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Reed

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[54] PURGE GAS ADMISSION CONTROL FOR FLARE SYSTEM

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[52] **U.S. Cl.** .... **431/202,** 23/277 C
[51] **Int. Cl.** **F23d 13/20**
[58] **Field of Search** .... 431/202; 23/277 C

[56] **References Cited**
UNITED STATES PATENTS

2,779,399	1/1957	Zink et al.	431/202
3,658,482	4/1972	Evans et al.	23/277 C
3,667,408	6/1972	Jasinsky et al.	431/202 X

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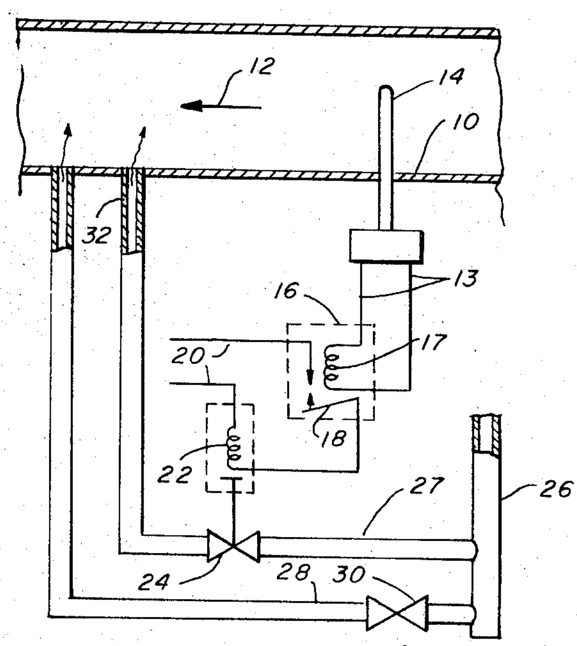
[57] **ABSTRACT**

This invention describes a system for controlling the rate of flow of purge gas through a flare stack system as a function of the temperature of the gases inside of the flare stack.

10 Claims, 7 Drawing Figures



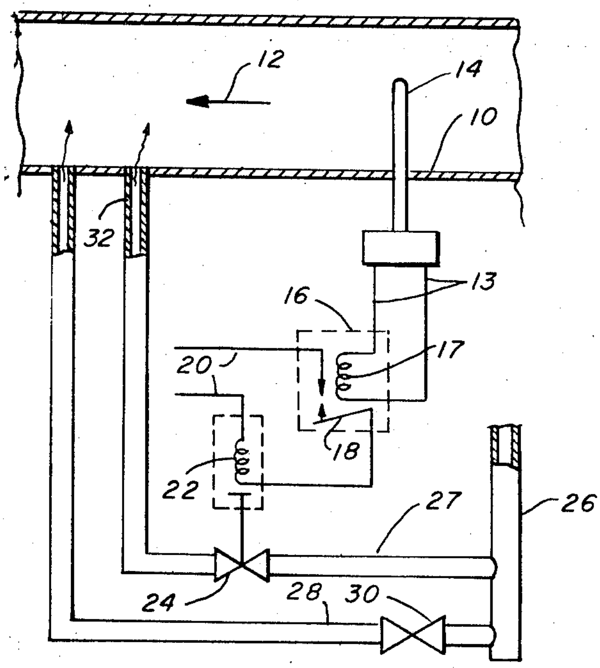


FIG. 1

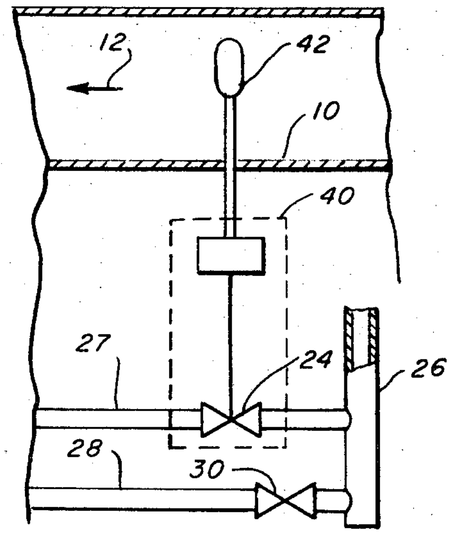


FIG. 2

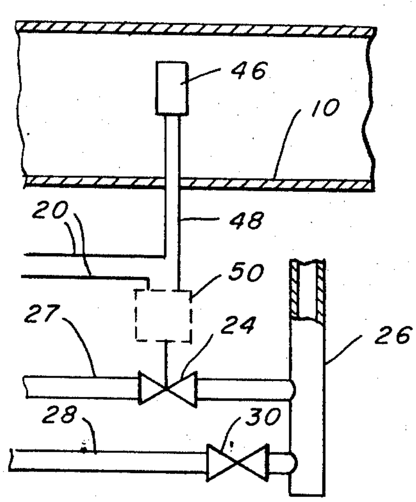


FIG. 3

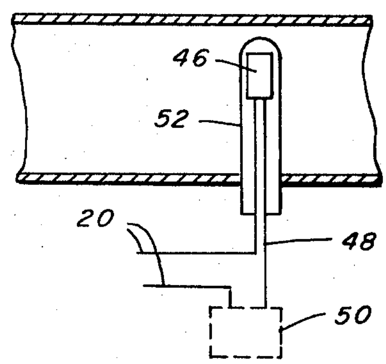


FIG. 6

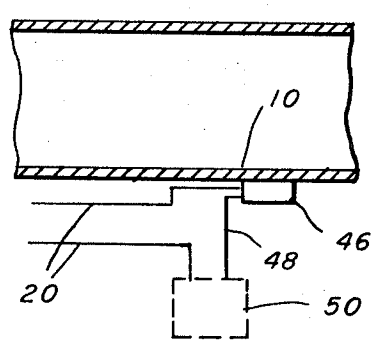


FIG. 7

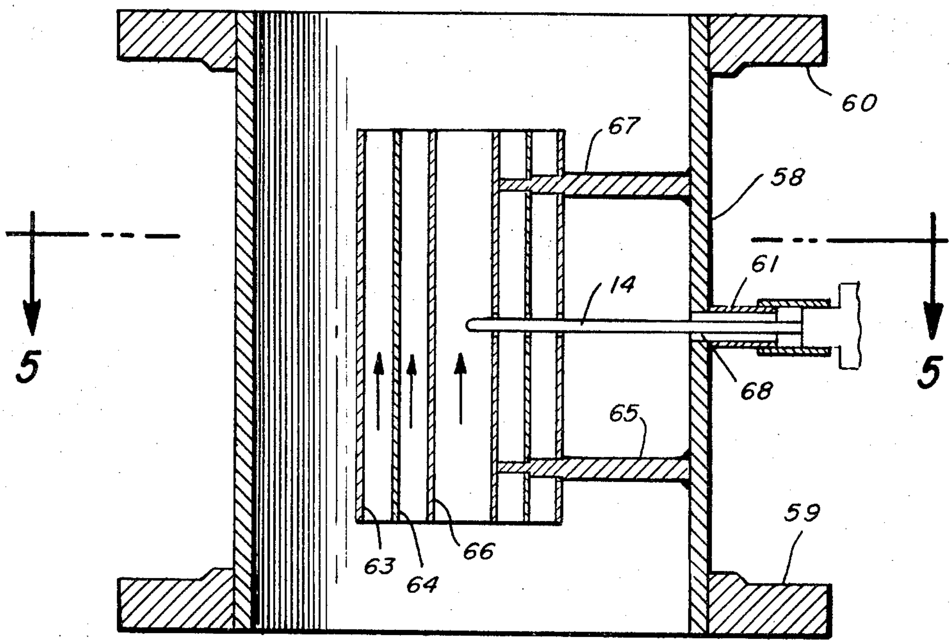


FIG. 4

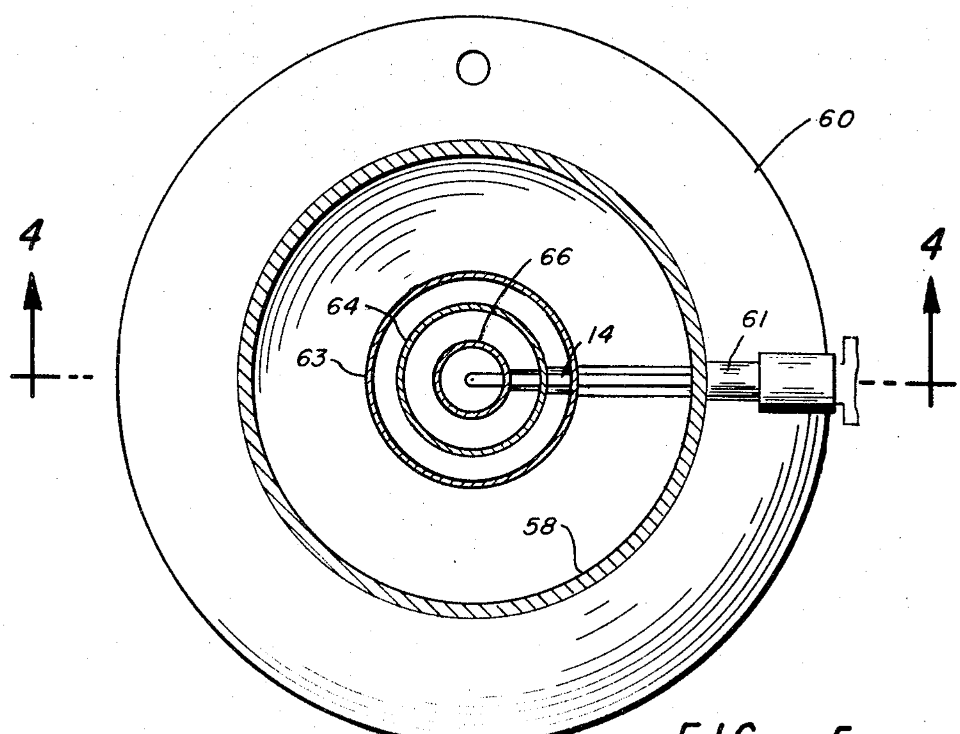


FIG. 5

PURGE GAS ADMISSION CONTROL FOR FLARE SYSTEM

BACKGROUND OF THE INVENTION

In chemical and petroleum refining systems it is necessary to maintain a flare stack, through which combustible, usually waste, gases can be released, in such a way as to be always safely available to accept and burn such gases as the need arises. Often very large quantities of flare gas become available, sometimes in emergency situations, which gases are generally at a temperature in excess of 250° to 300° F. A constantly burning pilot flame is provided so that any gas introduced into the flare stack will be ignited without fail.

When the flaring of gas is stopped at the conclusion of the emergency, the stack, and the gas in the stack, which have been at an elevated temperature, begin to cool to ambient temperature. As a result, the pressure of the gas in the stack reduces proportionately to the absolute temperature of the gas. This reduction in pressure permits atmospheric air to be drawn into the top of the flare stack. This creates a dangerous situation. When the next flaring of gas is required, because of the combustible nature of the flared gas, the presence of the air can provide an explosive mixture which is easily ignited because of the constantly burning pilot.

In order to keep the system air-free at all times, it is common to admit to the system a quantity of 'purge' or 'sweep' gases to maintain constant slow movement of gases through the system enroute to the exit point.

Two factors govern the purge or sweep gas movement. One factor is due to the passage of wind across the open discharge end of the stack. To counter this effect it is common to use what is called a molecular seal in which there are two 180° F. flow reversals. Such seals are described in U. S. Pat. Nos. 3,289,729 and 3,055,417. This allows entry of outside air only to the structure downstream of the molecular seal which is generally placed immediately below the point at which ignition occurs. For large flare stacks this is an expensive addition to the stack, and does not provide a complete solution to the problem.

The second factor is temperature change within the system due either to meteorological conditions or due to the flaring of waste gases at significant temperature level. For example, in a flare stack thirty inches in diameter and five hundred feet tall the system volume is approximately 2,400 cubic feet. Assuming such a volume is filled with flare gases at 250° F. during a flaring period, when the discharge of hot gases is stopped, the system would cool to ambient temperature in about 15 minutes.

The volume of gases within the flare stack at atmospheric pressure would decrease proportionately to the absolute temperature, to approximately 1,700 cubic feet. Thus, air will be drawn into the stack in the amount of 2,400 minus 1,700 or approximately 700 cubic feet. This would cause an air penetration down the stack of approximately 150 feet. Since this column of air would travel for a period of 15 minutes it corresponds to a velocity of 0.15 feet per second. Thus, a thirty inch stack would require about 700 cubic feet of purge gas, or to provide a margin of safety, approximately 800 cubic feet, each 15 minutes. The hourly volume would be about 3,200 SCFH.

When the system is at ambient temperature there is no longer need for this large flow of purge gas at 0.15 feet per second. A nominal flow velocity of about 0.03 feet per second is adequate to ensure that air is kept out of the stack at all times.

SUMMARY OF THE INVENTION

This invention provides means to switch from the large to the small rate of flow of purge gas. A saving of approximately 80 percent in the cost of gas during the 95 percent of the time that the flare system is ambient. In terms of conventional cost of the purge gas, this would mean savings of $1.00 per hour or more in the cost of the purge gas.

The invention further provides thermostatic means for determining the temperature in the flare stack and controlling the flow of purge gas in accordance with the temperature. When the temperature is above ambient, the flow rate is increased. When the temperature again drops back to ambient, the flow rate is decreased.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a preferred embodiment of the invention.

FIGS. 2 and 3 show alternate embodiments.

FIGS. 4 and 5 indicate the manner in which the temperature sensing element can be installed in the flare stack.

FIGS. 6 and 7 illustrate alternate methods of installation of the temperature sensor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

FIG. 1 illustrates a preferred embodiment of this invention. A flow duct through which the flare gases flow to a stack or a flare stack, per se, is indicated by numeral **10** and the direction of flow of the flare gases by the arrow **12**. Any form of stack, not shown in these views, may be used such as shown in U. S. Pat. Nos. 2,779,399 and 3,134,424. A temperature sensor **14** is inserted through the wall of the duct, which can be a pipe leading to the vertical stack, or can be the stack itself. Assuming that the temperature sensor **14** is a thermocouple, this is then connected by leads **13** to a relay **16** with operating coil **17** and relay switch **18**. A power supply **20** is provided which is connected to a solenoid coil **22** of a valve **24** through the relay switch **18**. When the temperature is higher than a preset value, the relay switch **18** closes, the power is applied to the solenoid coil **22**, which opens the valve **24** and allows purge gas flow from supply line **26** through pipe **27**, through valve **24** and pipe **32** into the duct **10**, which is downstream from the temperature sensor **14** to prevent a counter cooling effect of the purge gas. Purge gas is also continuously supplied through pipe **26** to pipe **28** through valve or metering means **30** at the minimum flow requirement, e.g. 0.03 feet per second. The flow rate through pipe **27** is set by conventional means such as valve or orifice, to the maximum flow rate desired, less that being supplied by pipe **28**. For example, 0.15

minus 0.03 feet per second. Thus when the waste gas, or stack temperature is ambient or low, the only gas flowing from the supply line **26** into the duct is that which flows through control **30** of pipe **28** to duct **10**. When the temperature is high, and a higher rate of flow is required, the solenoid valve **24** opens and additional flow enters through pipe **27** into the duct **10** at point **32**.

FIG. **2** illustrates a variation of the system of FIG. **1** in which a capillary system is used for the temperature measuring and actuating system. Capillary systems are available on the market as operating control systems, and generally involve a bulb **42** filled with suitable liquid such as mercury, glycol, oil, etc. When the bulb is heated the liquid expands and creates a pressure in the valve control box **40**. This pressure is sufficient to operate the valve and open it. When the temperature drops, the pressure in the capillary system falls, and the valve is allowed to close, shutting off the flow of extra purge gas. FIG. **3** illustrates a second variation of FIG. **1** in which the temperature sensing element is a bimetallic switch **46**. As the temperature increases the bimetallic strip bends, creating a force which actuates a switch, the closing of which passes current by way of line **48** to the solenoid valve **50**. Operating power is supplied by means of the leads **20**. This system like that of FIG. **1** requires auxiliary power **20** whereas the capillary system of FIG. **2** is self-sufficient and does not require auxiliary power by leads **20**. The configuration of purge gas supply line **26** and lines **27** and **28** is the same as in FIG. **1**.

In FIGS. **1**, **2** and **3** the sensing element is shown as being inserted through the sidewall of the duct. FIGS. **4** and **5** illustrate a specific means to accomplish this. The instrument may be a part of a section of vertical stack section **58** joined by welding or by flanges **59** and **60** into the duct or stack. In the center of the cylindrical shell **58** is a shielding area comprised of a set of two or more concentric tubes **62**, **64** and **66** which are coaxial with the shell and retained to the wall **58** by bracket means **65** and **67**. An opening **68** is provided through the wall **58** and through the pipes **64** so that the temperature sensor **14** can be inserted from the outside. A mounting nipple **61** is provided to conveniently support the sensing element. This can be either a thermometer of the bimetallic type, thermocouple, capillary device, or other similar means.

The system indicated in FIGS. **4** and **5** represent a modified velocity thermocouple and provides a sensitive installation which is in direct contact with the gases inside of the stack. It is possible as shown in FIG. **6**, as is well known, to insert a thermometer well through the sidewall of the stack into which the temperature sensor **46** is inserted. This provides protection for the temperature sensor. Another method is illustrated in FIG. **7** where the temperature sensor **46** is mounted on the outside wall of the stack or duct **10** and thus is protected from the corrosive gases inside the stack.

The sample valves chosen for sizes of stack and flow rates of purge gas, etc. which were given above, are only by way of example and any desired temperature settings can be chosen for the control of the high and low flow rates of the purge gases. Purge gases are preferably that gas or mixture of gases which cannot reach dewpoint at any ambient temperature.

As used herein "flare stack system" includes the waste gas supply conduit or duct and a flare stack receiving such waste gas.

What is claimed:

1. In a flare stack system for the flaring variable quantities of combustible and potentially explosive gases, the improvement comprising:

a. temperature sensing means in the flare stack system to determine the temperature of the gases therein;

b. means to flow purge gas through said system downstream of said temperature sensing means; and

c. means responsive to said temperature sensing means for controlling the rate of flow of said purge gas, between at least a low and a high rate of flow as a function of said temperature.

2. The flare system as in claim **1** in which said temperature sensing means includes thermocouple means, and including relay means controlled by said thermocouple means.

3. The flare system as in claim **1** in which said temperature sensing means includes capillary sensor means.

4. The flare system as in claim **1** in which said temperature sensing means includes bimetallic switch means.

5. The flare system as in claim **1** including short cylindrical pipe means supported axially in said stack, and means to position said temperature sensor inside said pipe means.

6. The flare system as in claim **5** in which said sensor is introduced through said stack and said pipe transverse to their axis.

7. The flare system as in claim **1** in which said temperature sensing means is mounted inside of a thermowell which passes through the sidewall of said stack.

8. The flare system as in claim **1** in which said temperature sensing means is mounted on the outside of the wall of said stack.

9. In a flare stack system for the flaring variable quantities of combustible and potentially explosive gases, the improvement comprising:

a. means to sense the temperature of gases within said flare stack system;

b. first and second purge gas inlet circuits to said system located downstream of said temperature sensing means;

c. means to maintain a constant minimal flow of said purge gas through said first conduit;

d. means responsive to said temperature sensing means to supply additional flow of purge gas through said second conduit as a function of said temperature.

10. A flare system of claim **1**, the further improvement of means surrounding said temperature sensing device to avoid heat loss therefrom by radiation to cooler duct walls.

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