FLOW MONITOR AND SAMPLE CONTROL DEVICE

This invention relates to the field of pollution control and involves a device for monitoring and controlling the sampling of fluids. More particularly the invention relates to such a device which will give an accurate and continuing indication of the rate of fluid flow and which will time the frequency at which samples of fluid are taken. The device also satisfies the function of indicating the total flow of liquid over a period, and indicating also the times at which samples are taken.

BACKGROUND

It has come to be important to know the character and rates of flow and the quantities of liquids being discharged into waste disposal systems such as institutions, including industrial plants, hospitals etc.. To obtain such information it was at first the practice to manually take samples of the liquid at certain intervals such as every hour over a twenty-four hour period. Later, automatic devices were developed which could be set at or in manholes and could be set to operate at timed intervals. These sampling devices are able to mechanically take samples of the liquid and either gather the composite of the samples taken during a test period or gather separate samples which can later be separately analyzed as to composition.

However, there has not been to my knowledge any practical way for automatically obtaining information as to the rate of flow of the liquids or for indicating and recording the accumulated quantity of liquids which pass during the period of a test.

Attempts have been made to obtain such information by manually measuring the height of the flowing liquid using a scale, and from this mathematically calculating the rate of flow. Some attempts have utilized the pressure of the waterhead, measuring the pressure by mechanical means, and then from this information mathematically calculating the flow at the time the pressure is taken. But such attempts have not satisfied the practical need for indicating automatically the needed information about rates and quantities of flow over a testing period, nor have they been sufficiently accurate to enable the collection of significant data.

The art has needed a device, particularly a portable device, which could easily be carried from one location to another, and which would accurately indicate the rate of flow of the liquid over the test period. It is desired also to register the total volume of liquid over the period and to indicate the times at which samples are taken. It is further desired that the device trigger the taking of the samples at spaced intervals with the samples being taken more frequently during periods of greater flow and less frequently during periods of lesser flow.

The art needs a device which is not dependent upon the operation of mechanical elements, these elements being always subject to wear and misalignment. Further, a device is needed which can be easily set up by non-skilled operating personnel.

Accordingly, I have set out to discover methods of obtaining such information in a practical way and to provide an instrument which can be utilized for this purpose.

An embodiment of the invention is illustrated schematically by the block diagram set forth in FIG. 1 of the accompanying drawing.

As illustrated in FIG. **1**, the invention contemplates a weir box **10** through which the liquid **11** may flow and having a weir opening **12** which as shown is V-shaped having an angle of 45°. However, it is understood that the weir with which my device is utilized may be of other and different shapes and may have different angles. My device is adjustable to accomodate weirs of such differing shapes instead of the particular weir as shown in FIG. **1.** With reference to the weir the lowest point of the opening is called the throat of the weir and I have designated this by the character **13** in FIG. **1.**

A dip tube **14** has its lower end extending into the weir box with its tip being at least as low as the throat of the weir. Connected to the upper end of the dip tube is a gas supply device **15** which includes cylinders **16,** a gauge **17** and a capillary element **18.** The gas may be any available pressurized inert gas such as the mixture sold under the code R-12. When the valve on one of cylinders **16** is open the pressure of the gas registers on gauge **17,** the gas flows through the capillary opening and is reduced to a lower desired pressure which is applied to the dip tube **14.** Gas flows at a constant rate to the lower end of the dip tube and issues in a stream from the lower end of the tube and bubbles to the surface of the liquid. The back pressure of the gas being passed through the tube is proportional to the head of liquid between the lower end of the tube and the surface of the liquid. It is necessary only that the pressure at the tube be sufficient to cause the gas to issue from the end of the tube at a substantially constant rate of flow.

The pressure of the gas being fed into the dip tube (P_1) is shown in FIG. 1 to be impressed on an electronic transducer which, in the drawing, is represented by the large block designated **20.** Also impressed upon the electronic transducer is the pressure of the atmosphere (P_2), and the difference between P_1 and P_2 is utilized in the transducer in a way which will now be explained.

The transducer **20** has a pressure sensitive diaphragm formed by etching the back surface of a thin silicon die in a defined area until a thickness of only a mil or two remains. A piezoresistive strain gauge bridge **21,** diagramatically illustrated in the drawing, is diffused into the front surface of the sensitive diaphragm. Input power of the bridge is supplied at terminals **22,** and terminals **23** represent the output.

The bridge includes resistances R_1, R_2, R_3 and R_4, and even slight variation of R_1 due to diaphragm action by reason of the difference between P_1 and P_2 operates to unbalance the bridge and to produce a voltage at the output **23.** The value of this voltage is directly proportional to this difference in pressure.

Resistors R_2 and R_3 serve to compensate the transducer for possible drift due to ambient temperature changes.

The voltage output of the transducer is fed to a differential amplifier **30** which, through the variable resistance element **31,** can function to reduce the voltage output of the amplifier to the extend that this voltage becomes zero when the height of the liquid above the throat of the weir is zero. This, in effect, removes from the voltage output signal the effect due to having the lower end of the dip tube below the throat of the weir, and the putput of the amplifier is directly proportional to the height of the liquid above the throat of the weir.