

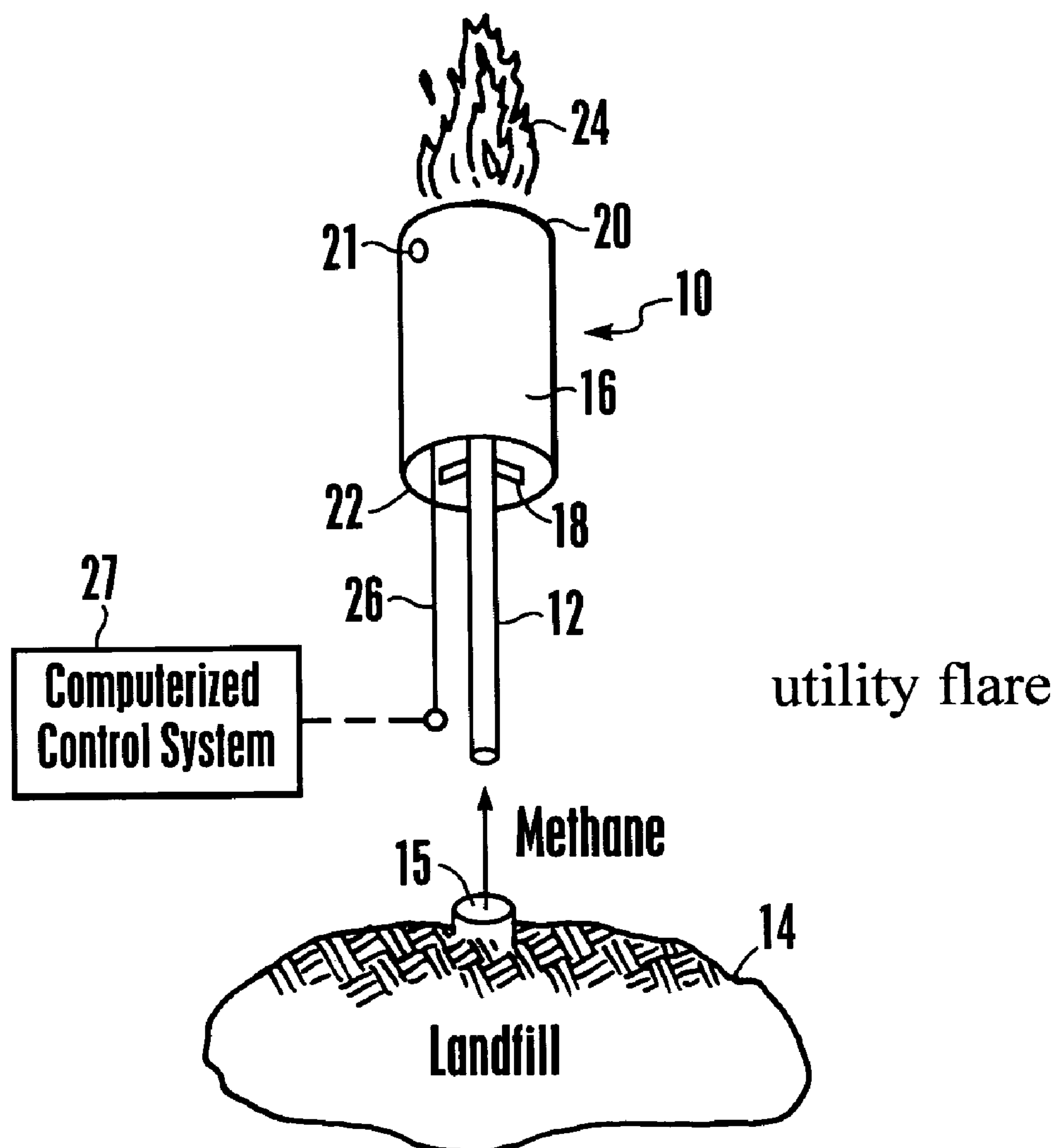
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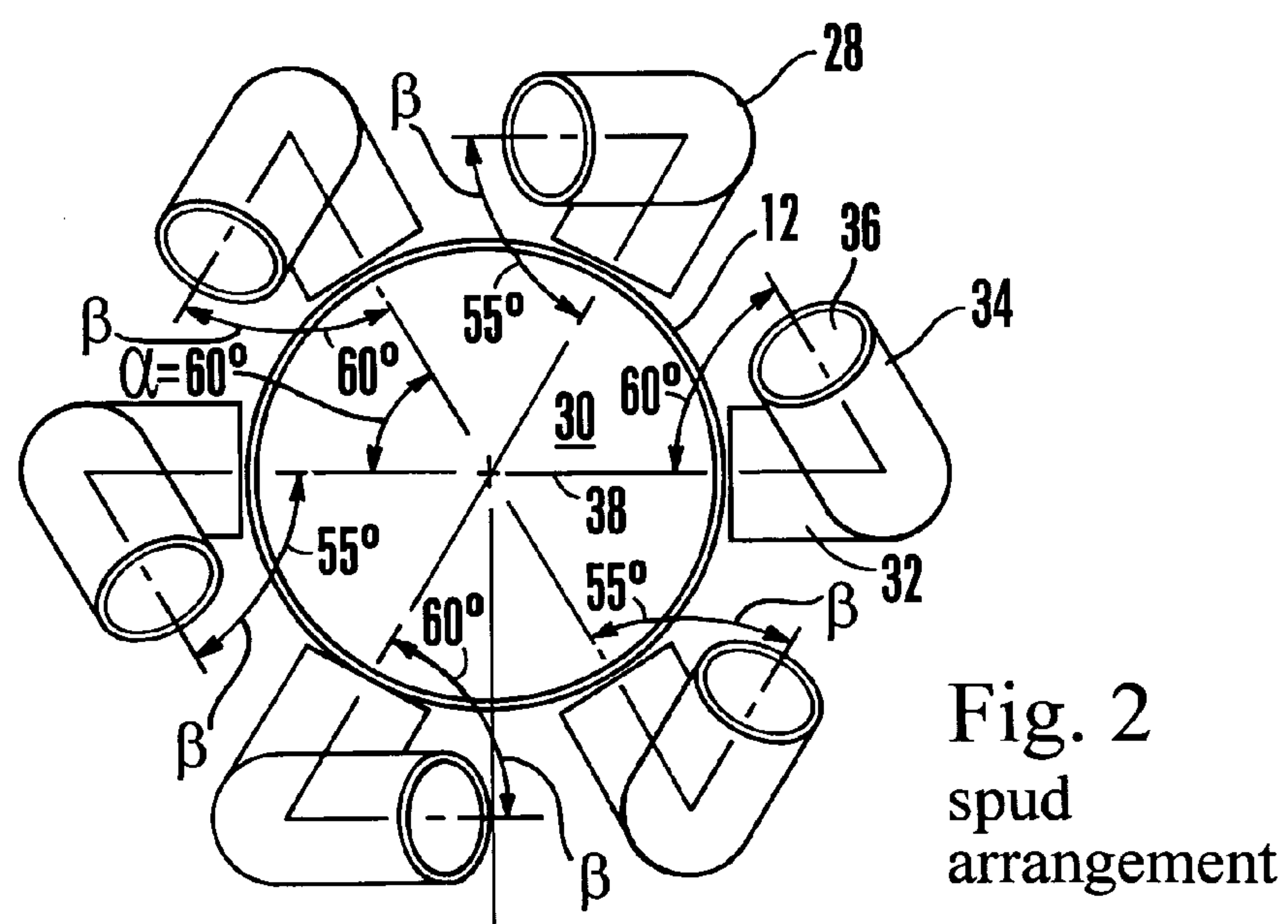
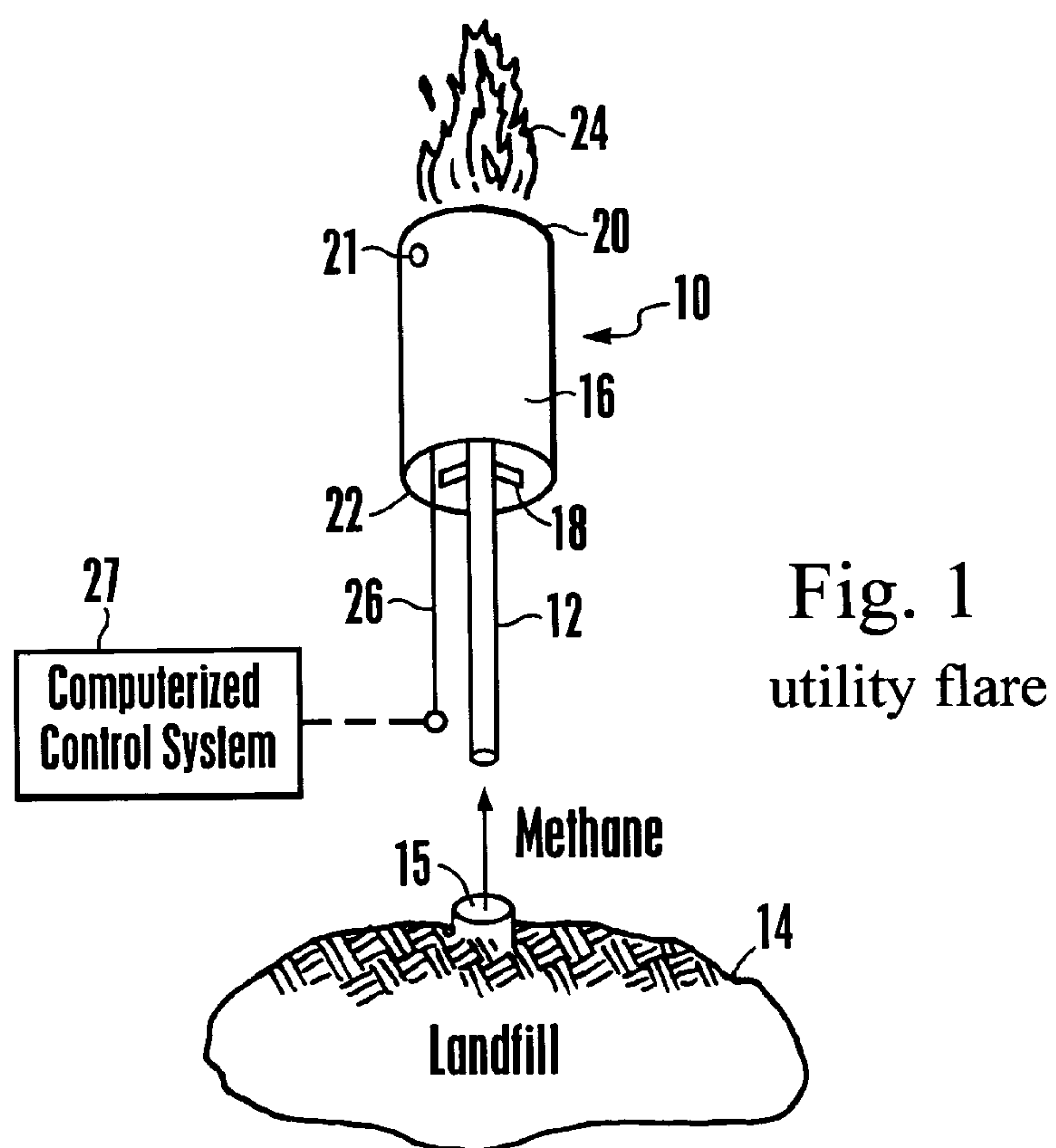
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**Brookshire et al.**(10) **Pub. No.: US 2005/0074712 A1**(43) **Pub. Date: Apr. 7, 2005**(54) **LANDFILL GAS EXTRACTION FLARE****Publication Classification**(76) Inventors: **Ronald L. Brookshire**, Alpine, CA  
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(US)(51) **Int. Cl.<sup>7</sup>** ..... **F23D 14/00**(52) **U.S. Cl.** ..... **431/202; 431/350**

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**San Diego, CA 92101 (US)**(57) **ABSTRACT**

A landfill methane burner flare has a methane riser within a shroud. The methane riser terminates in a series of spuds that are bent to promote turbulence and mixing in methane passing through and out of the spuds. Louvers can be positioned in the riser to selectively establish a methane gas pressure within the riser, and/or louvers can be positioned between the methane riser and shroud to selectively establish combustion air flow in the flare.

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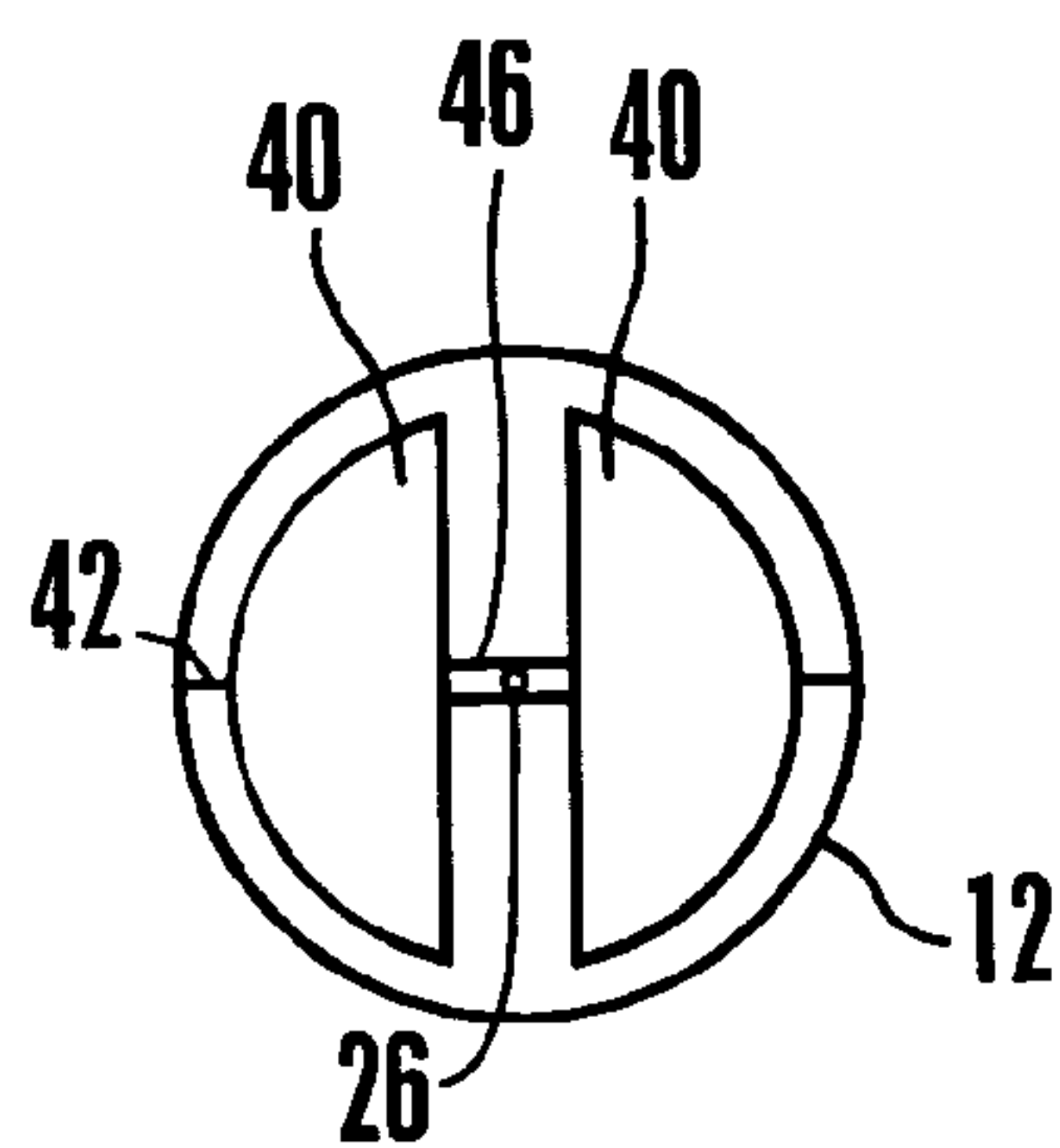


Fig. 3  
utility flare,  
louvers mostly closed

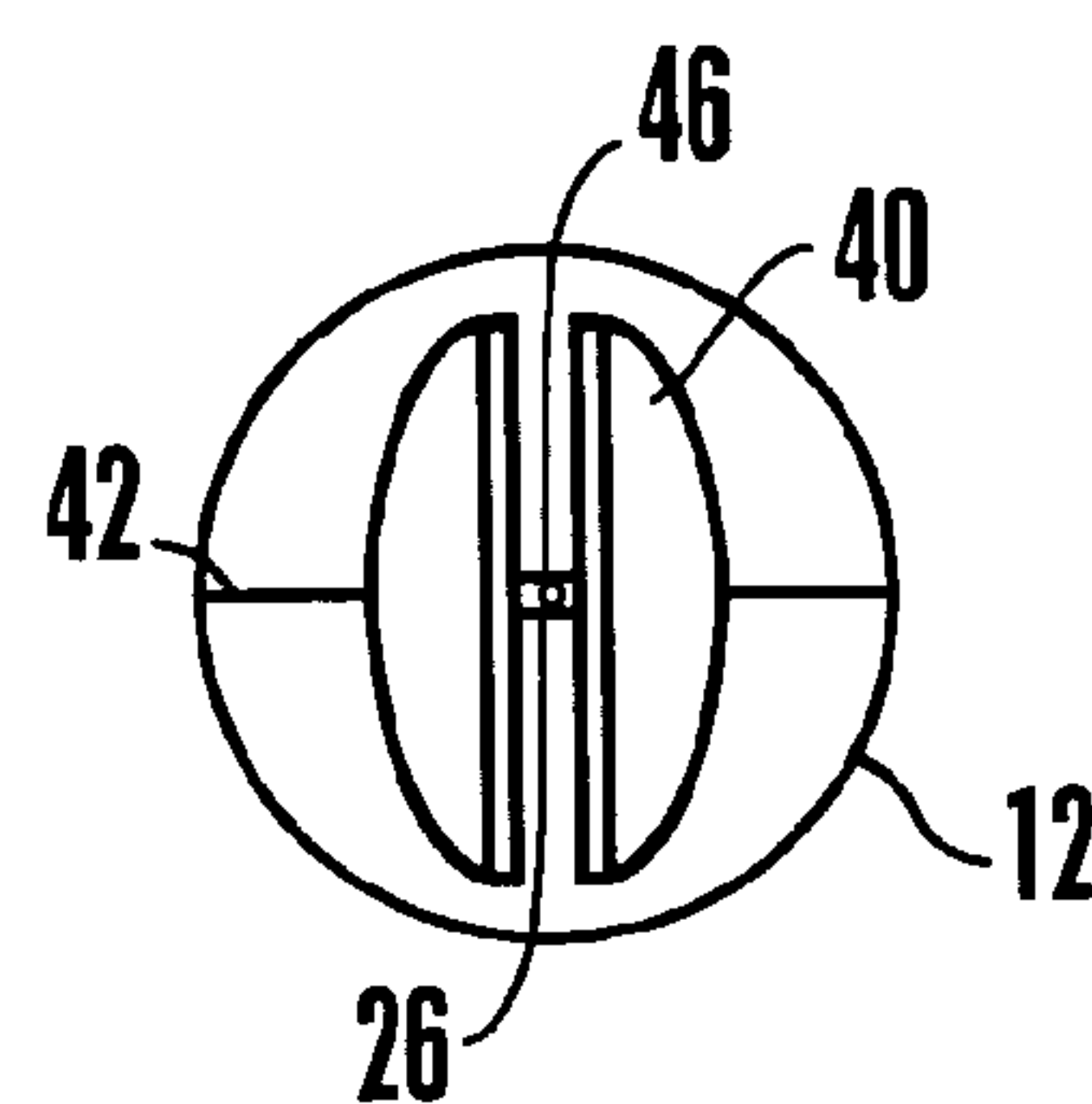


Fig. 4  
louvers mostly open

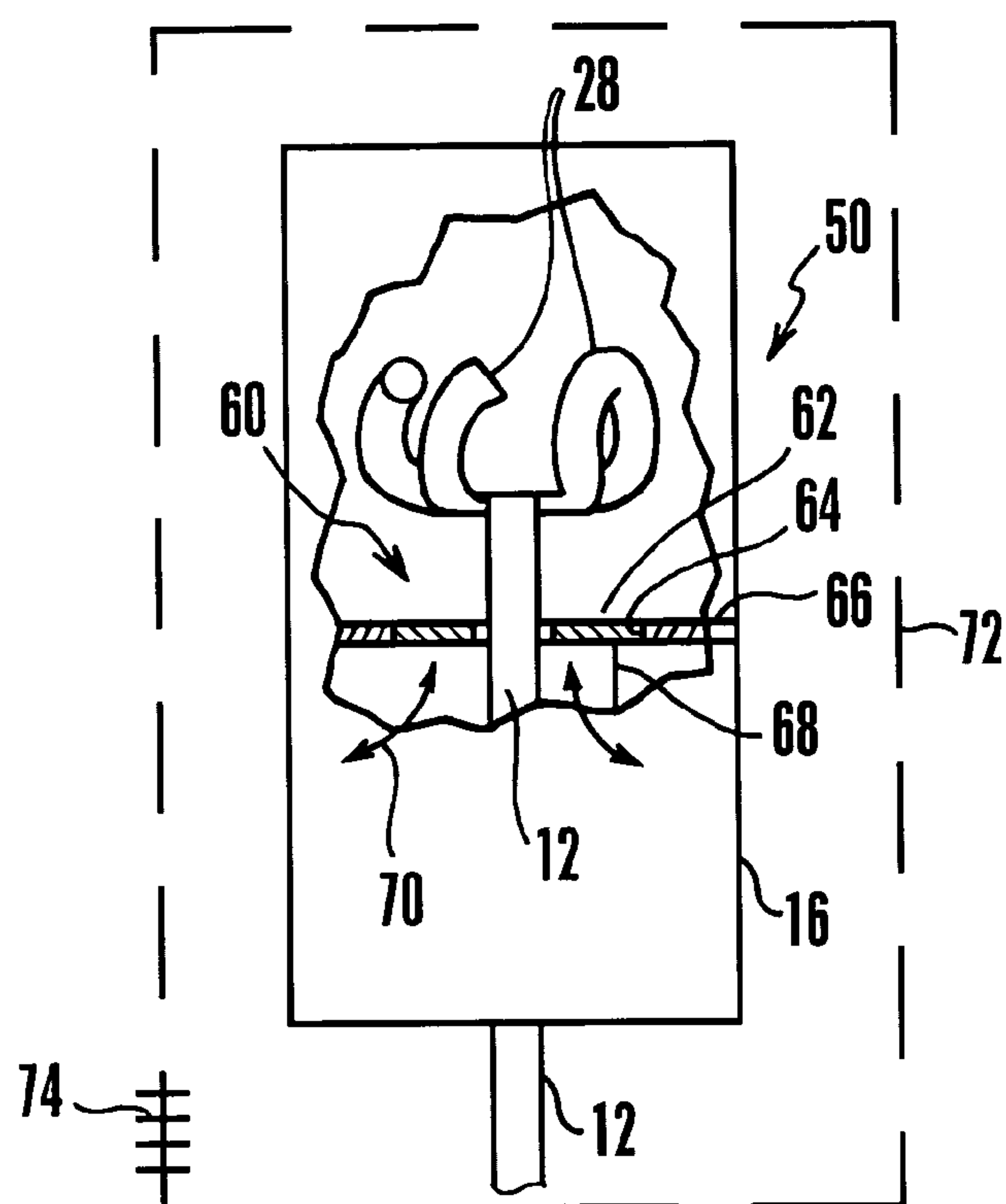


Fig. 5  
flare cut-away

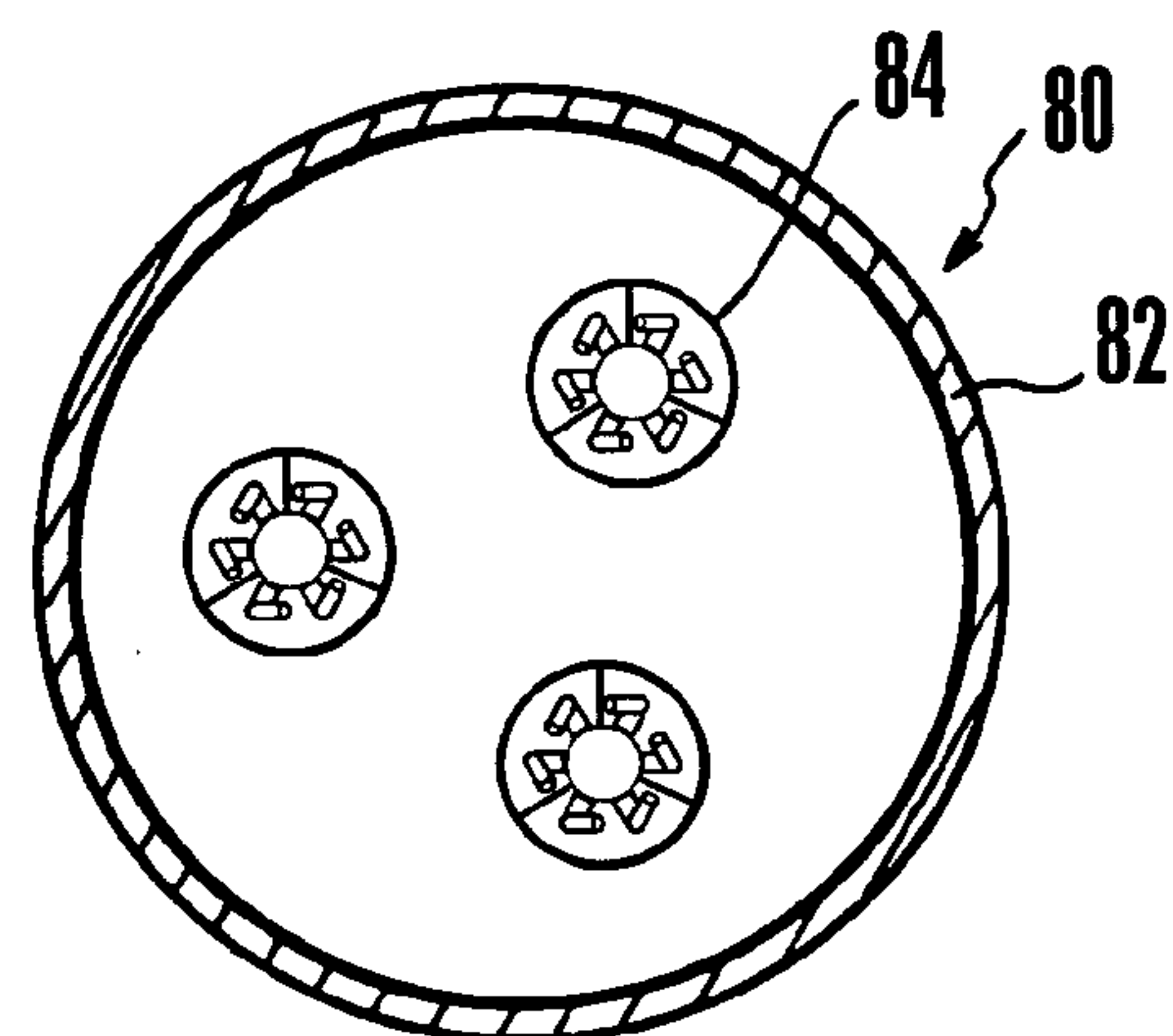


Fig. 6  
alternate flare with  
multiple sets of spuds



## LANDFILL GAS EXTRACTION FLARE

### I. FIELD OF THE INVENTION

[0001] The present invention relates generally to landfill gas extraction systems.

### II. BACKGROUND OF THE INVENTION

[0002] Landfills produce methane gas which must be extracted from the landfills. In some cases, this can be done passively, simply by placing open pipes in the landfill through which the methane can vent. For environmental reasons, however, many localities require that the methane be eliminated as much as possible by actively directing the methane through a flare, which burns the gas.

[0003] Two types of flares are generally provided. The first type is referred to as a utility flare, which has a cylindrical shroud with an open top, above which a flame appears when the flare is burning gas. A methane riser extends from the ground into the shroud, with the bottom of the shroud generally being above the ground and supported on the riser. The methane is pumped up through the riser and out of an outlet into the shroud, where an ignition device ignites the gas to produce the flame and oxidize the methane.

[0004] A second type of flare is referred to as an enclosed flare, which is essentially a utility flare with methane riser and shroud disposed inside a cylindrical flare housing that extends to the ground. Combustion air is provided through louvers in the flare housing wall.

[0005] In either case, it is desired that the flare burn as much methane as possible, as well as have a large operating range, so that it can effectively burn methane at both low and high extraction rates. The "turndown ratio" of a flare refers to the operating range of the flare. Currently, most flares provide at best around a 5:1 turndown ratio (e.g., most flares can effectively burn methane at rates of, to give but one example, 100,000 BTU/minute to 500,000 BTU/minute. The reason that better turndown ratios have not been achieved are many, but include the fact that most flares cannot be optimized for any particular methane flow rate, but instead must be able to burn methane at what often are widely varying and unpredictable methane flow rates. Moreover, most localities require the exhaust constituents remain within nitrous oxide and carbon monoxide specifications, which can compete with the desire to burn as much methane as possible. Also, flares must typically achieve a desired amount of destruction of non-methane organic compounds, and this consideration can compete with methane oxidation optimization. Having recognized the above considerations, the present invention has been provided.

### SUMMARY OF THE INVENTION

[0006] A landfill gas flare includes a shroud and a methane riser in the shroud and defining a methane passageway. Plural non-straight pipes are mounted on the methane riser in communication with the methane passageway. Also, a flow alteration assembly is juxtaposed with the methane riser to selectively establish a fluid flow through the assembly.

[0007] The flare can be an enclosed flare or a utility flare. The flow alteration assembly can surround the methane riser within the shroud, and can include movable louvers that are

disposed between the shroud and the methane riser. The louvers are movable to establish a combustion air flow past the pipes. In a preferred embodiment, the louvers are coupled to an operating member that extends outside the shroud and that is manipulable by a person or computer to move the louvers.

[0008] Alternatively the flow alteration assembly (or, in addition to the assembly discussed above, a second assembly) can be disposed in the top end of the riser. In this embodiment, the flow alteration assembly includes movable louvers disposed to at least partially block the top end of the riser. The louvers are movable to establish a methane gas pressure.

[0009] In either flare type, each pipe, referred to herein as a "spud", includes a radial segment lying along a radius of the methane riser and a distal segment establishing an angle with respect to the radial segment. The angle can be approximately fifty five degrees for some spuds and approximately sixty degrees for other spuds.

[0010] If the flare is an enclosed flare having a housing surrounding the shroud and riser and extending to the ground, housing louvers can be formed near the bottom of the housing to establish a means for controlling combustion and quench air flow in the housing.

[0011] In another aspect, a landfill flare includes a shroud defining an open top end, and a methane riser in the shroud. The methane riser terminates in at least two exhaust pipes that are configured for inducing turbulence in methane gas passing through the exhaust pipes. A movable louver assembly is disposed between the riser and shroud to establish a combustion air flow and/or in the top of the riser to establish a gas pressure.

[0012] In still another aspect, a landfill flare includes a shroud, a housing enclosing the shroud and defining a wall, and a methane riser in the shroud. The methane riser terminates in at least two exhaust pipes that are configured for inducing turbulence in methane gas passing through the exhaust pipes. A louver assembly is disposed between the shroud and the methane riser, with the louver assembly being movable to establish a combustion air flow past the exhaust pipes, and/or a louver assembly is disposed in the riser to establish a gas pressure.

[0013] The details of the present invention, both as to its structure and operation, can best be understood in reference to the accompanying drawings, in which like reference numerals refer to like parts, and in which:

### BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** is perspective view of a utility flare according to the present invention, schematically showing a landfill and a computerized louver control system;

[0015] **FIG. 2** is a top view of the methane riser and spud assembly of the flare shown in **FIG. 1**, with the louver assemblies removed for clarity, schematically showing radii of the methane riser along which the radial segments of the spuds lie;

[0016] **FIG. 3** is a top plan view of the open top end of the riser shown in **FIG. 1**, with the louvers in a mostly closed configuration;



[0017] FIG. 4 is a top plan view of the open top end of the riser shown in FIG. 1, with the louvers in a mostly open configuration;

[0018] FIG. 5 is an elevational view of the flare of the present invention, with portions cut away for clarity to show the louver assembly placed between the riser and shroud, showing an optional enclosed flare housing in phantom; and

[0019] FIG. 6 is a top plan view of an alternate flare, showing three multi-spud assemblies.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] Referring initially to FIG. 1, a flare is shown, generally designated 10, that includes a methane riser 12 in fluid communication with a landfill 14 for removing methane gas from the landfill 14. A methane pump or blower 15 can be provided to direct methane gas to the methane riser 12.

[0021] The flare 10 includes a shroud 16 surrounding the methane riser 12, if desired in a coaxial relationship and radially spaced therefrom, with the shroud 16 being located above the ground. Brackets 18 can connect the shroud 16 and the methane riser 12. The shroud 16 has an open top end 20. An ignition device 21 can be provided near the open top end 20 to provide an ignition spark within the flare 10. If desired, the shroud 16 can have an open bottom end 22. When burning methane, a flame 24 appears inside and above the open top end 20. Also, a louver actuator 26 is disposed in the shroud 16 and has an end that extends outside the shroud 16 for purposes to be shortly disclosed. It is to be understood that the louver actuator 26 can be manipulated by a person or a computerized control system 27 to move the below-disclosed louvers in accordance with the disclosure below. The control system 27 may receive input from various gas sensors/flow rate sensors/pressure sensors within the flare 10 and/or landfill 14 and move one or both sets of louvers described below in response thereto to establish desired riser 12 gas pressures and/or shroud 16 combustion air flow rates.

[0022] FIG. 2 shows the preferred spud arrangement of the present invention. Plural spuds 28, preferably four, six, or eight (six spuds 28 shown), can be provided on the methane riser 12 in fluid communication with a methane gas passageway 30 defined by the methane riser 12. Each spud 28 is a non-straight short pipe that in the preferred embodiment includes at least a radial segment 32 and a distal segment 34 that is angled relative to the radial segment 32. Each distal segment 34 has an open distal end 36 through which methane gas is exhausted.

[0023] As shown, the preferred angular spacing  $\alpha$  between adjacent spuds 28 can be sixty degrees ( $60^\circ$ ). Also, each radial segment 32 of each spud 28 can lie along a respective radius 38 that is defined by the methane riser 12.

[0024] As shown in the preferred embodiment of FIG. 2, a spud angle  $\beta$ , preferably an oblique angle or even a right angle, is defined between each radial segment 32 and its distal segment 34. As indicated in FIG. 2, for every other spud 28, the spud angle  $\beta$  is fifty five degrees ( $55^\circ$ ), with the intervening spuds having spud angles of sixty degrees ( $60^\circ$ ). With the arrangement shown, the distal segments 34 are oriented with their axial dimensions more or less tangent to

the methane riser 12. While FIG. 2 shows each of the individual spud segments 32, 34 to be straight, the segments can also be curved.

[0025] While FIG. 2 shows a preferred non-limiting spud arrangement and configuration, it is to be understood that in general the spuds of the present invention are configured to induce turbulence and mixing of the methane as it exits the spuds 28 and is ignited. In part because of the tangential orientation of the distal segments 34, the methane gas ignites while it is in somewhat of a vortex-type flow pattern. With this cooperation of structure, improved turndown ratios and lower emission levels can be achieved.

[0026] FIGS. 3 and 4 show the preferred louver assembly for covering the top end of the riser 12 below the spuds 28 to establish pressure in the riser. Plural movable louvers (two louvers 40 shown in the exemplary non-limiting embodiment of FIG. 3) are mounted on the riser 12 at or near the top end thereof. In one embodiment, each louver 40 is coupled to the riser 12 (or to supporting structure that can be on the riser 12) by being slidably mounted at or near their outer peripheries to a support 42. The louvers 40 are connected at or near their inner edges to the louver actuator 26 by a linkage 46, such that when the actuator 26 is moved, the inner edges move and up and down, the outer edges slide along the support 42, and the louvers 40 are pivoted thereby between open and closed configurations.

[0027] Accordingly, each louver 40 pivots between a closed configuration, shown in FIG. 3, wherein the top end of the riser 12 is mostly or completely blocked by the louvers 40, and an open configuration, shown in FIG. 4, wherein the top end of the riser 12 is mostly unblocked and gas can flow (in the preferred non-limiting embodiment) around the outer edges of the louvers 40. By establishing the configuration of the louvers 40, the gas pressure within the riser 12 can be established as appropriate for maximizing the turndown rate in combination with the arrangement of the spuds 28 in FIG. 2 while remaining within specifications for carbon monoxide, nitrous oxides, and non-methane organic compounds, i.e., the louvers 40 of the flare 10 can be adjusted to optimize the burning of methane.

[0028] While FIGS. 3 and 4 show a manually activated louver actuator 26, as mentioned above if desired, the actuator 26 could be activated by the computerized control system 27 (FIG. 1) in response to variables such as pressure, temperature, methane gas flow rate, methane gas concentration, etc. that can be sensed by sensors within the flare 10.

[0029] In addition to or as an alternative to the above-described louver assembly that can be positioned in the riser 12 to establish gas pressure in the riser 12, FIG. 5 shows that a louver assembly can be disposed between the riser 12 and the wall of the shroud 16 near the bottom end of the shroud to establish a combustion air flow rate in the flare.

[0030] This second louver assembly in all essential respects can be identical in operation to the louver assembly shown in FIGS. 3 and 4. FIG. 5, however, shows an alternative non-limiting exemplary louver mounting implementation that can be used if desired. Louvers 62 of the louver assembly 60 shown in FIG. 5 can be pivotally mounted between the methane riser 12 and the wall of the shroud 16 to provide a means for establishing combustion air flow in the flare. More specifically, each louver 62 can be



mounted by means of a respective pivot mount **64** to a stationary radial flange **66** in the shroud **16** (or to the wall of the shroud itself, if desired). A manually-activated or computer-activated actuator **68** can be attached through a linkage to the louvers **62** to move the louvers **62** in the directions indicated by the arrows **70**. Regardless of how the louvers are mounted, it may now be appreciated that by moving the louvers **62**, the amount of combustion air flowing to the spud assembly **58** around the outside of the methane riser **12** can be established to maximize/optimize the turndown ratio of the flare.

[0031] If desired, the shroud **16** and riser **12** can be disposed inside of a cylindrical flare housing **72** that extends to the ground to establish an enclosed flare. The housing **72** can be formed with conventional housing louvers **74** near its bottom to establish another means for controlling combustion and quench air flow in the flare.

[0032] FIG. 6 shows an enclosed or utility flare **80** that includes a shroud **82** with multiple (in the exemplary embodiment shown, three) spud assemblies **84** disposed in the shroud **82**. Each spud assembly **84** is substantially identical in configuration and operation to the spud assembly shown in FIG. 2.

[0033] While the particular LANDFILL GAS EXTRACTION FLARE as herein shown and described in detail is fully capable of attaining the above-described objects of the invention, it is to be understood that it is the presently preferred embodiment of the present invention and is thus representative of the subject matter which is broadly contemplated by the present invention, that the scope of the present invention fully encompasses other embodiments which may become obvious to those skilled in the art, and that the scope of the present invention is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more". Moreover, it is not necessary for a device or method to address each and every problem sought to be solved by the present invention, for it to be encompassed by the present claims. Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims. No claim element herein is to be construed under the provisions of 35 U.S.C. §112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or, in the case of a method claim, the element is recited as a "step" instead of an "act". Absent express definitions herein, claim terms are to be given all ordinary and accustomed meanings that are not irreconcilable with the present specification and file history.

We claim:

1. A landfill gas flare, comprising:

a shroud;

a methane riser in the shroud and defining a methane passageway;

plural non-straight pipes mounted in communication with the methane passageway;

at least a first flow alteration assembly surrounding the methane riser to selectively establish a fluid flow through the assembly; and

a second flow alteration assembly positioned within the methane riser.

2. The flare of claim 1, wherein the first flow alteration assembly surrounds the methane riser within the shroud to establish a combustion air flow rate in the shroud.

3. The flare of claim 1, wherein the second flow alteration assembly is positioned within the methane riser to establish a methane gas pressure.

4. (canceled).

5. The flare of claim 2, wherein at least one flow alteration assembly includes movable louvers disposed between the shroud and the methane riser, the louvers being movable to establish a combustion air flow past the pipes.

6. The flare of claim 5, wherein the louvers are coupled to an operating member, the operating member being manipulable in response to a computer signal to move the louvers.

7. The flare of claim 1, comprising plural sets of pipe spuds in the flare, each set including plural spuds arranged generally in a circle, the sets being separated from each other.

8. A landfill gas flare, comprising:

a shroud;

a methane riser in the shroud and defining a methane passageway;

plural non-straight pipes mounted in communication with the methane passageway; and

at least a first flow alteration assembly juxtaposed with the methane riser to selectively establish a fluid flow through the assembly, wherein each pipe includes a radial segment lying along a radius of the methane riser and a distal segment establishing an angle with respect to the radial segment.

9. The flare of claim 8, wherein the angle is approximately fifty five degrees.

10. The flare of claim 8, wherein the angle is approximately sixty degrees.

11. A landfill flare, comprising:

a shroud defining an open top end;

a methane riser in the shroud, the methane riser terminating in at least two exhaust pipes configured for inducing turbulence in methane gas passing through the exhaust pipes; and

a movable louver assembly positioned in at least one of: the riser, and the shroud between the shroud and riser.

12. The flare of claim 11, wherein the louver assembly can be moved to establish a methane gas pressure.

13. The flare of claim 11, wherein the louver assembly includes an operating member, the operating member extending outside the shroud and being manipulable to move the louver assembly.

14. The flare of claim 11, wherein each exhaust pipe includes a radial segment lying along a radius of the methane riser and a distal segment establishing an angle with respect to the radial segment.

15. The flare of claim 11, wherein the louver assembly is movable in response to a computer signal.

**16.** The flare of claim 13, wherein the operating member is manually movable.

**17.** A landfill flare, comprising:

a shroud defining a wall;

a methane gas pipe in the shroud and spaced from the wall, the methane riser terminating in at least two exhaust pipes configured for inducing turbulence in methane gas passing through the exhaust pipes; and

a louver assembly disposed in at least one location selected from the group comprising: between the shroud and the methane riser, and within the riser, the louver assembly being movable.

**18.** The flare of claim 17, wherein the louver assembly includes an operating member, the operating member extending outside the shroud and being manipulable by a person to move the louvers.

**19.** The flare of claim 17, wherein each exhaust pipe includes a radial segment lying along a radius of the methane riser and a distal segment establishing an angle with respect to the radial segment.

**20.** The flare of claim 17, wherein the louver assembly includes an operating member, the operating member extending outside the shroud and being manipulable in response to a computer signal.

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