and adds a new water count to the previously received water counts.

If it was a good water count, it is then determined if a new maximum amount of water counts should be calculated at **145**. If a new maximum should be made, the program calculates a new maximum water count at **149**, using the head from the previous sample or the head defined by the user in the head subsequence **196** (FIG. **14**), and then decides at **147** if the sample water count is the correct amount. If not enough sample was pumped, the program returns to wait for the pump count at **133** and pumps more liquid until it has pumped a predetermined amount of pump counts and continues with the series of steps **139** starting at **161** to determine if the maximum count was exceeded. If the pump did receive a correct water count, it is recorded in memory at **159** that the sample volume was delivered correctly and proceeds with the series of steps **153** of shutting down the pump at **155** and returning to the calling routine at **157**.

If it is not necessary to calculate the maximum water count, then the program skips the step **149** and determines at this point if it is a correct water count at **147**, records that the sample volume was delivered correctly at **159** and proceeds with the series of steps **153** of shutting off the pump at **155** and returning to the calling routines at **157**.

When the program returns to the calling routine at **157**, the memory is accessed to find out if the liquid was detected at **112** (FIG. **15**) and if it was not, the program would advance to the program at **128** to access **170** of the options for the liquid detector control **162** (FIG. **9**) of the configure sequence **150** to find out if it should retry pumping sample before shutting down. If the user entered any retries, and the total amount of retries has not been met, then the program returns to purging the pre-sample at **98** and continuing with the rinse routine **100** (FIG. **15**).

In FIG. **17**, there is shown a flow diagram of the program and run review sequence **220** (FIG. **8**). The program and run review sequence **220** is used to check program setting or sampling routine results. The subsequences included are the pump tubing warning subsequence **222** and the sample information for the last sample routine subsequence **223**.

Each time the pump count maximum for replacing the tubing is exceeded, the pump tubing warning message at **222** is displayed. The threshold for the pump count maximum has been user-defined in the tubing life indicator control **154** at **156** (FIG. **10**) before beginning the pump. If the user does not enter a new threshold, the threshold from the previous sampling process will be used.

After each sample gathering process, certain information is stored in memory for future use at **223**. Included are: (1) if the sample process was performed and no liquid was detected at **224**; (2) the time and date at **226**; and (3) the number of pump counts before liquid was detected at **228** and the amount of time for the entire pump cycle. The number of counts before liquid was detected at **228** is used to calculate the head at **149** (FIG. **16**).

In FIG. **18**, there is shown a block diagram of another embodiment of tubing life indicator circuit **154**A for providing a signal after a predetermined number of strokes of roller against the tube **20** (FIGS. **1**, **2** and **5**) in the peristaltic pump assembly **16** (FIG. **1**), having the cycle signal generator **11**, a counter **240**, a switch **246**, a manually resettable switch **242** and a warning light **252**. The counter **240** is directly connected to the conductor **13** to receive all counts regardless of direction and having an output set at a predetermined number of counts connected to the resettable switch **242** to actuate the switch at the predetermined number of counts and thus energize the warning light to which it is connected.

With this arrangement, the operator may set the counter **240** at a count that indicates the tube **20** (FIGS. **1**, **2** and **5**) should be replaced. When the number of pulses from the cycle signal generator **11** reaches the preset number, the counter **240** supplies a signal to the resettable switch **242** which applies a signal from the source of voltage **254** to the warning light **252**. The resettable switch **242** can be manually reset when the tube is changed and it resets the counter **240** and disconnects the power **254** from the warning light **252**.

To permit a hardware determination of the direction of rotation, the switch **246** receives pulses from the conductor **13** and a direction signal from the cycle signal generator **11** to switch from one of the two output conductors **248** or **250** to the other so that pulses representing the number cycles in each direction can be determined. This function can also be performed in software.

From the above description, it can be understood that the pumping system of this invention has several advantages, such as for example: (1) it more precisely meters the amount of liquid because it is based on pulsations and pump cycles which react to the head of pressure; (2) measurement is made using a criteria which is not altered by splashing or surging of the water or the light transmission characteristics of an optical path or the capacitance or other noise affects that has caused difficulties with other types of sensors; and (3) the metering criteria is partly determined by a statistical base to compensate more readily for variations from sample to sample.

Although a preferred embodiment has been described with some particularity, many modifications and variations of the preferred embodiment can be made without deviating from the invention. Therefore, it is to be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described.

What is claimed is:

1. A method of pumping liquid comprising the steps of:

sensing changes in the strain in a conduit carrying the liquid to be measured;

pumping liquid through the conduit in a manner that causes strain related to the flow of liquid under the control of the pump; and

using the sensed strain to detect the pumping of liquid to a predetermined point.

2. A method according to claim **1** in which the step of sensing changes in the strain includes the steps of:

continuously sensing pulses as the liquid moves through the conduit;

sensing an increase in the amplitude of the pulses indicating liquid is approaching the pump; and

counting pulses during higher amplitude pulse reception.

3. A method according to claim **2** further including the steps of:

determining the first presence of higher amplitude pulses;

sensing gaps in the pulses;