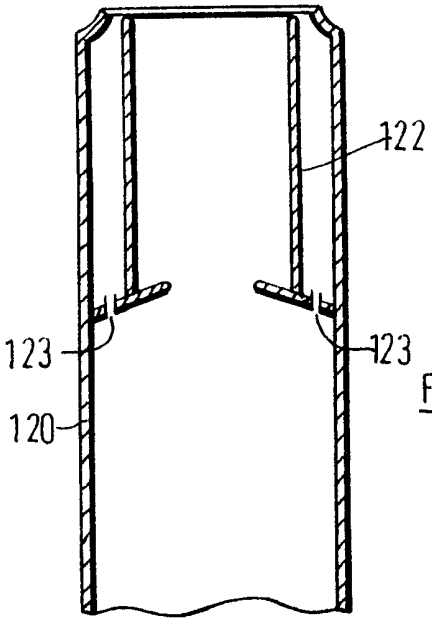

FIG. 4.

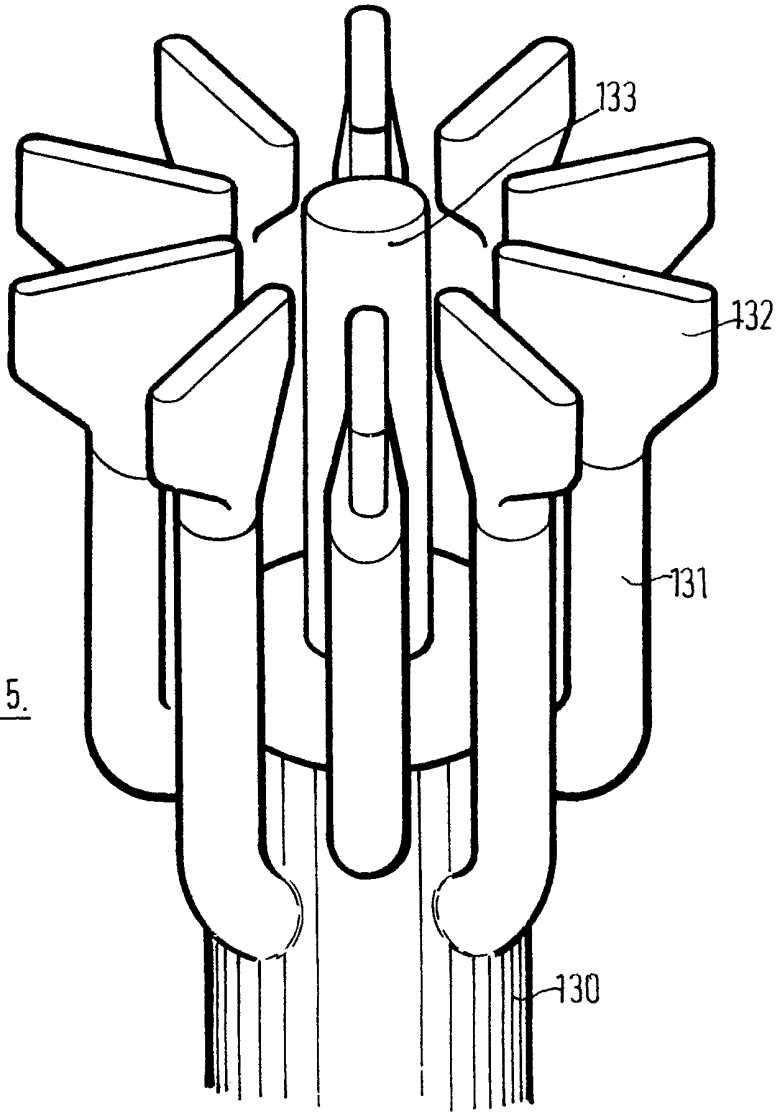

FIG. 5.

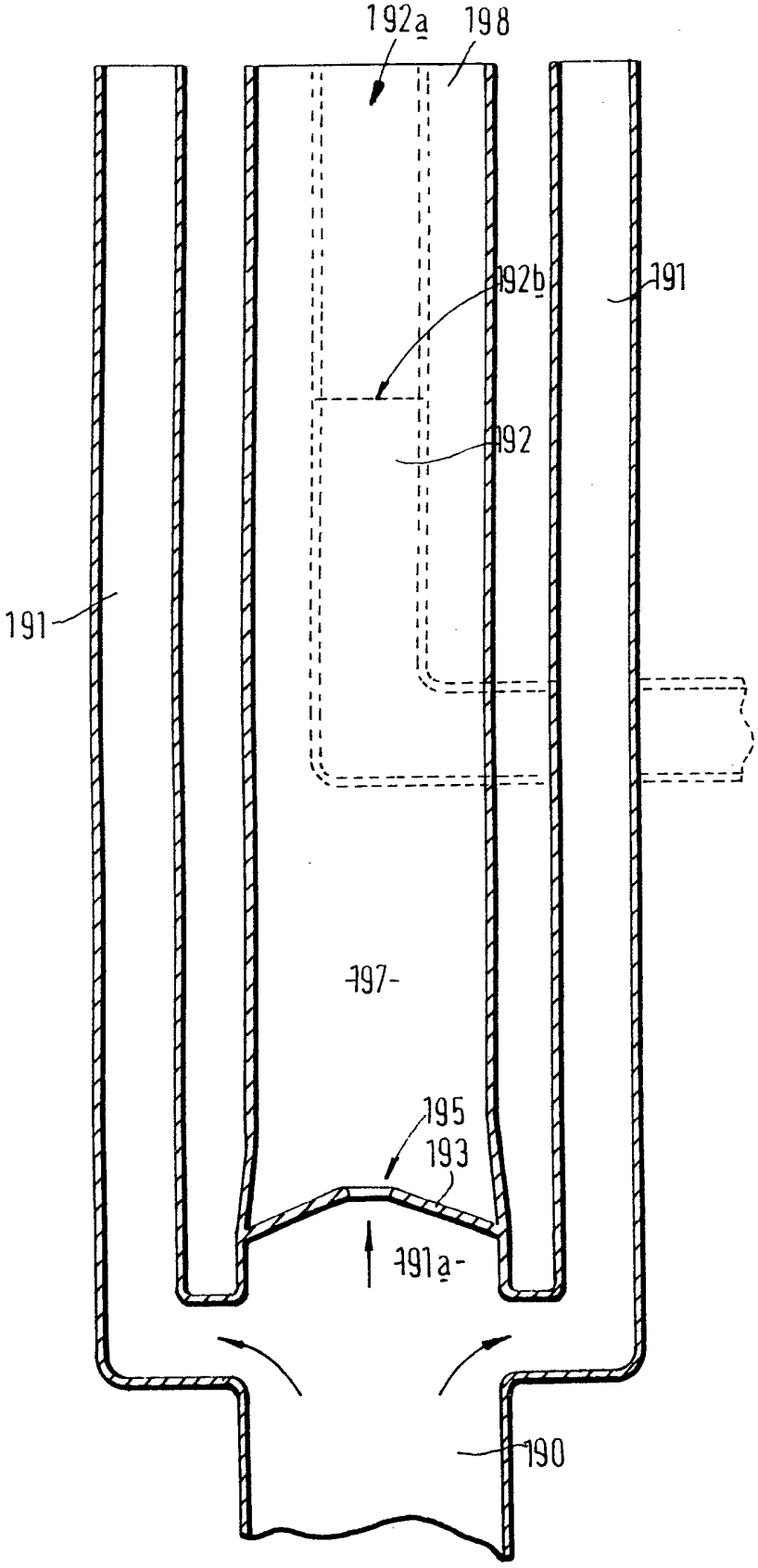

FIG. 6.

SPECIFICATION

Flares

This invention relates to the disposal of flammable gases by flaring.

Large quantities of unwanted flammable gas can be burnt at flares of open pipe type. The gas may be supplied to such a flare at high pressure and released at high velocity, possibly sonic velocity, but one problem which arises at high velocity is that the flame can lift off the tip of the flare. Whilst lift off is not in itself a problem, indeed, a lifted flame benefits from improved aeration, there is the possibility that the flame may be unstable and lift off to the extent that the flame is blown out, which leads to the dangerous accummulation of unburnt flammable gas. Flares may be fitted with flame retention devices to attempt to prevent lift off, which operate by establishing regions of lower gas velocity at the flare tip and small stable flames, which provide a continuous re-ignition source for the main flame at the flare tip if it tends to lift off the tip. However, at high gas velocities such small flames are not sufficient for reliable flame retention and cannot provide stability when the flame is lifted to any great extent. For this reason conventional open pipe flares cannot be operated at a discharge velocity greater than that at which lift off occurs, typically at about half sonic velocity. However, it is an advantage if the flare can be operated with a gas velocity of the sonic order, since, inter alia, lower radiation of energy from the flame can be achieved. It is the object of the present invention to provide for stable operation of a flare at high discharge velocity including sonic velocity.

According to one aspect of the invention, we provide a method of flaring flammable gas supplied at high pressure and released at high velocity from an open pipe flare, wherein gas at a pressure and velocity lower than said gas supplied is burnt at or adjacent the tip of said flare in one or more further outlets adapted to produce stable flames of sufficient size and energy to establish continuous ignition of the high velocity gas up to a considerable distance above the tip. By considerable distance, we mean a distance greater, preferably a number of times greater, than that over which ignition can be maintained by the use of a conventional pilot flame or flame retention device, typically at least and generally well in excess of 1.5 metres or more.

The use of one or more further outlets burning gas at lower pressure than that which is burnt in the main flare, and arranged to provide flames of relatively great size and energy will be much more effective at maintaining stability of a high velocity flame than flame retention devices used hitherto. Because the lower pressure gas is burnt at low velocity, it itself is not subject to lift off and is inherently stable.

The low pressure, low velocity gas may be obtained partly or wholly from a source independent of the high pressure, high velocity gas or it may be wholly or partly provided by a portion of the high pressure, high velocity gas supply which is derived from a point upstream of the tip or tips of the open pipe flare, and expanded to a lower pressure and lower velocity before being burnt as stated above. The portion taken may be typically of the order of 10% by volume of the said supply but will depend on circumstances and would normally be 5-15% by volume. The size of the portion taken is desirably kept to a minimum so that as much gas as possible is burnt at high velocity to minimise radiation energy.

The velocity at which the low pressure, low velocity gas is released will be generally less than half sonic velocity, typically 10-330m.s.$^{-1}$ and preferably about 0.2 sonic velocity (about 220 m.s.$^{-1}$).

Where the low pressure, low velocity gas is derived from an independent source it may be burnt in an amount up to the amount of high pressure, high velocity gas, by volume. This is especially useful where it is required to burn a low pressure supply of gas, which if burnt alone would cause smoking. When burnt with the high pressure high velocity gas smoking is reduced to a negligible extent or obviated.

The invention provides in another aspect an open pipe flare for burning flammable gas supplied at a high pressure and released at high velocity at at least one flare outlet tip, the flare comprising one or more further outlets for gas supplied at a velocity and pressure lower than the gas released at the open pipe flare tip, the further outlets being arranged such that the low pressure, low velocity gas is burnt at or adjacent to the open pipe flare tip or tips to produce stable flames of sufficient size and energy to establish continuous ignition of the high velocity gas up to a considerable distance above the tip or tips.

Said further outlet or outlets may be disposed within an array, e.g. in the centre of a circular array, of flare tips releasing said high velocity gas, or vice versa.

Alternatively there may be a manifold supplied with said lower pressure gas and supplying a plurality of individual outlets disposed adjacent the tip or tips of the main flare. By this means, the flame of at least one of the further outlets will be to windward of the main flare so that ignition of the high velocity gas at or above the flare tip occurs reliably even under windy conditions.

The open pipe flare may comprise means for deriving some of said high pressure, high velocity gas from the supply thereof at a position upstream of the flare tip or tips, and means for expanding said derived gas to a lower pressure and velocity to provide said low pressure, low velocity gas.

Embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

FIGURE 1 is a diagram illustrating the principle of a flare according to the invention;

FIGURE 2 is a diagrammatic perspective view of an embodiment of the flare according to the invention, and

FIGURES 3, 4, 5 and 6 are diagrammatic views of further alternative embodiments of the invention.

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

Referring firstly to Figure 1, there is illustrated a flare comprising outlets 10, 11 supplied with high pressure gas from a manifold 12. The configuration of the outlets 10, 11 is such that gas is released from them in streams 13, 14 of high, e.g. sonic, velocity. These streams of high velocity gas entrain at their peripheral regions air, which mixes with the gas.

Between the outlets 10, 11 is disposed a further outlet 15 which is supplied with gas through a pipe 16. This gas is supplied at a lower pressure than that which is supplied to the outlets 10, 11 such that the gas emerges from the outlet 15 in a relatively low velocity stream 17. At outlet 15 there is provided a conventional flame retention ring 18 which because the velocity of the stream of gas 17 emerging from outlet 15 and entraining air with it is typically 50-350 $m.sec^{-1}$, and results in an inherently stable flame 19 being established above the outlet 15, once the gas stream 17 is ignited. The flame 19 reaches to a relatively great distance above the outlet 15, typically 1.5m and provides a continuous ignition source for the aerated high velocity gas streams 13, 14 which commence combustion in regions 20, 21. The turbulent nature of the high velocity gas streams entrains sufficient air to support combusion of this gas stably at a distance above the outlets 10, 11, and this combustion in turn intensifies combustion within the low velocity flame 19. The result is a low radiation combined flame which is extremely resistant to cross-winds.

A practical embodiment of the flare of Figure 1 is shown in Figure 2. The same reference numerals as those of Figure 1 have been applied to corresponding parts. The flare comprises circumferentially spaced high velocity gas outlets 10, 11, and a single central low velocity gas outlet 15. Three pilot burners 22 are provided for initial ignition. The flare further comprises an assembly of peripheral wind break slats 23. The operation of the flare is as described above in relation to Figure 1.

Referring now to Figure 3, there is shown an open pipe flare 110. Upstream of the tip of the flare 110, there is a passage 111 by which a proportion of the main flow of gas to the tip of flare 110 is supplied to a manifold 112 by way of a restriction 113 so that the gas pressure and velocity in manifold 112 is less than that in the flare 110. The manifold 112 feeds a plurality of individual outlets 114 disposed around the tip of flare 110 and arranged to produce flames which are of sufficient size and energy to ensure continuous ignition of gas at a distance above the tip of the flare.

In the embodiment of Figure 4, a flare 120 has, up stream of its tip, a baffle plate 121 whose purpose is to provide a baffle seal to resist entry of air into the flare upstream thereof which could give rise to an explosive mixture in the flare when it is not actually flaring. Downstream of the baffle plate 121, the flare tip contains an internal tube 122 which defines an annular region communicating with the flare up stream of baffle plate 121 by passages 123 extending through the plates. If the flare is supplied with gas at high pressure, the annular space out side tube 122 will contain gas at a relatively lower velocity and pressure by virtue of the restrictions afforded by passages 123, which gas will emerge at a velocity such that an annular relatively stable flame is established around the main flame of the gas passing through the interior of tube 122. Again, this ensures ignition of the main supply of gas at or above the flare tip and ensures stability of the flame.

The flare would desirably be provided with conventional pilot burners or the like for initial ignition.

Figure 5 of the drawings shows a flare with a stack pipe 130 terminating in an annular array of pipes 131 having elongated mouths 132. In the centre of this array is a further outlet pipe 133 which is supplied with gas from the pipe 130 by way of a restriction in an analogous manner to that described above, so that the gas issuing from pipe 133 is expanded to a relatively low velocity and pressure compared with the main quantity of gas issuing from the pipes 131, 132. Again, the flame produced by pipe 133 is sufficient to ensure reliable ignition of gas even at a distance above the mouths of pipes 132. Stable combustion is thus achieved, even when the flames of the high velocity gas are lifted off their flare tips.

The embodiment of Figure 5 is advantageous in that it allows maximum access of air to the streams of high velocity gas. In addition, the central flame of low velocity gas is to an extent shielded from wind by the surrounding high velocity gas streams.

In the embodiment shown in Figure 6, the apparatus comprises a conduit 190 supplying high pressure high velocity gas the conduit branching into a plurality (only two of which are shown) of branch conduits 191 for high pressure high velocity gas, and a central conduit 191*a* within which is situated an orifice plate 193. Some of the high pressure gas passes through the orifice 195 of this plate and is then expanded in the expansion chamber 197 before being burnt at an outlet 198 of the latter, with a large energetic flame. There may be provided a conduit 192 (shown in broken line) in this instance concentric with the conduit 191*a*, supplied with low pressure gas from an independent source to supplement the gas expanded in chamber 197. The said conduit may terminate at the same level 192*a* as the conduit 191*a* to keep the low pressure gases separate or may terminate short thereof 192*b* so that mixing of the low pressure gases occurs before combustion. The low pressure conduit 192 may be provided externally of conduit 191*a* in a similar manner to the embodiment of Figure 3.

By way of example only, the amount of gas burned at low pressure and velocity may be of the order of 10% of the total quantity of gas passing to the flare, and it may issue from the further outlets at a velocity typically of the order of 20% of the velocity of the main quantity of gas.

The invention may be utilised where one or more high pressure flares is disposed in close proximity to a low pressure flare whose source of low pressure gas is separate from the gas source for the high pressure flare or flares. An advantage of such an arrangement is that the presence of the high pressure gas flares improves the combustion of the low pressure gas flare and reduces the quantity of smoke produced. In such a situation, the low pressure flare may provide for stable operation of the high pressure flares in the lifted off condition, but if the supply of gas to the low pressure flare fails such stability cannot be

ensured. According to the invention, the low pressure flare may be arranged to be additionally supplied with gas drawn from the high pressure flare and expanded to low pressure. Thus there is a flame available from the low pressure flare to stabilise the high pressure flare whenever the latter is operating, even if the flow of low pressure gas from the separate source ceases.

The flare can be provided with one or more outlets for the low pressure gas drawn from the high pressure flare which are separate from the outlet(s) being supplied from the separate low pressure source. Alternatively all or some of the low pressure gas outlets may be supplied with low pressure gas drawn from the separate source and also low pressure gas drawn from the high pressure supply.

CLAIMS

1. A method of flaring flammable gas supplied at high pressure and released at high velocity at an open pipe flare comprising one or more outlets, wherein gas at a velocity and pressure lower than the gas released at said open pipe flame is burnt at or adjacent the tip of said flare in one or more further outlets to produce stable flames of sufficient size and energy to establish continuous ignition of the high velocity gas up to a considerable distance above the tip.

2. A method as claimed in Claim 1 in which the high pressure, high velocity gas is released at from half sonic to sonic velocity and the low pressure, low velocity gas is released at less than about half sonic velocity.

3. A method as claimed in Claim 1 or Claim 2 in which the high pressure, high velocity gas is released at substantially sonic velocity and the low pressure, low velocity gas is released at between 10-330m.sec^{-1}.

4. A method as claimed in any preceding Claim in which all or part of the low pressure, low velocity gas is provided by a portion of the high pressure, high velocity gas and is derived from a region upstream of the tip or tips of the open pipe flare and expanded to low pressure and low velocity before being burnt.

5. A method as claimed in Claim 4, in which 5-10% by volume of the high pressure, high velocity gas is used to provide the low pressure, low velocity gas supply.

6. A method as claimed in any of Claims 1 to 3 in which all or part of the low pressure, low velocity gas is derived from a source separate from the high pressure, high velocity gas and is burnt in up to an amount by volume equal to the amount of high pressure, high velocity gas burnt at the open pipe flare.

7. A method as claimed in any preceding claims in which part of the low pressure low velocity gas is derived from the source independently of the high pressure, high velocity supply and part is derived from the said supply, the latter part being expanded to produce said part of the low pressure, low velocity gas before being burnt.

8. A method as claimed in Claim 7 in which each respective part is released from separate further outlets.

9. A method as claimed in Claim 7 in which all or a proportion of both said parts are released from the same further outlets.

10. An open pipe flare for burning flammable gas supplied at high pressure and released at high velocity at at least one flare outlet tip, the flare comprising one or more further outlets for gas supplied at a velocity and pressure lower than the gas released at the open pipe flare tip, the further outlets being arranged such that the low pressure low velocity gas is burnt at or adjacent the open pipe flare tip or tips to produce stable flares of sufficient size and energy to establish continuous ignition of the high velocity gas up to a considerable distance above the flare tip or tips.

11. An open pipe flare as claimed in Claim 10, in which said further outlet or outlets are disposed within an array of said open pipe flare tips releasing high velocity gas.

12. An open pipe flare as claimed in Claim 11, which there is provided one of said further outlets disposed at the centre of a circular array or of said open pipe flare tips releasing high velocity gas.

13. An open pipe flare as claimed in Claim 10, in which there is provided one or more open pipe flare tips disposed within an array of said further outlets.

14. An open pipe flare as claimed in Claim 11, in which there is provided a single open pipe flare tip disposed within a circular array of said further outlets.

15. An open pipe flare as claimed in any of claims 10 to 14 also comprising means for deriving at least some of said high pressure, high velocity gas from the supply thereof at a position upstream of the flare tip or tips and means for expanding said withdrawn gas to a lower pressure to provide said lower pressure, low velocity gas.

16. An open pipe flare as claimed in any of claims 10 to 15 also comprising means for deriving at least part of said low pressure, low velocity gas from a source independent of said supply.

17. An open pipe flare as claimed in claim 15 comprising means for deriving part of said low pressure, low velocity gas from a source independent of said supply and part from the supply.

18. An open pipe flare as claimed in claim 17 in which the said parts of the low pressure, low velocity gas share at least some common further outlets.

19. An open pipe flare as claimed in claim 17 in which the said parts of the low pressure low, velocity gas are released from separate further outlets.

20. An open pipe flare substantially as hereinabove described reference to Figures 1 and 2, Figure 3, Figure 4 or Figure 5 of the accompanying drawings.

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