# EXPLOSION-PROOF FLOW SAMPLING APPARATUS

## BACKGROUND OF THE INVENTION

This invention relates to apparatus and method for sampling liquid and solids-bearing liquid media such as sewage, particularly in explosive-atmosphere environments, by means of automatically functioning, pneumatically-operated apparatus.

In many flow streams it is desirable to monitor the contents of the flow by periodic sampling, as in the case of stream pollution control, sewage monitoring and industrial waste situations. Such monitoring is required by government in some cases. A variety of stream sampling devices have been proposed for these purposes. See, for example, U.S. Pat. Nos. 3,120,128; 3,438,262; 3,589,197; 3,750,477; and 3,795,347, and also British Pat. No. 720,161.

Increasing recognition of the explosive atmosphere hazard in sewage lines and other wastewater works has created a need for an explosion-proof sampling device. Electrically-operated devices must be either explosion proof or intrinsically safe (e.g., through use of extremely low voltage), to be operated in explosive atmospheres, or the device and/or the surrounding atmosphere must be purged with air. None of these methods provides absolute safety, and electrically-operated devices have proved dangerous. Several all-pneumatic samplers have previously been developed, but these devices have been underpowered, delicate, and undependable in sewage applications.

Of the above-cited patents, none shows a completely pneumatic sampler which avoids any reliance on electric circuitry, except U.S. Pat. No. 3,750,477, but the sampling apparatus disclosed in that patent is different from and without many advantages of the present invention. U.S. Pat. No. 3,795,347 does show a height-adjustable volume control tube as is included in the present invention described below, but the present sampler is all pneumatic and includes many other advantageous features not found in any of the apparatus of the cited patents.

## SUMMARY OF THE INVENTION

The present invention overcomes the shortcomings, disadvantages, and dangers of prior sampling devices by the provision of a sufficiently powerful, entirely pneumatically operated and fully automatic flow sampler which may be positioned and used directly within an explosive atmosphere, such as a sewage conduit. The sampler draws liquid and accompanying solids from the sampled medium through a conduit to a quantimetric chamber within apparatus, measures a preselected quantity of sample material, returning the excess to the source, and dispenses the retained sample into a storage container. The apparatus may include a means for depositing a selected number of plural samples in each container and a full-storage sensing device for preventing the sampler from entering further sampling cyles once all storage facilities are full. Although the sampling apparatus may be very close to the sampled source, for example operating as a portable unit, it may also be at a distance from the source, communicating therewith through only a single intake line. In the usual installation the sampling device will be at a greater altitude than the sampled medium, although it can be adapted, if necessary, to operate at or slightly below the liquid level.

The quantimetric chamber device of the sampler is directed through the various phases of its cycles by a pneumatic controller which, by use of a single source of pressurized air (which may be a portable tank), supplies operating and pilot pressure to a number of valves, sensors, and other components including a cycle advancing cylinder, a timer and a vacuum generator. The controller has a number of components but yet is relatively simple in concept and operation, and utilizes trouble-free components, so that it is highly dependable in service. The controller is also structured to use a minimum of pressurized gas, thus permitting portable application and relatively infrequent compressed gas cartridge replacement.

It is therefore among the objects of the invention to provide an all pneumatic, amply powerful, reliable flow sampling system suitable for use with sewage and other explosive gas atmospheres, while providing for simple enough operation that the system can be used by unskilled personnel.

Other objects, advantages and features of the invention will become apparent from the following description of a preferred embodiment, taken in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a schematic representation showing the major components of the flow sampling system of the present invention;

FIG. **2** is a sectional elevation view of a measuring chamber associated with the system, including fill-sensing apparatus;

FIG. **3** is a diagrammatic representation of a pneumatic controller of the system, indicating the various pneumatic circuitry;

FIG. **4** is a view showing a valve-operating cam included in the controller, taken along the line **4—4** of FIG. **3**;

FIG. **5** shows a second cam, viewed along the line **5—5** of FIG. **3**;

FIG. **6** shows a third cam, viewed along the line **6—6** of FIG. **3**; and

FIG. **7** is a chart which diagrams the positions of the main cam-operated valves during the several phases of operation in a cycle of the controller.

## DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. **1** shows a source of pressurized gas **1**, which ordinarily contains air under pressure, unless some other gas is preferred for reasons of the particular environment in which the system is used. A conduit **2** leads from the gas source **1** to a controller **3** which directs the operation of the sampling system. A signal for starting the controller **3** and the cycling of the system may be provided by an external initiating apparatus **4** connected to the controller by a conduit **5**. The initiator **4** may supply a pressure pulse for the purpose of starting the controller, and may include a pneumatic timer or other timing device, or a solenoid valve located outside the explosive atmosphere, such devices being well known in the art. If the initiator **4** operates on pressurized gas, a further conduit (not shown) may be provided from the controller or directly from the line **2** to the initiator.