A method and an apparatus for washing a probe (15) in a receiving cup (20). The probe (15) is positioned in the receiving cup (20) having a drain (26) therein. Initially, fluid is dispensed through the probe (15) and simultaneously drained from the receiving cup (20) through the drain (26) at least as fast as it is dispensed into the cup (20). Once a sufficient volume of fluid has been passed through the probe (15) to remove the majority of the contaminants from the interior of the probe (15), the flow rate is increased or the rate of evacuation of fluid from the receiving cup (20) is decreased, or both, to build up a level of fluid in the receiving cup (20). This fluid is allowed to contact and wash the interior of the probe (15) and fluid is desirably continuously flushed through the probe until it has been sufficiently cleaned.
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APPARATUS AND METHOD FOR WASHING A
PIPETTE PROBE

FIELD OF THE INVENTION
The present invention provides an apparatus and a method for
5 cleansing liquid dispensers and has particular utility in cleansing pipetting
probes, such as the type of pipettes commonly used in automated analyzers.

BACKGROUND OF THE INVENTION
When a pipette or the like is used to dispense fluids, the fluid being
dispensed will tend to contaminate the interior of the tube or other structure
through which the fluid is dispensed. When fluids are transferred using
pipettes, an end of the pipette is commonly immersed in the fluid to aspirate
the fluid into the pipette. Accordingly, both the interior and the exterior of
the pipette will become contaminated with the fluid being dispensed.

In those situations where a pipette or the like is dedicated to
dispensing a single fluid, this contamination generally is not a problem.
Likewise, if cross-contamination between two or more fluids is not a concern
in the particular application for which the pipette is used, there is generally no
need to remove any previously dispensed fluid from the interior and exterior
of the pipette.

In many situations in which pipettes are used, though, cross-
contamination of fluids is a major concern. For example, in conducting
chemical analyses of medical samples, such as assays for a particular
constituent in a patient’s blood, care must be taken not to introduce any of
the patients’ samples into the reagent supplies or to intermingle one patient’s
sample with that of another patient.

When manually processing such patient samples with pipettes, one will
commonly employ disposable pipette tips. These tips are typically thrown
away after they are used to aspirate and dispense a single patient sample,
effectively preventing cross-contamination of the different samples. In
automated analyzers of the type commonly used for clinical laboratory
analysis of such samples, though, disposable pipette tips generally are not
deemed to be practical and the pipette probes used in such analyzers must typically be cleansed after each dispensing operation to maintain integrity of both the patients' samples and the reagent supplies used to conduct the tests.

A number of different approaches to washing pipette probes have been developed. In each case, the function of the pipette washing apparatus is to clean the pipette sufficiently to avoid any deleterious cross-contamination of the fluids being handled. In most cases, this means that the wash station must efficiently and relatively thoroughly wash both the exterior and interior surfaces of the probe to remove any contaminating fluids.

One common way to clean probes in automated pipettors is to dispense a wash fluid through the pipette probe from a dedicated wash fluid supply and to spray the outside of the probe with wash fluid supplied through a separate washing element. Contaminated wash fluid will typically be withdrawn from a collecting cup positioned below the probe and transferred to a waste fluid collector. This construction provides an efficient cleansing of the probe. Unfortunately, it also requires a relatively large volume of wash fluid and requires separate pumping mechanisms and fluid supply systems for both the pipette probe and the separate external washing hardware, increasing both the cost and complexity of the device and generating more biohazardous waste.

Another approach known in the art for cleansing pipette probes in automated analyzers is to dispense wash fluid through the probe into a relatively shallow receiving cup and to use the same fluid to rinse both the interior and exterior surfaces of the probe. At first blush, this would appear to provide a superior washing station in that only one wash fluid supply system - i.e. the one connected to the probe - need be provided and it seems that the quantity of wash fluid needed to cleanse the probe would be minimized since the same fluid is used to wash the entire pipette.

In practice, however, this has proven to be a somewhat inefficient way to cleanse pipette probes. The problem arises from the fact that the interior of the pipette probe tends to carry the highest concentrations of
contaminated fluids since the fluids being transferred are received in the interior of the probe. When wash fluid is first passed through the probe, it will carry with it the bulk of the contaminated fluid with it into the small receiving cup and this contaminated fluid is flushed around the outside of the probe. In order to cleanse the probe, one must pump further fluid through the probe both to increase turbulence in the receiving cup and to dilute to contaminated wash fluid with more fresh wash fluid. If low levels of possible cross-contamination are required, as is the case for most automated chemical analyzers used in the medical field, it takes a fair amount of wash fluid to sufficiently clean the pipette probe and yield reliable results.

SUMMARY OF THE INVENTION

The present invention provides a method for cleaning pipette probes and the like and an apparatus for carrying out this method. In accordance with the method, a pipette probe is positioned in or adjacent to a receiving cup. Initially, fluid is dispensed through the probe and simultaneously drained from the receiving cup at least as fast as it is dispensed into the cup. Once a sufficient volume of fluid has been passed through the probe to remove the majority of the contaminants from the interior of the probe, the flow rate is increased or the rate of evacuation of fluid from the receiving cup is decreased, or both, to build up a level of fluid in the receiving cup. This fluid is allowed to contact and wash the exterior of the probe and fluid is desirably continuously flushed through the probe until is has been sufficiently cleaned.

The apparatus of the invention provides a receiving cup having a drain therein. In one embodiment, the drain is designed to remove fluid at a relatively constant rate, such as by simply having an open port in the cup through which spent wash fluid is allowed to pass under gravity. Wash fluid is passed through the probe at an initial rate which is slow enough to allow all of the fluid to exit the receiving cup through the drain. After the majority of the contaminant in the probe is dispensed into and drained out of the cup, the flow rate of wash fluid through the probe is increased so that it is greater than the rate at which it will drain from the cup. In this device, it may be desirable to have a larger wash basin around the receiving cup to catch
overflow from the receiving cup during the washing of the exterior of the probe.

In another embodiment of the present apparatus, a selectively controllable pump is attached to the drain in the receiving cup. Initially, the pump will aspirate fluid from the receiving cup at least as rapidly as it is dispensed. Once the majority of the contaminating fluid within the probe is washed into the receiving cup and pumped out, the drainage rate of the pump will be slowed to allow fluid to build up in the receiving cup and cover a portion of the exterior of the probe to wash it. The pump is then operated to withdraw fluid from the receiving cup rapidly enough to prevent it from overflowing, but slowly enough to permit the exterior of the pump to be washed. When washing is complete, flow through the probe may be terminated and the remaining fluid in the receiving cup can be withdrawn through the drain.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic cross sectional view of a washing system in accordance with the present invention; and

Figure 2 is a schematic cross sectional view of an alternative embodiment of a washing system of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 schematically illustrates one embodiment of a washing system in accordance with the present invention. The system includes a receiving cup 20 positioned within a wash basin 30. The receiving cup 20 of Figure 1 has a generally cylindrical side wall 22 and a bottom 24, with a drain 26 positioned adjacent the bottom for draining fluid out of the receiving cup. Although the drain may take any desired form, in the illustrated embodiment the drain simply comprises a port which extends generally horizontally through the wall 22 of the cup adjacent the lower end of the wall. This permits any fluid within the receiving cup 20 to drain into the wash basin 30 for removal.

The wash basin 30 is desirably larger than the receiving cup. The wash basin, not unlike the receiving cup, may have a generally cylindrical wall
32 and a bottom 34, with a drain 36 positioned adjacent the bottom to allow fluid to be drained from the wash basin. The drain 36 of the wash basin is desirably connected, e.g. by flexible tubing, to a waste container (not shown) so that spent wash fluid can be collected to later disposal.

If so desired, the receiving cup can be positioned generally concentrically with respect to the wash basin, but this is not necessary. It may be desirable, though, to maintain at least some space between the wall 22 of the receiving cup and the wall 32 of the wash basin at all points so that fluid overflowing from the receiving cup can flow into the wash basin without fear of spilling over into other parts of the apparatus with which the wash system 10 is used. In order to minimize any problems associated with splashing of wash fluid out of the receiving cup 20, it may be advantageous to have the wall 32 of the wash basin extend higher than the top of the wall 22 of the receiving cup, as shown.

The absolute and relative sizes of the receiving cup 20 and the wash basin 30 can be varied to accommodate the equipment with which it is to be used. In order to reduce the amount of wash fluid necessary to wash the outside of a pipette probe 15 received in the receiving cup, the inner diameter of the receiving cup is desirably relatively small. However, care should be taken to ensure that there is enough clearance between the exterior of the probe and the interior of the receiving cup to both allow turbulent flow within the receiving cup and to avoid undue splashing of wash fluid out of the receiving cup.

It may be desirable to position the probe 15 toward a side of the receiving cup rather than having it aligned with the axis of the cup, as illustrated in Figure 1. This tends to increase turbulence in the cup, further aiding in washing the exterior of the pipette. Much the same effect could also be achieved by changing the shape of the bottom 24 of the receiving cup from the relatively flat shape shown in Figure 1 to either an irregular shape or a shape which is asymmetrical with respect to the axis of the probe.

As noted above, the wash basin is desirably larger than the receiving cup. So long as the wash basin can readily capture and drain away the wash
fluid coming out of the receiving cup during the washing operation, though, the relative sizes of these two components is not believed to be critical. For example, if drainage of fluid from the wash basin through the drain 36 were enhanced with a pump, the wash basin would not need to be larger than the wash basin and, as a matter of fact, the wash basin could have a smaller volume than that of the receiving cup.

Figure 2 shows an alternative design of a washing system 10' in accordance with the invention. This system 10' has a receiving cup 20 which is directly analogous to the receiving cup of Figure 1. However, this design eliminates the wash basin and instead employs a pump 40 to control the rate of drainage from the receiving cup during operation.

The pump 40 should be selectively controllable to allow an operator or a computer-based automated controller (not shown) to control the pump and the rate at which it removes fluid from the receiving cup. Although Figure 2 schematically shows a pump to be used for selectively controlling drainage of the receiving cup, it should be understood that other functional equivalents of a pump could instead be employed, such as providing a vacuum line with a valve to control the rate of aspiration of fluid from the receiving cup. The operation of the pump or aspiration line in a washing operation is described below.

Another aspect of the present invention provides a method for washing a fluid dispensing tube, such as a manual pipette or an automated pipette probe used in an automated analyzer. Before the probe or other fluid dispensing tube needs to be washed, it will generally be used to transfer a fluid which raises a possible cross-contamination risk, such as a sample of a patient's bodily fluid or a reagent used to carry out a specific chemical reaction.

When such fluids are transferred or dispensed with a pipette or automated pipette probe, the tip of the probe is usually inserted a relatively short distance into a supply of the fluid to be transferred. Once at least the tip of the pipette is immersed in the fluid, a predetermined quantity of the fluid will be aspirated into the interior of the probe. The fluid will be held in
the probe until it is positioned over the vessel into which it is to be dispensed and is then forced out of the interior of the tube. At the end of this transfer process, some fluid will usually cling to or wet both the interior of the tube and the exterior of the tube where it was immersed in the fluid.

Once a fluid has been transferred with a fluid dispensing tube, the tube can be washed in accordance with the present invention, such as with a washing system 10 or 10' described above. The probe or other dispensing tube is positioned adjacent, and desirably within, a receiving cup 20. As discussed above, it may be desirable to position the probe within the receiving cup so that the probe axis is spaced away from the axis of the generally cylindrical receiving cup to increase turbulence in the cup when washing the exterior of the probe. A wash fluid is dispensed through the pipette to flush contaminants from the interior of the tube and the contaminated wash fluid is simultaneously drained from the receiving cup. This draining desirably takes place at least as fast as the fluid is dispensed from the probe.

Once a majority of the contaminants in the interior of the tube have been removed, wash fluid is dispensed through the probe at a rate faster than it is drained from the receiving cup so that the level of fluid in the cup will rise to cover a portion of the exterior of the probe. In particular, the wash fluid in the receiving cup in this stage of washing should be deep enough to cover at least that length of the probe which was immersed in the contaminating fluid. Wash fluid can then be delivered through the probe to carry away, or at least greatly dilute, the contaminants in the cup and this can be continued until the exterior and interior of the probe are as clean as the system’s requirements dictate.

The particulars of this method will vary somewhat on the nature of the wash system employed to carry out the invention. If the wash system 10 shown in Figure 1 is used, the first, initial cleansing of the interior of the tube desirably takes place at a relatively slow flow rate, while the second stage of washing where the exterior is also cleaned takes place at a higher flow rate. For example, the flow rate of wash fluid in the first stage of washing can be
on the order of 400-450 microliters per second while the second stage of washing employs a significantly faster flow rate, such as on the order of 1700-1800 microliters per second. The exact flow rate employed in any given situation will depend on a number of factors, including the dimensions of the probe, the dimensions of the receiving cup, the viscosity and solubility of the contaminant, and other factors which will be readily recognized by one skilled in the art.

Employing two different flow rates in the wash system 10 of Figure 1 permits the present method of washing to be carried out without requiring any complex equipment. In the first stage of washing at the lower flow rates, the fluid will drain out of the receiving cup through the drain 26 and simply flow into the wash basin 30 for disposal. When the flow rate is increased beyond the rate through which the fluid will exit through the drain 26, the fluid level will inherently rise in the receiving cup. In a preferred embodiment, the rate at which wash fluid flows through the probe is significantly higher than the rate at which it can exit through the drain, causing the wash fluid to flow over the top of the wall 22 of the receiving cup. If the flow rate and dimensions of the receiving cup are properly chosen, this will also tend to provide good turbulence in the receiving cup to help wash the exterior of the probe.

If the washing system 10' of Figure 2 is instead employed, the rate at which the fluid is drained by the pump 40 (or other functionally equivalent component) can remain substantially constant and the wash fluid’s flow rate through the probe can be varied in much the same manner as that described above for the system 10 of Figure 1. Care should be taken, however, not to allow any of the contaminated wash fluid to spill out of the washing system 10’.

In a preferred embodiment, though, the washing system 10’ is operated somewhat differently, with the selectively controllable pump 40 controlling the rate at which waste fluid is drained and the pipette probe delivering a relatively constant flow of wash fluid. In the first washing stage, the pump is operated so that the wash fluid is drained relatively rapidly,
preventing the wash fluid from building up in the receiving cup and contacting the exterior of the probe. Once a majority of the more concentrated fluid from the interior of the probe has been flushed and drained through the drain 26, the rate at which the pump withdraws fluid can be reduced, or even temporarily terminated, to allow fluid to build up in the receiving cup. The pump can then be operated to withdraw fluid from the receiving cup at the same rate at which it is delivered through the probe to prevent it from overflowing.

Hence, the present invention provides an effective method and apparatus for washing pipette probes and the like. This method and apparatus are believed to simplify the equipment necessary to cleanse a pipette probe and, at least in some circumstances, provide the possibility of reducing the volume of wash fluid necessary to reach the necessary level of cleaning.
We claim:

1. A method for washing a probe in a receiving cup, comprising positioning the probe so that fluid passing therethrough will be deposited in the cup; carrying out a first washing stage by delivering fluid through the probe while draining fluid from the cup at a rate no less than the rate at which fluid is delivered through the probe; and, thereafter, carrying out a second washing stage by delivering fluid through the probe while draining fluid from the cup at a rate less than the rate at which fluid is delivered through the probe to wash the exterior of the probe.

2. The method of claim 1 wherein the cup has an axis and the probe has a tip and an axis, the probe being positioned so that its tip is positioned within the cup and the axis of the probe is laterally displaced from the axis of the cup.

3. The method of claim 1 wherein fluid is delivered through the probe at a substantially constant rate and the rate at which fluid is drained from the cup is varied between the first and second washing stages.

4. The method of claim 3 wherein the cup is operatively connected to a selectively controllable pump, the pump operating at a first, faster pumping rate during the first washing stage and operating at a second, slower pumping rate during the second washing stage.

5. The method of claim 1 wherein fluid is delivered through the probe at a slower rate during the first washing stage than during the second washing stage.

6. The method of claim 5 wherein fluid is drained from the cup under gravity through a drain having fixed dimensions.

7. The method of claim 6 wherein wash fluid is passed through the probe during the first washing stage at a rate slow enough to allow substantially all of the wash fluid to exit the drain during the first washing stage and wash fluid is passed through the probe during the second washing stage at a rate greater than the rate at which the wash fluid will exit the drain.
8. The method of claim 5 wherein the cup is positioned within a wash basin, the fluid being allowed to overflow over a top of the cup into the wash basin.

9. The method of claim 8 wherein fluid is drained from the wash basin with assistance of a pump.

10. The method of claim 1 further comprising establishing a turbulent fluid flow pattern in the cup during the second wash stage.

11. An apparatus for washing a probe, comprising a probe, a receiving cup and a wash basin, the receiving cup being positioned within the wash basin and the tip of the probe being positioned within the receiving cup, the probe having an axis laterally displaced from an axis of the cup.

12. The apparatus of claim 11 wherein a top of the cup is positioned below a top of the wash basin.

13. The apparatus of claim 11 wherein the cup has a drain of fixed size which directs fluid into the wash basin.

14. The apparatus of claim 13 wherein the wash basin has a drain, a pump being operatively connected to the drain of the wash basin to remove contaminated fluid from the wash basin.

15. The apparatus of claim 11 wherein the wash basin has a larger volume than the volume of the cup.

16. An apparatus for washing a probe, comprising a probe adapted to pass fluid therethrough, a receiving cup, and a selectively controllable pump in fluid communication with the receiving cup and a controller; the controller being adapted to drain fluid from the cup with the pump at a rate greater than a rate at which fluid is delivered through the probe during a first wash stage and to drain fluid from the cup with the pump at a rate less than a rate at which fluid is delivered through the probe during a second wash stage.
# INTERNATIONAL SEARCH REPORT

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC(6)**: B08B 3/04, 9/02  
**US CL**: 134/88, 170; 422/100; 73/864.22, 864.24  
According to International Patent Classification (IPC) or to both national classification and IPC.

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
U.S. : 134/88, 170; 422/100; 73/864.22, 864.24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US, A, 4,948,563 (KANEWSKE, III.) 14 August 1990, figures 5 and 8.</td>
<td>11, 12 and 15.</td>
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☐ Further documents are listed in the continuation of Box C.  ☑ See patent family annex.

### Special categories of cited documents:

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#### Date of the actual completion of the international search
05 SEPTEMBER 1996

#### Date of mailing of the international search report
02 OCT 1996

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