PUMPING SYSTEM

RELATED CASES

This application is a continuation-in-part of U.S. application Ser. No. 08/120,724 (now abandoned), filed Sep. 13, 1993, which is a divisional application of U.S. application Ser. No. 07/807,200, filed Dec. 16, 1991, now U.S. Pat. No. 5,401,139, which is a divisional of U.S. application Ser. No. 07/474,154 filed Feb. 2, 1990, now U.S. Pat. No. 5,125,801 in the names of Frederick Alan Nabity, Paul George Wright, Raymond Hulinsky and Douglas Timothy Carson for PUMPING SYSTEM and assigned to the same assignee as this application.

BACKGROUND OF THE INVENTION

This invention relates to pumping systems and more particularly to pumping systems that draw samples from a source of liquid.

It is known from U.S. Pat. No. 4,415,011 to Douglas M. Grant, issued Nov. 15, 1983, and from U.S. Pat. No. 4,660,607 to Carl D. Griffith, issued Apr. 28, 1987, to pump liquids from a liquid source through a peristaltic pump into sample containers. In such system, the liquid is pumped through a flexible tube, the location of the liquid in the tube is sensed and it is metered into sample containers. The tube is subjected to flexing by rollers at a rate intended to deposit a predetermined sample volume into preprogrammed containers arranged in a sample tub. A distributor may move a nozzle over the appropriate sample bottle to deposit the sample therein. The distributors usually follow one predetermined path.

In the prior art samplers of this type, the peristaltic pumps are generally mounted horizontally with a horizontal axis of rotation for the roller assembly and fasteners such as bolts or screws must be removed to obtain access to the interior of the pump. The distributor only follows a continuous path and stops at mechanically fixed positions to deposit samples. Equipment used for triggering the taking of samples such as flow meters in stand alone equipment for such measurements.

These prior art samplers have several disadvantages such as for example: (1) under some circumstances, the tubes may travel laterally out of position within the peristaltic pump, resulting in a decrease in efficiency and increase in wear on the tube; (2) the pump may be unable to pump at the desired flow rate when there is a large head of pressure; (3) the tube within the pump may be subject to excessive wear; (4) it is difficult to change the peristaltic pump tube; (5) there may be occasions in which the outlet port of the sampler does not align in a satisfactory manner with the container to provide liquid therein; (6) there is insufficient flexibility in the movement of the distributor; (7) the samples may under some circumstances be tampered with to avoid detection of of some water conditions; and (8) the equipment used in cooperation with the sampler is excessively bulky and expensive.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide a novel liquid sampler.

It is a further object of the invention to provide a novel pumping system.

It is a still further object of the invention to provide a pumping technique which provides higher average line velocity under a head of pressure.

It is a still further object of the invention to provide a pumping system that permits easy changing of tubes;

It is a still further object of the invention to provide a peristaltic pump in which the tubes within the peristaltic pump have a longer life;

It is a still further object of the invention to provide a sampler which is able to deposit samples at random time intervals in containers in order to avoid tampering;

It is a still further object of the invention to provide a sampler having a distributor for distributing samples into bottles in which the resolution of the position of the distributor is accurately programmably controllable;

It is a still further object of the invention to provide a sampler in which different modules such as bubbler modules or data processing modules may be attached;

It is a still further object of the invention to provide a novel sampling technique in which better registration of the outlet nozzle with the sample container is provided.

In accordance with the above and further objects of the invention, a sampler includes: (1) a peristaltic pump that is mounted horizontally with a vertical axis of rotation of the roller assemby for easy insertion of pump tubing, has a tube aligning system to reduce creeping and peristaltic pump tube wear, a pump tube through which liquid is drawn at a higher average velocity, particularly when the speed of pumping cooperates with the pump tubing energy of restoration; (2) a distributor that has improved registration with containers to receive samples from the pump; and (3) is able to deposit samples in bottles having random time intervals under program control for security reasons.

The peristaltic pump housing is mounted to rotate the rollers in a horizontal plane about a vertical axis. One side of the pump housing is opened easily to expose the rollers for easy insertion of tubing. The rollers are designed with guides to avoid moving the tubing out of position and in one embodiment, are spring biased against a platen to avoid crushing the tubing. A safety check is provided by a magnet and reed switch to prevent the pump motor from operation when the pump housing is open.

The tubes are specially constructed to cooperate with the pump motor for maximum efficiency by utilizing a speed and energy of restoration that maximizes vacuum force on the liquid. For this purpose, the hose is specially cured for stability and a thickness is selected to provide a coefficient of restoration that increases the vacuum pressure. The pump is operated at a speed in which the energy of restoration is sufficient to restore the shape of the tube between compression at relatively high speed and may pull water under a twenty-four foot head with a velocity of two feet per second. The housing accommodates modules connected to sensors for transmitting sensed values and for recording them.

In operation, the nozzle of the distributor is adjustable in position and may be programmed with precision to register with bottles of different sizes and at different locations. For zeroing, the distributor is moved in a first direction against a stop and then rotated in the opposite direction to press against the stop from the opposite side. The play between the two caused by pressure against the stop is measured and utilized to provide a zeroing function from the distributor and thus permit greater accuracy during distribution. The distributor includes a coded pulse generator that generates pulses in accordance with its movement among the bottles to