

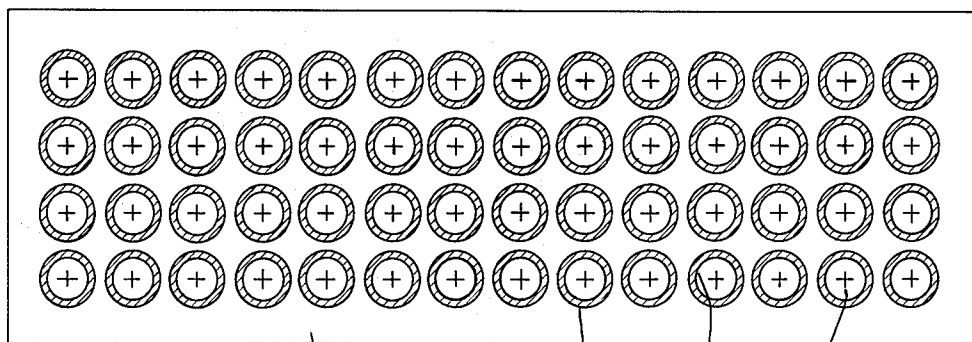
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3,204,446

APPARATUS FOR TESTING DILUTION LOOPS AND SIMILAR DEVICES

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FIG. 1

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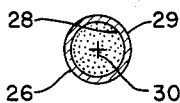


FIG. 3

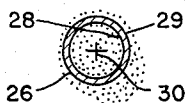


FIG. 4

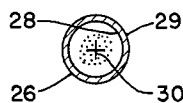


FIG. 5

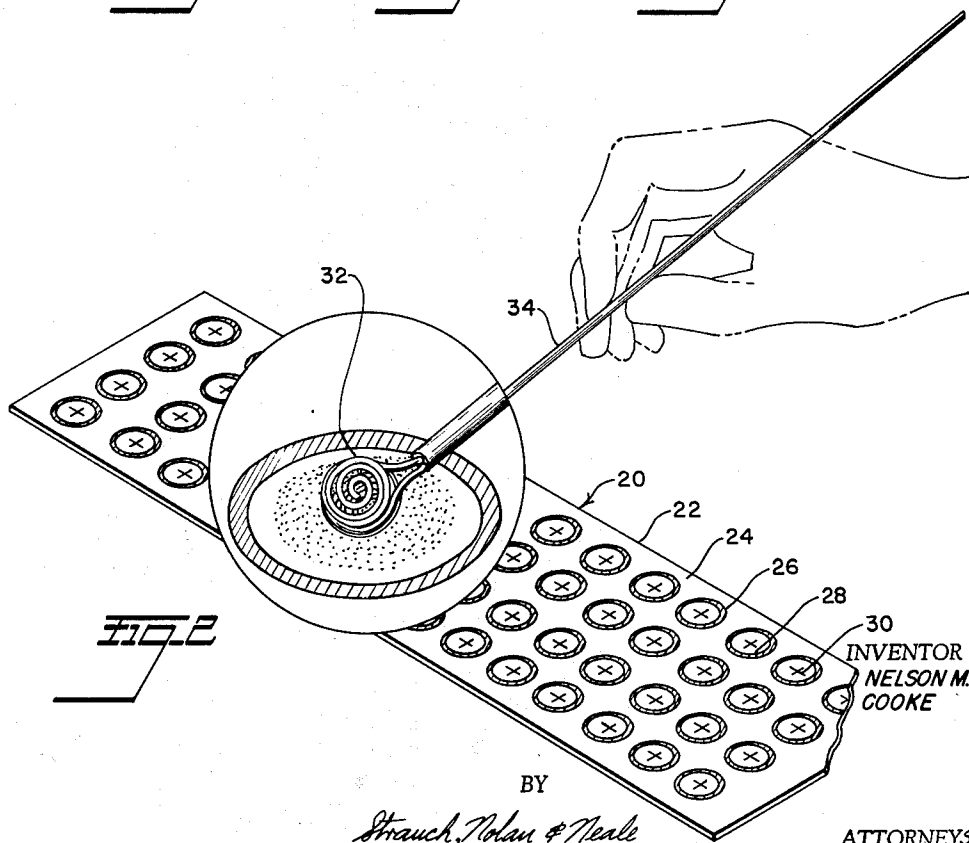


FIG. 2

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APPARATUS FOR TESTING DILUTION LOOPS AND SIMILAR DEVICES

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This invention relates to testing apparatus and, more specifically, to apparatus for ascertaining, with a high degree of accuracy, the volumetric capacity of receptacles and for ascertaining the ability of receptacles to properly discharge their contents. This apparatus is particularly useful for ascertaining the volumetric capacity of liquid-handling laboratory instruments although it is by no means limited to this application.

A typical application of the present invention is its employment in conjunction with the novel microtitration apparatus for performing viral serological investigations described in copending application No. 135,364 filed August 31, 1961, by Alan A. Duff et al. This microtitration apparatus includes plexiglass plates each having a plurality of rows of cups or recesses which are first filled with a predetermined minute volume (either 0.025 or 0.050 milliliter) of an appropriate diluent.

A number of dilution loops equal to the number of recess rows, each including a liquid-carrying head in the form of a spiral tendril and usually having a capacity of either 0.025 or 0.050 milliliters, are then filled by dipping the heads in a liquid reagent. The filled loops are removed to the plexiglass plate and inserted into the first of the diluent-filled recesses in each row. After rotating the loops to mix the reagent and the diluent, the loops are removed to the adjacent cup in each row and rotated to mix the diluted reagent carried by the loops with the diluent in those recesses. The process is repeated down the rows, progressively decreasing the concentration of the reagent in the recesses. The concentrations thus prepared are then treated or analyzed in accordance with the particular serological investigation being conducted.

Since the volumes of diluent and liquid reagent employed in the foregoing microtitration apparatus are very small, it is of the utmost importance that these volumes be accurately measured and that the dilution loops properly discharge their contents since, if they do not, dependable results will not be obtained. The liquid-carrying heads of the dilution loops are especially susceptible to foreign influences which affect their volumetric capacity. Specifically, before the dilution loops are used in the microtitration sequence in the manner described above, the heads are passed through the flame of a Bunsen or similar burner to remove contaminating material. The loops are then prewet by dipping the heads in a saline solution. After they are used, the contaminated loops are soaked in a 0.5% solution of sodium hypochlorite and placed on a blotter to discharge the hypochlorite solution. The loops are then placed in deionized water, blotted, and passed through a flame.

Failure to properly prepare the loops such as failure to flame off contaminants or to prewet the loops in the saline solution will result in erratic delivery. And, if after use, the sodium hypochlorite solution and deionized water are not discharged from the loops or if the loops are not passed through a purging flame, the loops will rapidly deteriorate with resultant erratic delivery and deviation from the desired volumetric capacity.

Since there are such a large number of ways in which the volumetric capacity and delivery characteristics of the dilution loop heads may be altered, of which the foregoing are exemplary, it is necessary to provide testing apparatus for insuring that the volumetric capacity

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and delivery characteristics have not been affected between succeeding tests so that consistent and dependable test results may be obtained.

The necessity for accurately ascertaining the capacity of a liquid receptacle and for insuring that it will properly discharge its contents is, of course, not limited to the dilution loops discussed above. On the contrary, these criteria are important in any circumstance where test or manufacturing process results, for example, are dependent on the confinement of a volumetric parameter within narrow limits.

By capacity, it is to be understood, is meant not only "brimful" capacity, but also the partial capacities of a receptacle. To elaborate, the method and apparatus of the present invention may be employed to determine the accuracy of the scale on a graduate, pipette, or similar receptacle, as well as to determine the receptacle's overall or "brimful" capacity.

It is an object of the present invention, therefore, to provide novel testing apparatus and a novel method for insuring, with a high degree of accuracy, that liquid receptacles designed to hold a predetermined volume of liquid have a volumetric capacity between predetermined minimum and maximum limits and that they will properly discharge their contents.

To be effective, and of benefit to the technician conducting the test or monitoring the manufacturing process, the testing apparatus must facilitate rapid and easy performance of the necessary volumetric capacity and content discharge tests.

Therefore, it is a further object of the present invention to provide novel apparatus and a novel method for rapidly and easily ascertaining the volumetric capacity of a liquid receptacle and the ability of the receptacle to discharge its contents.

In conjunction with the foregoing objects, it is a further object of this invention to provide testing apparatus for the purposes described above which is simple and inexpensive to manufacture and which will have no upkeep or maintenance costs.

It is a further specific object of the present invention to provide novel apparatus and a novel method which may be utilized for quickly insuring, with a high degree of accuracy, that liquid-handling laboratory instruments such as the dilution loops described above have the desired volumetric capacity and that they will properly discharge their liquid contents.

The testing apparatus of the present invention consists, generally, of (1) mechanism for receiving the liquid from the receptacle to be tested and uniformly distributing it over an area proportional to the discharged volume and (2) mechanism responsive to the area of distribution for generating a signal if the volume is within the desired minimum and maximum limits.

In one embodiment, useful with the novel microtitration apparatus described above, the present invention includes a member formed from a uniformly thick sheet of especially selected absorbent material. When the head of a dilution loop is touched to the surface of the absorbent member, the liquid it carries is absorbed by the member, moistening an area of its surface which is directly proportional to the volume of liquid absorbed. It is, of course, essential that the absorbent material uniformly distribute the liquid discharged from the loop so that the area moistened will be proportional to the volume of liquid withdrawn.

Outlined on the surface of the absorbent member are a number of annular comparison areas defined by concentric inner and outer circles. If the periphery of moistened area lies within the inner circle, the technician will be advised that the capacity of the dilution loop is unacceptably low or that the dilution loop is not prop-

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erly discharging its contents. Similarly, if periphery of the moistened area extends beyond the outer circle, this signal will advise the technician that the capacity is unacceptably high. On the other hand, if the periphery of moistened area lies between the inner and outer circles, the signal will indicate that the loop has a capacity within the predetermined maximum and minimum limits and that it is properly discharging its contents. The technician performing the test can, in this manner, quickly and easily determine if the dilution loop has the proper capacity and if it is properly discharging the liquid carried by it.

It will be understood, of course, that precisely the same procedure may be followed with receptacles other than dilution loops. Moreover, the invention is not limited in its broader aspects to absorbent material, but, as was indicated above, may employ any material or apparatus or combinations thereof which will uniformly distribute the contents of a receptacle over an area proportional to the volume of the contents and generate at least one signal if such volume is within predetermined maximum and minimum limits.

Other objects and novel features of the present invention will become more fully apparent by reference to the appended claims and as the following detailed description proceeds in reference to the accompanying drawing, in which:

FIGURE 1 is a plan view of the novel testing apparatus provided by the present invention;

FIGURE 2 is a perspective view illustrating one step in the novel method provided by the present invention for ascertaining the volumetric capacity and delivery capability of a liquid receptacle;

FIGURE 3 is a plan view of a portion of the apparatus of FIGURE 1, illustrating the results obtained when the receptacle tested has the proper volumetric capacity and is properly discharging the liquid it carries;

FIGURE 4 is a view similar to FIGURE 3, but illustrates the results obtained if the volumetric capacity of the receptacle tested is too high; and

FIGURE 5 is a view similar to FIGURES 3 and 4, but illustrates the results obtained if the volumetric capacity of the receptacle tested is too low or the receptacle is not properly discharging the liquid it carries.

Referring now to the drawings, FIGURE 1 illustrates exemplary testing apparatus 20 constructed in accordance with the principles of the present invention. Testing apparatus 20 consists of a member 22 made from a uniformly thick sheet of highly absorbent material such as 100 substance, 20 weight Albemarle "Verigood" stock. Other materials may be employed for the member 22, but the material selected must have the capacity to uniformly distribute or disperse liquid over the surface of the member since the accuracy of the volumetric capacity test depends upon the area of distribution being directly proportional to the volume of liquid withdrawn or discharged from a receptacle. Outlined on the surface 24 of absorbent member 22 are a number of equidistantly spaced, annular comparison areas 26 defined by concentric, circular, inner and outer boundaries 28 and 29. Printed, or otherwise provided at the common center of the concentric circular boundaries 28 and 29 is a target 30 in the form of a small cross. Boundaries 28 and 29 are related to the volume of a particular size receptacle and are so dimensioned that inner boundary 28 and outer boundary 29 correspond to the acceptable minimum and maximum receptacle capacities. Thus, the annular area 26 represents the permissible variation in receptacle capacity.

Referring next to FIGURE 2, the receptacle to be tested, in this case head 32 of a dilution loop 34, is touched to the target 30 in one of the comparison areas 26. The liquid carried by the head will be discharged by the head and absorbed by member 22, moistening an area directly proportional to the volume of liquid discharged.

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As was pointed out above, each of the comparison areas 26 is so sized that, if the head 32 has the proper capacity and properly discharges its contents, the periphery of the moistened area will lie between the boundaries 28 and 29 of the comparison area (FIGURE 3). If this signal is obtained, the technician performing the test is assured that the dilution loop is of the proper capacity and that it is properly discharging its liquid contents. On the other hand, if the moistened area is larger than the comparison area so that its periphery extends beyond boundary 29 (FIGURE 4) or smaller so that it does not extend to boundary 28 (FIGURE 5), the technician will know that the loop does not have the proper capacity and/or that it is not properly discharging the liquid it carries and that it should be discarded.

Preferably, this volumetric capacity test is conducted immediately after prewetting the dilution loop in the saline solution and again after it has been used to mix the diluent and reagent. If the results of both of these tests indicate that the loop 34 has the proper capacity, a high degree of probability exists that the loop has retained the proper capacity and has properly discharged its contents throughout the sequence of reagent diluting steps in the microtitration process described above. At each of these times, the test may be repeated a predetermined number of times, if desired, to insure maximum reliability. Infrequent spurious test results may be disregarded. However, if indications that the loop is defective are obtained with any degree of regularity, the instrument should be discarded.

Although the novel testing apparatus and method provided by the present invention have been described in conjunction with dilution loops, it is to be understood that both are equally useful for ascertaining the volumetric capacity of any receptacle. Moreover, the principles of the present invention are not limited to the specific apparatus illustrated. Any apparatus may be employed which will: (1) receive the liquid from the receptacle of which it is desired to ascertain the volumetric capacity; (2) distribute or disperse the liquid uniformly over an area proportional to the volume of liquid discharged from the receptacle; and (3) generate a signal in response to the area of distribution indicative of whether the volume discharged is between predetermined minimum and maximum limits. For example, testing apparatus employing the principles of the present invention may be so designed that, if the dispersed liquid covers an area lying between the predetermined minimum and maximum limits, it will complete an electrical circuit in which is disposed a source of current and a signaling device to thereby generate a visual or audible signal. As a further example, and with reference again to FIGURE 3, the comparison area 26 lying between inner and outer boundaries 28 and 29 may be saturated with a dye which will change color if contacted by the reagent carried in the receptacle. Thus, if the receptacle is of the desired capacity, a visual "color change" signal will be generated, indicating to the technician performing the test that the receptacle is of the desired capacity.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. The method of testing a receptacle and providing an indication if its capacity is within predetermined minimum and maximum limits, comprising the steps of:

- (a) withdrawing the liquid from a receptacle;

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(b) distributing said liquid over an area substantially proportional to the volume of liquid withdrawn by depositing said liquid on an absorbent member having the capacity of uniformly distributing liquid over a surface thereof; and

(c) providing an indication of whether said area of distribution lies between predetermined minimum and maximum limits.

2. The method of claim 1, wherein said indication comprises a first signal if the periphery of said area of distribution lies within an annular area formed by two concentric circles representing the minimum and maximum acceptable limits of the desired capacity.

3. The method of testing a receptacle and providing an indication if its capacity is within predetermined minimum and maximum limits, comprising the steps of:

(a) filling a receptacle with a liquid;

(b) depositing said liquid on an absorbent member having the capacity of uniformly distributing liquid over a surface thereof, whereby said surface will undergo visual transformation over an area proportional to the volume of liquid deposited; and

(c) providing an indication of the relation between the sizes of said transformed area and an annular area of such size that if said receptacle has the desired capacity, the boundary of said transformed area will lie within said annular area.

4. The method of claim 3, wherein:

(a) said steps are repeated a predetermined number of times; and

(b) spurious test results obtained from said repetitions are eliminated.

5. Apparatus for ascertaining if the capacity of a receptacle is within predetermined minimum and maximum limits, comprising:

(a) a uniformly thick member of absorbent material

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adapted to receive liquid from a receptacle constructed to have a predetermined capacity;

(b) a planar surface on said member having substantially equal absorptive power at all points thereof;

(c) at least one circular area defined on said surface;

(d) target means located at the center of said circular area and coplanar therewith, the absorptivity of said absorbent material and the size of said circular area being so correlated with the capacity of the receptacle that, when the liquid from said receptacle filled to capacity is deposited on said target means, said circular area is substantially completely moistened.

6. The apparatus of claim 5 wherein said circular area has boundary means therearound such that, the entire surface within said boundary means will not be moistened when said liquid is deposited on said target means if said receptacle has a volume smaller than said predetermined volume, and such that the area outside of said circular area will be moistened when said liquid is deposited on said target means if the volume of the receptacle is greater than said predetermined volume.

7. The apparatus as defined in claim 6, wherein said boundary means comprises a pair of concentric circles and the annular area between said circles is of a color contrasting with the color of said circle within and beyond said boundary means.

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