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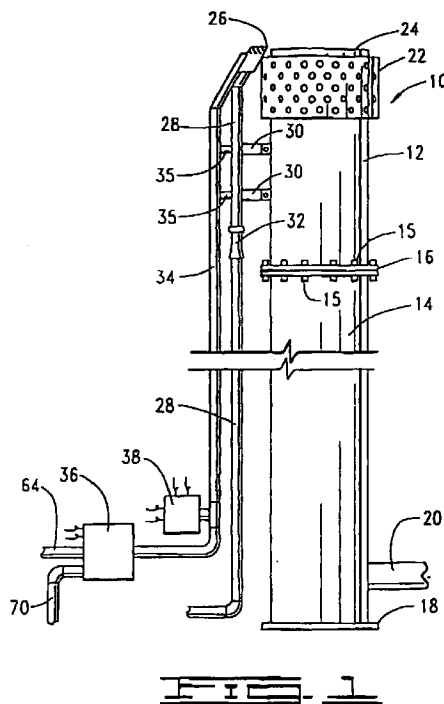
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(54) Flame detection apparatus and method

(57) A flame detection apparatus and method for detecting the presence or non-presence of a flame from a location remote from the flame. The flame detection (34,28,100,120,150) apparatus comprises a conduit extending between the location of the flame to be detected and the remote location, a sound detector (38) connected to the conduit at the remote location for detecting sound conducted to it by the conduit and generating a signal representative thereof and means for receiving the signal and indicating the presence or non-presence of the flame in response thereto.



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Description

[0001] The present invention relates to a flame detection apparatus and method for detecting the presence or non-presence of a flame from a location remote from the flame.

[0002] Burners for combusting fuel and air mixtures generally include one or more pilot burners for igniting the fuel and air mixture when the burner is operated. Usually the main burners are operated intermittently and the pilot burners are operated continuously. In order to prevent explosions or the like, when the pilot burner malfunctions and an ignition flame is not provided, pilot flame detection apparatus are provided and are commonly set up to shut off the fuel to the burner if a pilot flame is not present.

[0003] Flares or flare stacks are used for combusting and disposing of combustible wastes and other materials. Flare stacks are commonly located at production, refining and processing plants for disposing of combustible wastes or other combustible streams which are diverted during venting, shut downs, upsets and/or emergencies.

[0004] Flares generally also include continuously operated pilot burners and flame detection apparatus which are often located at the elevated open discharge ends of the flares at the tops of stacks. Because of the heights of such flare stacks and the high temperatures experienced during flaring, failures of flame detection apparatus have often occurred and have been relatively difficult to repair and replace.

[0005] One prior art flame detection system for flares includes a thermocouple for generating a thermoelectric current when heated by a pilot flame. When the pilot flame is not present, less thermoelectric current is generated which is electronically sensed and an alarm is indicated.

[0006] Optical systems have heretofore also been developed for use with flare stacks which are mounted on the ground and detect the presence or non-presence of flame at the top of the flare stacks. However, such systems are susceptible to false readings as a result of varying weather conditions and the like. In addition, they may not distinguish between the pilot flame and the main flame.

[0007] Other infrared, ultraviolet, optical and acoustical flame detection devices have been developed and used with burners and flares, but they also must be mounted relatively close to the flame being detected to be effective, i.e., within a metre or less and are subject to rapid deterioration due to intense heat and are difficult to repair or replace.

[0008] According to the present invention, there is provided a flame detection apparatus for detecting the presence or non-presence of a flame at a location remote from the flame, said apparatus comprising:

a pipe having an end positioned with respect to said

flame and length whereby sound produced by said flame is conducted by said conduit to a location remote from said flame;

a sound detector connected to said conduit at said location remote from said flame for detecting sound conducted by said conduit and for generating a signal representative of said sound; and
means for receiving said signal and for indicating the presence or non-presence of said flame in response thereto.

[0009] The flame detection apparatus of this invention can be located a relatively long distance from the flame being monitored whereby it is not subjected to intense heat, is resistant to changing weather conditions and can easily be serviced or replaced.

[0010] A sound detector is connected to the conduit positioned at a location remote from the flame, i.e., at about 1 metre to 200 metres or more from the flame. The sound detector detects sound produced by the flame and conducted by the conduit and generates an electric signal representative of the sound. Electronic means are provided for receiving the electric signal and for indicating the presence or non-presence of the flame in response thereto.

[0011] The method of this invention basically comprises the steps of conducting sound from the location of the flame being monitored to a remote location; detecting the sound at the remote location and producing an electric signal representative thereof, and electronically indicating the presence or non-presence of the flame from the electric signal representative of the sound.

[0012] While the apparatus and method of this invention can be used for detecting the presence or non-presence of any flame including pilot burner flames and process burner flames, they are particularly suitable for use in applications involving relatively long distances between the locations of the flames and the remote locations of the flame detector such as flare stack applications.

[0013] In order that the present invention may more readily be understood, the following description is given, merely by way of example, reference being made to the accompanying drawings in which:-

Figure 1 is a side elevational view of a flare stack including one embodiment of detection apparatus of the present invention;

Figure 2 is a top plan view of the flare stack of Figure 1;

Figure 3 is an enlarged schematic view of the pilot burner ignition flame generator shown in Figure 1; Figure 4 is an enlarged schematic view of the flame detector illustrated in Figure 1;

Figure 5 is an enlarged view of the pilot burner and sound conducting conduit illustrated in Figure 1;

Figure 6 is a cross-sectional view taken along lines

6-6 of Figure 5;

Figure 7 is a cross-sectional view taken along lines 7-7 of Figure 5;

Figure 8 is a side elevational view of the flare stack of Figure 1 showing a second embodiment of the flame detection apparatus of the present invention;

Figure 9 is a partial side elevational view of the flare stack of Figure 1 showing a third embodiment;

Figure 10 is a side view of a pilot burner for use in a process burner or the like including the flame detection apparatus of the present invention;

Figure 11 is a side view of the pilot burner of Figure 10 illustrating an alternative arrangement of the flame detection apparatus of the present invention; and

Figure 12 is a side cross-sectional view of a process burner including the flame detection apparatus of the present invention.

[0014] Figures 1 and 2 show a flare stack 10 including the improved flame detection apparatus of the present invention, the flare stack 10 including a flare 12 and stack 14 which are bolted together by a plurality of bolts 15 at a flanged connection 16. While the heights of flare stacks vary depending upon various factors, most flare stacks utilized in production, refining and processing plants range in height from about 6 metres to as high as about 200 metres. The bottom end of the stack 14 is closed by a ground level base plate 18 and one or more waste gas inlet pipes 20 located at or near ground level are connected to the stack 14.

[0015] The flare 12 (also sometimes referred to as a flare tip) may include a cylindrical perforated wind deflector 22 attached thereto adjacent to the upper open discharge end 24 of the flare 12 and at least one pilot burner 26 positioned adjacent the open discharge end 24. The pilot burner 26 is usually operated continuously to provide a continuous flame for igniting streams of combustible gases which are intermittently flowed to the flare stack 10.

[0016] Pilot burner 26 is connected to a pipe 28 which is attached to the flare 12 by a plurality of brackets 30. A conventional fuel-air mixer 32 is disposed in the pipe 28 near the flanged connection 16 between the flare 12 and stack 14, and the pipe 28 is connected to a source of combustible fuel gas, such as methane. Fuel gas is mixed with inspired air as it flows through the mixer 32, the mixture flows through the pipe 28 above the mixer 32 to the pilot burner 26 and is burned within and adjacent to the pilot burner 26.

[0017] A second pipe 34 extends from the pilot burner 26 to a location at or near ground level and is attached to the pipe 28 by a plurality of brackets 35. The pipe 34 is connected at its upper end to the pilot burner 26 and to an ignition flame generator 36 at its lower end. In addition, a flame detector assembly 38 is connected to the pipe 34 near ground level between the ignition flame generator 36 and the pilot burner 26.

[0018] An ignition flame generator 36 is operated to produce a flame which is propagated through the pipe 34 to the pilot burner 26. When the ignition flame exits the pipe 34, it ignites the fuel-air mixture flowing from the pilot burner 26. After the pilot burner 26 is ignited, the ignition flame generator 36 is shut off.

[0019] The sound produced by the flame (not shown) of the pilot burner 26 is conducted by the pipe 34 to the flame detector assembly 38, which continuously indirectly detects the sound or lack of sound, which indicates the presence or non-presence of the flame at the pilot burner 26. If the flame of the pilot burner 26 is extinguished for any reason, the flame detector assembly 38 provides a warning such as a light and/or audible alarm so that the pilot burner 26 can immediately be reignited. Preferably the ignition flame generator 36 can be set up to be electronically operated each time the flame detector assembly 38 detects the non-presence of a flame at the pilot burner 26.

[0020] Referring now to Figures 5-7, the pilot burner 26 and the upper end portions of the pipes 28 and 34 are illustrated in detail. The pilot burner 26 comprises a cylindrical perforated wind shield 40 which is attached to a conventional pilot burner nozzle (or tip) 42 which is in turn attached to the pipe 28. The nozzle 42 includes one or more fuel-air mixture discharge orifices 44 therein for discharging the fuel-air mixture in a pattern which produces a stable pilot flame.

[0021] As best shown in Figure 7, the cylindrical wind shield 40 includes a side opening formed therein within which the top end portion 48 of the pipe 34 is welded. An elongated end segment of the pipe 34 within the wind shield 40 is removed and the top end of the pipe 34 outside the wind shield 40 is closed whereby the pipe 34 opens into the wind shield 40 by way of an opening 50 extending below, beside and above the nozzle 42.

[0022] A variety of pilot burner 26 and flame sound-conducting pipe 34 designs and arrangements can be chosen, it only being necessary that the sound produced by the presence of a flame be conducted to the remote location where the flame detector assembly 38 of this invention is mounted.

[0023] Referring now to Figure 3, the ignition flame generator 36 includes a plate 52 upon which a transformer 54 is located connected to an electric power source (not shown) by wires 56. Wires contained within an electric wire conduit 60, connect transformer 54 to an enclosed spark plug 58, which is connected to a fuel-air ignition chamber 61 having a sight glass 62 therein. The chamber 61 is connected to an air inlet conduit 64 having a shut-off valve 66 and a pressure gauge 68 disposed therein and to an ignitor fuel gas conduit 70 having a shut-off valve 72 and pressure gauge 74 disposed therein by way of a T-connection 76.

[0024] In operation of the ignitor flame generator 36, a combustible fuel gas-air mixture is flowed to the pilot burner 26 by way of the conduit 28. The valves 66 and 72 of the ignitor flame generator 36 are then opened to

produce a combustible fuel gas-air mixture which flows into the chamber 61 and through the conduit 34 to the pilot burner 26. The transformer 54 is operated by pushing the button 55 thereon to spark the spark plug 58 and ignite the fuel gas-air mixture flowing through the chamber 61. The sight glass 62 provides a visual indication of the ignition. The flame flows through the opening 50 of the conduit 34 within the wind shield 40 of the pilot burner 26 whereby the fuel gas-air mixture being discharged by the nozzle 42 is ignited. After the ignition of the pilot burner 26 has been accomplished, the valves 66 and 72 of the ignition flame generator 36 are closed.

[0025] Referring now to Figure 4, the flame detector assembly 38 is shown enclosed in a housing 78 and includes a sound detector 80 which is sealingly connected to the conduit 34. The sound detector 80 is an electronic acoustic vibration receiver such as a microphone, a piezoelectric crystal, a geophone or the like, which converts the sound conducted to it into an electric signal which is conducted to an electronic network 84 by wires 82. The electronic network 84 filters the electric signal to a signal representative of one or more preselected frequency bands, the signal then being conducted by wires 86 to an electronic energy detecting circuit 88 which determines the energy content of the electric signal at the preselected frequency band or bands thereby to indicate the presence or nonpresence of the pilot burner flame. That is, if the energy content of the signal is equal to or higher than a predetermined energy content for the preselected frequency band or bands, the presence of flame is indicated. If lower, the non-presence of the flame is indicated.

[0026] Various other techniques can be used to electronically analyze the signal produced by the acoustic vibration receiver in order to detect the presence or non-presence of the flame. For example, the signal can be analyzed to determine the presence or non-presence of an energy peak at a preselected frequency band or bands; or the shape of a plot of the signal frequency versus energy can be compared to a standard plot indicating the presence of flame; or the rate of change of the frequency versus energy in a preselected frequency band or bands can be compared to the rate of change when a flame is present.

[0027] Electric power is provided to the electronic components 84 and 88 by a transformer 92 connected to an electric power supply (not shown) by wires 94 and to the electronic component 88 by wires 90. The presence or non-presence of the pilot burner flame is indicated by the electronic component 88 by an electric signal which is conducted by wires 96 to an alarm and/or other electronic system, e.g., a system for automatically operating the ignition flame generator 36.

[0028] In carrying out the step of indicating the presence or non-presence of the flame electronically or otherwise from an electric or other signal, e.g., microwave, light wave, etc., generated by the sound detector, various techniques can be utilized.

[0029] The apparatus and method of this invention can be utilized with flare sacks or other burners which do not include ignition flame generators and separate conduits for conducting ignition flames to the burners or pilot burners thereof. In those applications where an existing conduit for conducting sound to the detection apparatus is not available, an additional conduit for conducting the sound can be installed. Also, as illustrated in Figure 8, if for some reason it is undesirable to utilize the ignition flame generator conduit 34 for conducting flame sound, a separate conduit 100 can be installed and the flame detector assembly 38 can be connected to it as shown.

[0030] In another arrangement as shown in Figure 9, if an existing ignition flame conduit is unavailable and if installing an additional conduit is undesirable, the flame detector assembly 38 can be connected to the pipe 28 at a remote location from the flame of the pilot burner 26 above the fuel-air mixer 32. While the fuel-air mixture for the pilot burner 26 flows through that portion of the pipe 28, the flame detector assembly 38 is still capable of detecting the presence or non-presence of flame sound and determining the presence or non-presence of flame at the pilot burner.

[0031] Referring now to Figure 10, a pilot burner assembly 110 for use in a process burner, boiler burner or the like is illustrated and includes a pilot burner tip 112 connected to a fuel-air mixture pipe 114. A fuel-air mixer 116 is connected to the pipe 114 which is in turn connected to a fuel gas supply pipe 118. A flame sound conducting conduit 120 attached to the fuel-air mixture pipe 114 by brackets 122 extends from the pilot flame discharge end of the burner tip 112 to a location remote from the burner tip 112 where a flame detector assembly of the present invention 124 is connected to the conduit 120. In operation of the apparatus of Figure 10, fuel gas is supplied to the fuel-air mixer 116 and the resulting fuel-air mixture flows by way of the pipe 114 to the burner tip 112 wherein the mixture is discharged and continuously burned. The sound of the flame issuing from the burner tip 112 is conducted by the conduit 120 to the flame detector assembly 124. The flame detector assembly 124 is identical in structure and operation to the flame detector assembly 38 described above.

[0032] Referring now to Figure 11, the pilot burner 110 of Figure 10 is shown having an alternative arrangement of the flame detection apparatus of the present invention. Instead of being attached to an elongated conduit 120, the flame detector assembly 124 is attached directly to the fuel-air mixture pipe 114. While the fuel-air mixture continuously flows through the pipe 114, the flame detector assembly 124 can still detect the presence or non-presence of a flame issuing from the burner tip.

[0033] Figure 12 is a side cross-sectional view of a process burner including a further flame detection apparatus 130 which includes a burner housing 132 connected through an opening in the insulated wall 134

of a process heater. The housing 132 includes a combustion air inlet 136 having a damper 138 therein. A fuel gas supply pipe 140 having a burner tip 142 connected thereto is disposed within a guide tube 144 attached within the housing 132. The burner tip 142 extends into a flame holder 146 attached to the guide tube 144. Fuel gas which is discharged by way of the burner tip 142 mixes with combustion air flowing through the housing 132 and is combusted within the process heater to which burner 130 is attached.

[0034] A flame detection apparatus 148 of the present invention comprises a flame sound conductor pipe 150 and a flame detector assembly 152 identical in structure and operation to the flame detector assembly 38 described above is attached to the burner 130. That is, the sound conducting pipe 150 is connected through the housing 132 of the burner 130 with the inner end of the pipe 150 positioned adjacent to the flame holder 146. The flame detector assembly 152 is connected to the external end of the pipe 150 at a location remote from the burner flame.

[0035] In operation, a fuel-air mixture is discharged from the burner 130 and burned within the furnace to which the burner 130 is attached. The sound of the flame is conducted by the conduit 150 to the remotely positioned flame detector assembly 152 which functions in the manner described above to detect the presence or non-presence of the flame.

[0036] The flame detection apparatus and method can be utilized to detect and monitor any flame including, but not limited to, flames produced by pilot burners, process burners, boiler burners and any other flame producing burner or device. The term "flame" is used herein to mean any flame or combustion reaction which produces detectible sound. The flame detection apparatus of this invention can be utilized with burners that combust liquid fuel as well as gaseous fuel and that any oxidizer such as air, oxygen or other oxidizing substance can be used to support the combustion.

Claims

1. Flame detection apparatus for detecting the presence of non-presence of a flame at a location remote from the flame, said apparatus comprising:

a pipe (34,28,100,120,150) having an end positioned with respect to said flame and length whereby sound produced by said flame is conducted by said conduit to a location remote from said flame;

a sound detector (38,120,124,152) connected to said conduit at said location remote from said flame for detecting sound conducted by said conduit and for generating a signal representative of said sound; and

means (38,82-90) for receiving said signal and for indicating the presence or non-presence of

said flame in response thereto.

2. Apparatus according to claim 1, wherein said signal generated by said sound detector is an electric signal.
3. Apparatus according to claim 1 or 2, wherein said means for receiving said signal and indicating the presence or non-presence of said flame comprises electronic circuitry which determines the energy content of said signal at one or more preselected frequency bands to thereby indicate the presence or non-presence of said flame.
4. Apparatus according to claim 1 or 2, wherein said means for receiving said signal and indicating the presence or non-presence of said flame comprises electronic circuitry which determines the presence or non-presence of an energy peak in said signal at one or more preselected frequency bands to thereby indicate the presence or non-presence of said flame.
5. Apparatus according to claim 1 or 2, wherein said means for receiving said signal and indicating the presence or non-presence of said flame comprises electronic circuitry which determines the shape of a plot of the frequency of said signal versus energy and compares said shape with a standard plot to thereby indicate the presence or non-presence of said flame.
6. Apparatus according to claim 1 or 2, wherein said means for receiving said signal and indicating the presence or non-presence of said flame comprises electronic circuitry which determines the rate of change of the frequency of said signal versus energy at one or more preselected frequency bands to thereby indicate the presence or non-presence of said flame.
7. Apparatus according to any preceding claim, wherein said sound detector comprises an electronic acoustic vibration receiver.
8. Apparatus according to any one of claims 1 to 6, wherein said sound detector comprises a microphone or a piezoelectric crystal.
9. A combustible fluid stream flare stack (10,110) including a stack (14,114) having a flare (12,112) and a pilot burner (26) adjacent said flare, wherein a detection apparatus according to any preceding claim has said end of said sound detector pipe (38,120,124,152) adjacent said flare.
10. A stack according to claim 9 and further comprising an ignition flame generator (36) connected to said

pipe for producing an ignition flame for igniting said pilot burner that propagates through said pipe to said pilot burner.

11. A method of detecting the presence or non-pres- 5
ence of a flame at a location remote from the loca-
tion of the flame comprising the steps of:
- conducting sound through a conduit from the
location of said flame to said remote location; 10
detecting the sound at said remote location and
producing a signal representative of said
sound; and
indicating the presence or non-presence of 15
said flame from said signal representative of
said sound.
12. A method according to claim 11, wherein said sig-
nal is an electric signal and the presence or non-
presence of said flame is electronically determined 20
from said electric signal.
13. A method according to claim 11 or 12, wherein said
flame when present is issued from a pilot burner for
igniting a combustible gas stream. 25
14. A method according to claim 11, 12 or 13, which
further comprises the step of igniting said pilot
burner when required by generating an ignition
flame and propagating it through said conduit to 30
said pilot burner.

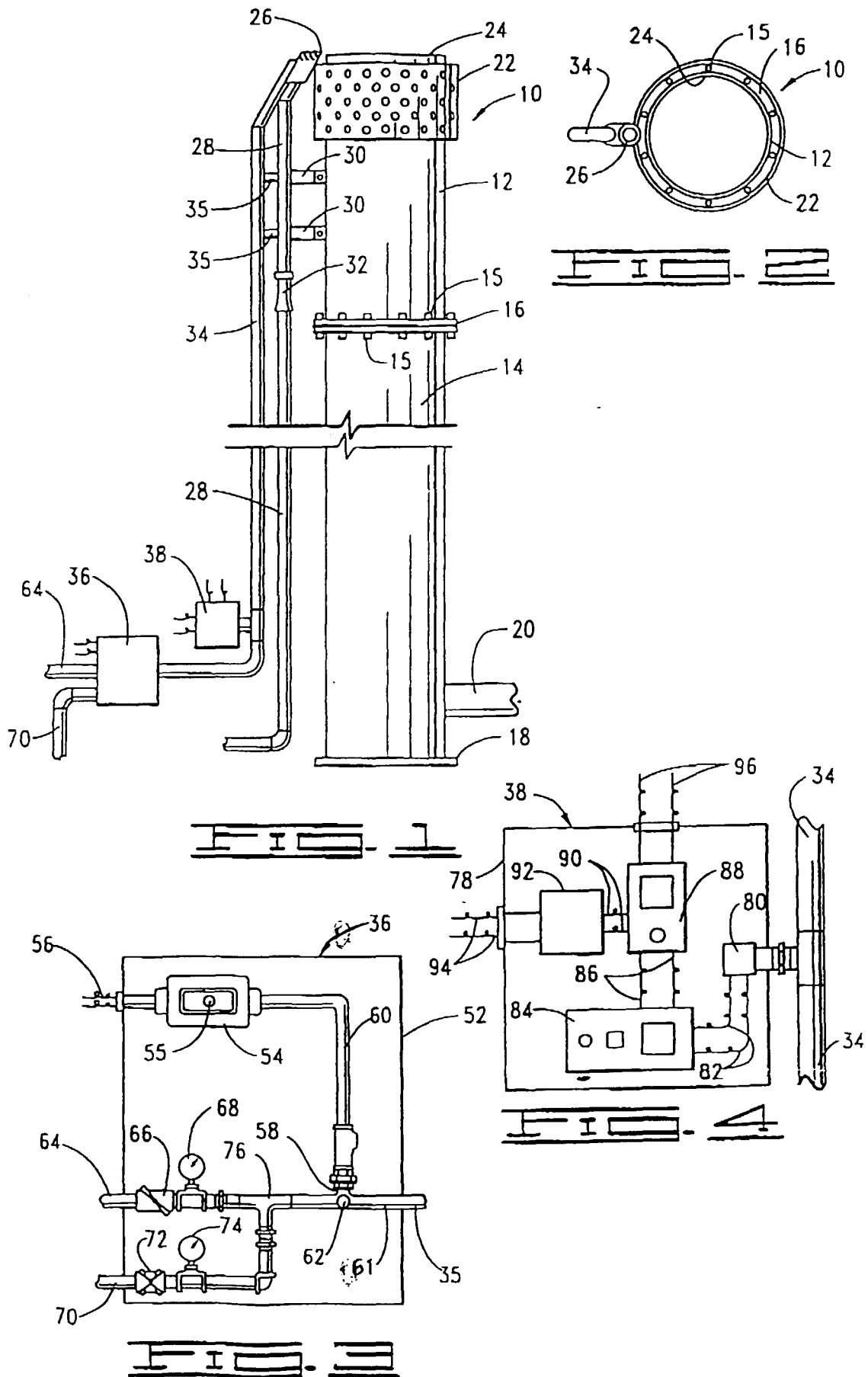
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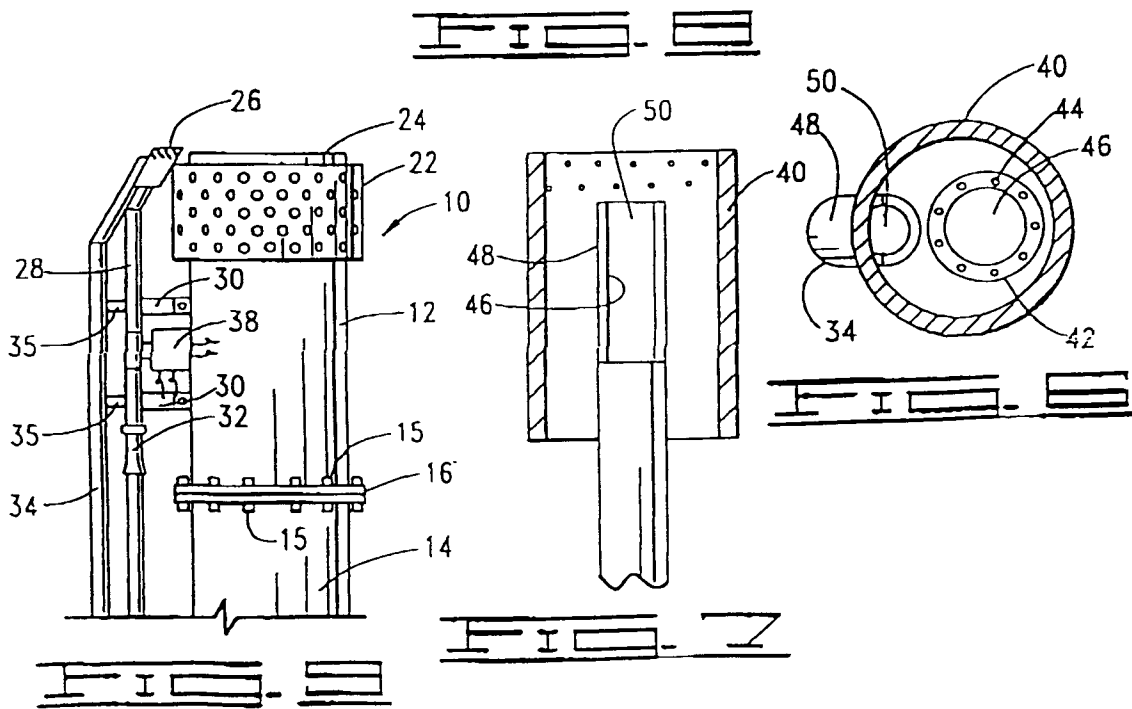
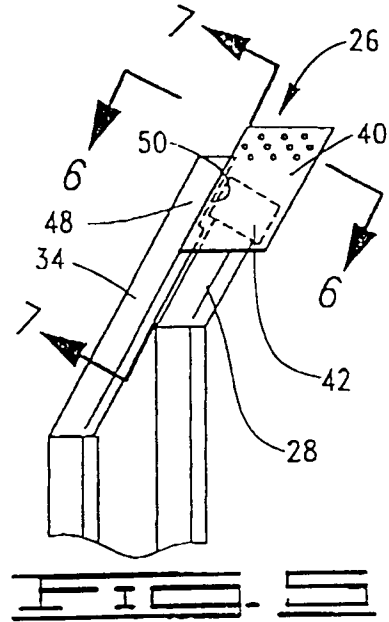
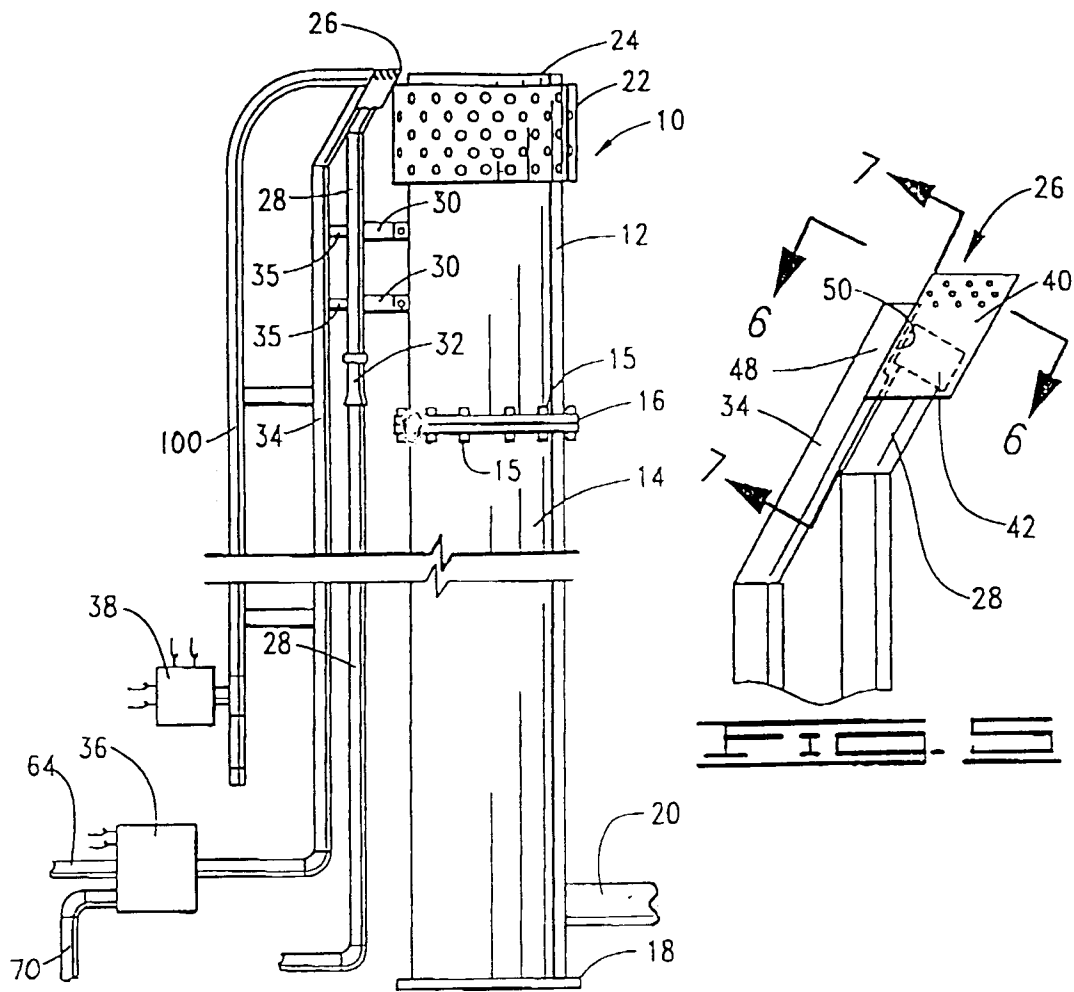
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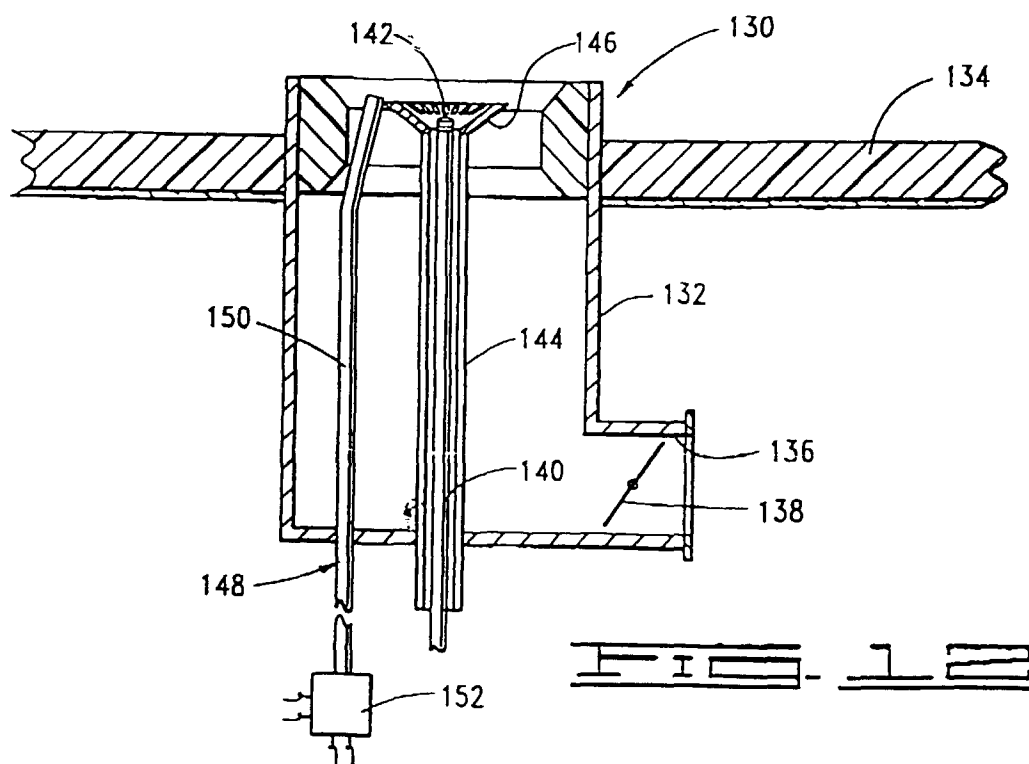
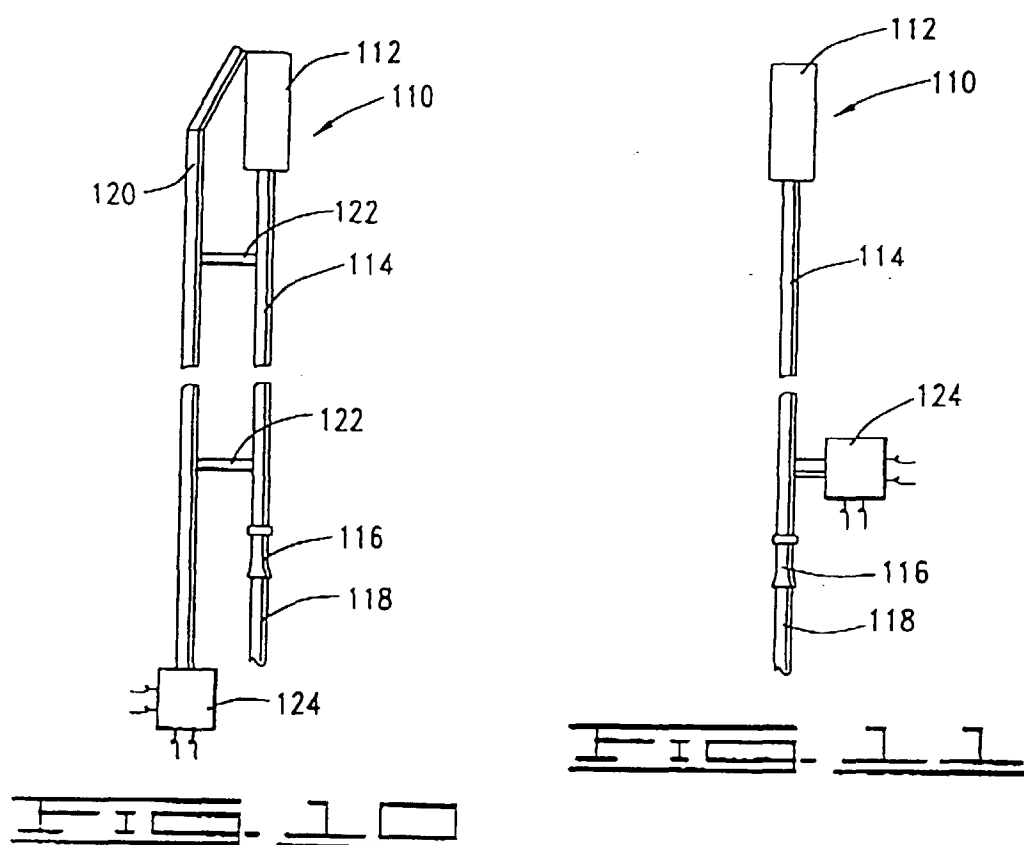
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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 0830

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 009, no. 057 (M-363), 13 March 1985 & JP 59 191812 A (NIPPON KOKAN KK), 31 October 1984, * abstract; figure *	1,2,7,8, 11-13	F23N5/16 F23G7/08
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A	US 3 811 816 A (WHITMAN) 21 May 1974 * column 2, line 59 - column 5, line 28; figure *	1-4,6, 11,12	
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A	EP 0 428 373 A (CONTROL TECHTRONICS) 22 May 1991 * abstract; figures *	1,3-6,11	
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17 June 1998	Examiner Kooijman, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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