AUTOMATIC BOTTLE SEALING MECHANISM FOR LIQUID SAMPLING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention generally relates to an automatic sealing device for containers, and is specifically concerned with an automatic sealing mechanism for sample receiving bottles of the type used in automatic liquid sampling devices.

2. Description of the Prior Art

In order to effectively monitor the water quality in a flowing river or stream, or to measure pollutant levels in industrial waste effluents which are discharged into natural bodies of water, it is generally necessary to take successive water samples at regular intervals over a period of time which typically ranges between twenty-four to forty-eight hours. It is possible to carry out the sampling procedure manually, with the samples either being tested in the field as soon as they are obtained or accumulated for testing at a later time, but in either case manual sampling becomes tedious and cumbersome when a large number of samples must be taken over a long period of time. For this reason, automatic sampling devices have been developed which are capable of obtaining and storing a number of liquid samples at regular intervals without human supervision. At the end of the sampling period, the bottled samples can all be retrieved and tested at the same time, thereby avoiding many of the manipulative difficulties involved in manual sampling.

A typical automatic liquid sampling apparatus of the type available at the present time is illustrated in FIG. **1**. The apparatus consists of a thermally insulated bottom casing section **20** for holding a circular array of sample receiving bottles **22** (shown with caps **23** in place), a thermally insulated upper casing section **24** which fits over the lower casing section **20**, and a protective upper cover **26**. A circular wall **28** is spaced inwardly from the outer wall of the lower casing section **20** to provide an annular space for receiving and locating the bottles **22**. The central area inside the inner wall **28** provides a space for ice to be stored for preserving the liquid samples after they have been introduced into the bottles **22**. A watertight electrical control unit **30** and a peristaltic pump **32** are affixed to the upper casing section **24**, the latter serving to draw in liquid samples through an intake device **34** and a flexible tube **36**. The output of the pump **32** is connected by additional lengths of flexible tubing **38** and **39** to a rotating sample distributing spout **40** mounted on the underside of the upper casing section **24**. The sample distributing spout **40** is rotated over the mouths of the bottles **22**, from which the caps **23** are first removed, in an incremental or step-by-step manner. This is accomplished by a motor (not shown) under the control of the control unit **30**. The pump **32** is also controlled by the control unit **30** and is operated during the stationary intervals of the spout **40**. In this way, each of the bottles **22** is filled in sequence with a liquid sample delivered by the spout **40**. Typically, the control unit **30** can be programmed so that samples are taken according to a preset time schedule, as for example once every sixty minutes. Alternatively, sampling may occur at intervals corresponding to a certain amount of volumetric flow of the effluent from which samples are being taken, as measured by an external flow sensing device. Although each discrete liquid sample will usually be introduced into a separate one of the bottles **22**, the control unit **30** can in some instances be programmed to fill two or more of the bottles **22** during each sampling cycle, or conversely, to combine two or more successive liquid samples in each bottle.

Although automatic liquid sampling devices of the type shown in FIG. **1** have proved very useful in eliminating much of the time-consuming field work involved in obtaining water samples at remote locations, certain difficulties still remain. A particularly troublesome problem involves the uncapping and recapping of the sample receiving bottles **22**. When the automatic sampling apparatus is set up for operation at the location where the samples are to be taken, the caps **23** must be removed from the bottles **22** so that the latter can be filled in sequence by the sample distributing spout **40**. When the sampling period has ended, and all of the bottles **22** have been filled, the caps **23** must usually be replaced in order to allow the bottles to be transported to a laboratory or other testing site without spillage of the liquid samples. Aside from the manipulative difficulty involved in separately recapping each of the numerous bottles contained in the sampling apparatus, there is the additional problem that the bottles have remained uncapped, with their contents exposed to the surrounding air, for a substantial amount of time before the end of the sampling period. For example, during a typical automatic sampling operation in which a total of twenty-four bottles are filled and a one-hour interval is provided between successive sampling cycles, the first bottle to be filled will remain uncapped for about twenty-four hours before the sampling operation is completed, even if the bottles are retrieved and sealed immediately. This presents problems in cases where the liquid being sampled is drinking water or waste water containing volatile organic compounds. Commonly occurring examples of such compounds include carbon tetrachloride, 1,1,2-trichloroethylene, and 1,1,2,2-tetrachloroethylene. The delay between filling and sealing of the bottles can allow these compounds to escape by evaporation, thereby reducing the accuracy and validity of subsequent testing procedures. In addition, the surrounding air can sometimes contaminate or oxidize the substances present in liquid samples if the sample receiving bottles are left open for an excessive length of time.

Recent studies have suggested that water samples containing volatile organic compounds can be preserved intact for relatively long periods of time, in some cases up to eight to ten days, if the sample bottles are sealed promptly after filling with a minimum of air space between the liquid sample and the bottle cap. Unfortunately, presently available types of automatic liquid sampling devices, such as that shown in FIG. **1**, do not provide any means for sealing the sample receiving bottles until the automatic sampling operation is complete and all of the bottles have been filled, and even then the bottles must be sealed manually. Prior to the present invention, the only known way to avoid the delay in sealing the sample receiving bottles was to interrupt the automatic sampling operation after each bottle was filled, manually place a cap on that particular bottle, resume the automatic sampling operation, and then repeat the process for each of the remaining bottles. The obvious disadvantage of this procedure is that it requires constant human supervision and intervention,