This invention relates to a flash point analyzer, and more particularly to an automatic, continuous flash point analyzer.

Certain liquid hydrocarbon products (e.g., household fuel oil) must have, as one of their specifications for marketing purposes, a stated flash point. It is important, therefore, to ascertain the flash point (stated as a temperature) of such products during manufacture thereof. Also, the flash points of other flammable liquids (such as hydrocarbon cleaning fluids, paint solvents, etc.) are important characteristics of such liquids, such that these flash points need to be determined.

The flash point of a combustible material (e.g., a combustible liquid hydrocarbon) is defined as the temperature at which its vapors first ignite, under specified conditions, in a laboratory test. These conditions must be controlled carefully, and considerable skill is required of the operator to obtain reproducible results.

Several different automatic flash point analyzers are being marketed, these analyzers giving more consistent results than the laboratory tests because their operating cycles are controlled automatically; that is to say, their results do not depend on the skill of the operator.

All of the prior automatic flash point analyzers are cyclic instruments which are similar in principle to the laboratory procedure, being programmed through a temperature cycle to give an intermittent reading of the flash point temperature. In all cases, the ignition temperature is determined by introducing a flame or spark intermittently into the vapor space of the flash chamber. It would be highly advantageous to have a continuous indication (or record) of the flash point temperature, rather than only an intermittent one as in the prior devices.

Accordingly, an object of this invention is to provide a flash point analyzer which gives a continuous output of intelligence, that is, a continuous indication of the flash point.

Another object is to provide a novel flash point analyzer.

The objects of this invention are accomplished, briefly, in the following manner: A continuous combustion detector, in the form of a hot-wire combustion meter, produces and detects the ignition of a combustible gaseous mixture emanating from a heated chamber operating as a flash vaporizer, and this detector in turn controls the temperature of the heated chamber. The temperature of the heated chamber is so controlled that the rate of vaporization of the combustible liquid being fed to this chamber is just sufficient to provide a combustible mixture at the detector. The temperature of the chamber is recorded continuously.

A detailed description of the invention follows, taken in conjunction with the accompanying drawing, wherein the single figure is a schematic diagram of a flash point analyzer according to the invention.

Referring now to the drawing, a sample of a combustible liquid (e.g., a combustible liquid hydrocarbon such as furnace oil) flows by means of a sample inlet line 1 into a sample chamber 2, at a constant rate. The sample chamber 2 is elongated in the vertical direction, for example, and the sample inlet line 1 enters the upper end of this chamber in such a manner that the sample liquid, as it enters the upper end of the chamber 2 and flows downwardly, forms a thin liquid film on the chamber walls. Liquid sample which is not vaporized in chamber 2 drains out through an outlet line 3 connected to the bottom of the chamber, through a suitable vapor trap (not shown) of conventional design.

Sample chamber 2 is arranged to operate as a flash vaporizer for the liquid sample, this chamber being heated to a temperature at which a small amount of vapor is produced therein. This heating is effected by means of an electrically-energized heater 4 surrounding chamber 2, in heat-transmitting relationship therewith. The energization of heater 4 is controlled by a temperature controller 5, which will be further referred to hereinafter.

A thermocouple 6 is utilized to sense the temperature at the inside wall of chamber 2. This thermocouple is connected by a pair of leads 7 to a recorder 8, which is continuously records the temperature sensed by thermocouple 6 (that is, the temperature of chamber 2).

Air is introduced by means of a pipe 9 into the bottom of chamber 2, which latter may be thought of as a vaporizer. This air forms, with the vapor produced in vaporizer 2, a combustible gaseous mixture, which mixture is swept by the air out the top of chamber 2 through a flame arrester 10 to a combustion detector 11. The vapor trap in the sample outlet line 3 prevents the escape of vapors through such line. Detector 11 is preferably a hot-wire combustion meter of conventional type, comprising a heated wire connected into a bridge network. Detector (meter) 11 operates to ignite the combustible mixture reaching it via flame arrester 10, and to produce a signal at its output 12 which is proportional to the concentration of combustible vapor in the combustible mixture.

The signal appearing on output lead 12 (that is to say, the signal produced by detector 11) is applied to temperature controller 5, as the input signal therefor. Controller 5 is of the so-called Proportional Controller with Reset type, and operates (in response to the signal fed to it at 12) to control or regulate the power supplied to the vaporizer heater 4. This it does by controlling the energization of this electrically-energized heater. The set point of controller 5 is so adjusted as to maintain (by control of the heater 4 by said controller) chamber 2 at a temperature such that the rate of vaporization of the liquid sample is just sufficient to provide a combustible mixture at detector 11. In other words, chamber 2 is maintained at the lowest temperature at which enough vapor is produced to flash in detector 11.

If for some reason the temperature of the vaporizer (chamber 2) increases, the amount of combustible vapor in the vapor stream moving to detector 11 would increase. The resulting increase in the output of the sample signal the controller 5 to reduce the vaporizer temperature, by reducing the energization of heater 4. The opposite action occurs if the temperature of the vaporizer decreases. Thus, the vaporizer temperature is controlled at a point where vaporization just begins in the vaporizer 2. The vaporizer temperature is recorded, by recorder 8, as the flash point temperature of the sample.

The flame arrester 10 may be of any well-known construction (e.g., an arrangement of screens, or steel wool, etc.) for preventing flashback. This arrester is required to prevent flashback from the combustion meter 11 into the vaporizing chamber 2. Burning must not occur in the vaporizer 2, because this would interfere with the proper operation of the combustion meter 11. In addition, the heat of combustion would heat the vaporizer 2 independently of the electrical heater 4, and the temperature controller 5 would lose control.
It is pointed out that the temperature control of the vaporizer 2 (by means of heater 4, controlled from controller 5) is continuous, and that the recording of this temperature (on recorder 8, the temperature being sensed by thermocouple 6) is also continuous. Thus, a continuous record of the flash point of the liquid sample is produced.

It is desired to be pointed out that the device of the present invention provides another advantage. If combustion took place in chamber 2 (as it does in devices of the prior art), rather than in detector 11, fouling would occur much more rapidly than it does in the present device; that is to say, the meter 11 does not become fouled, as a result of combustion, nearly as fast as would the chamber 2.

The invention claimed is:

1. A flash point analyzer comprising a sample chamber, means for flowing a sample of a combustible liquid into said chamber, controllable means for heating said chamber to cause it to act as a flash vaporizer for said liquid, a hot-wire combustion meter separate from said chamber and spaced therefrom, means providing a gaseous flow path between said meter and the interior of said chamber; said meter operating to ignite the combustible gaseous mixture reaching the same solely by way of said flow path and to produce a signal proportional to the concentration of combustible vapor in such mixture; and means receptive of said signal for controlling said heating means in dependence upon said signal.

2. An analyzer as set forth in claim 1, wherein the last-mentioned means controls said heating means to maintain said chamber at a temperature such that the rate of vaporization of said liquid is just sufficient to provide a combustible mixture at said meter.

3. An analyzer in accordance with claim 1, including also a flame arrester in said gaseous flow path, between said chamber and said meter.

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RICHARD C. QUEISSER, Primary Examiner.

DAVID SCHONBERG, Examiner.