

Nov. 25, 1969

D. A. HAMILTON

3,480,398

CHEMICAL PACKAGE

Filed Dec. 26, 1967

2 Sheets-Sheet 1

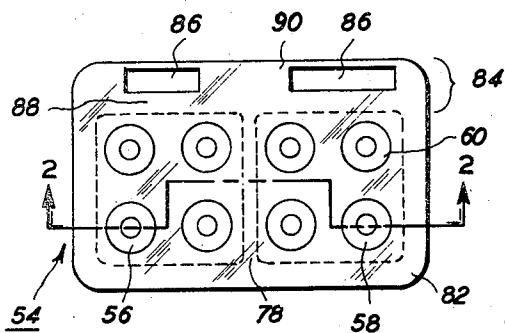


FIG. 3

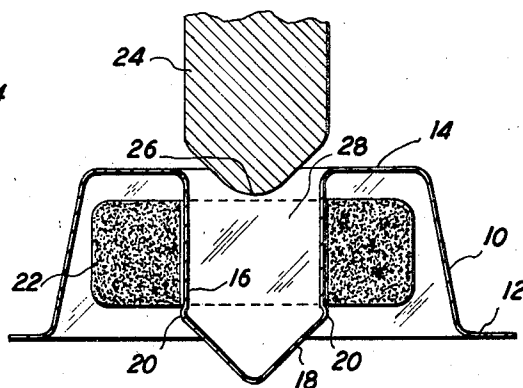


FIG. 1

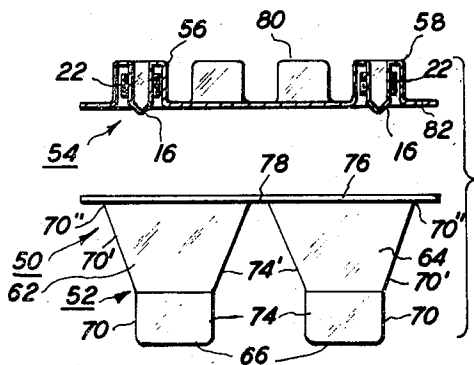


FIG. 2

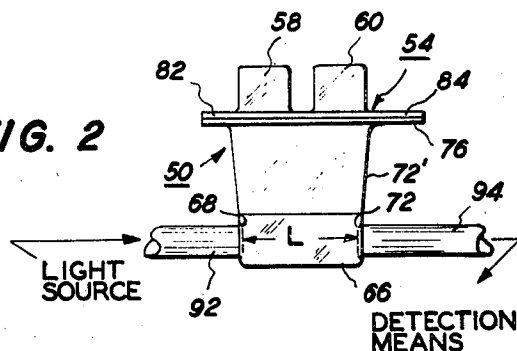


FIG. 4

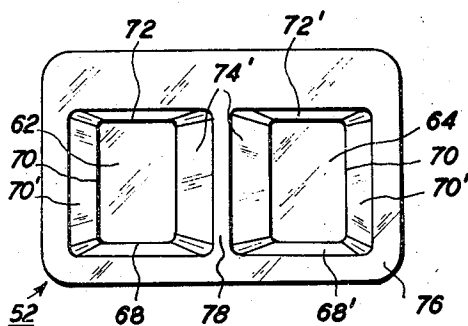


FIG. 5

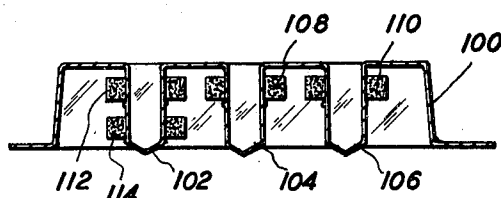


FIG. 6

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2 Sheets-Sheet 2

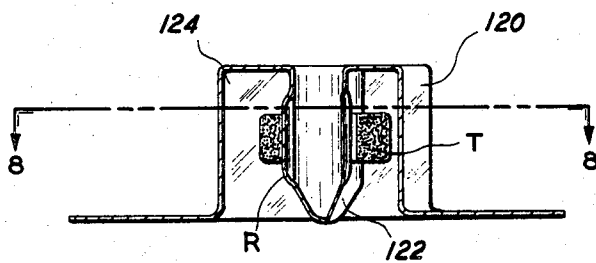


FIG. 7

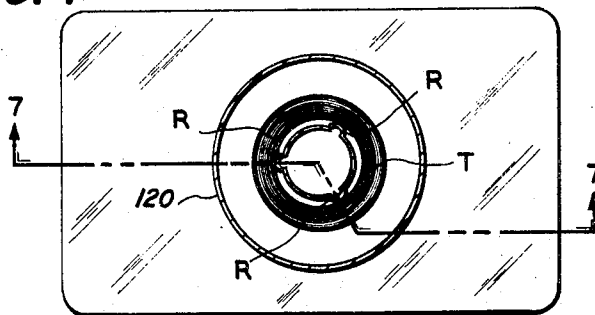


FIG. 8

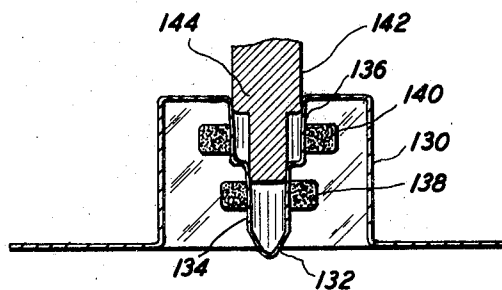


FIG. 9

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3,480,398

CHEMICAL PACKAGE

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Filed Dec. 26, 1967, Ser. No. 693,401

Int. Cl. G01n 33/16; B01l 3/00

U.S. Cl. 23—253

36 Claims

ABSTRACT OF THE DISCLOSURE

A disposable reaction container comprising a lower section having at least one compartment for the admixing of materials added thereto, an upper section securely mounted on said lower section and having at least one separate reagent storage chamber adjacent each of said compartments, each of said storage chambers having at least one hollow finger extending into said storage chamber from the top portion thereof and adapted for the storage of at least one donut-shaped reagent tablet thereon.

Background of the invention

This invention relates to automatic chemical analysis and, more particularly, to the automatic chemical analysis of body fluids, such as blood, urine, etc.

In copending application Ser. No. 602,025 filed Dec. 15, 1966, there is disclosed an automated chemical analytical system including a plurality of different disposable reaction containers, a magazine for the storage of the plurality of different reaction containers, a station for the addition of sample material to the reaction container, a mixing and incubation station wherein the reaction mixture is maintained in the disposable container for a period of time sufficient to culminate the chemical reaction, a detection station wherein the analytical data is obtained by monitoring one or more of the physical properties of the reaction mixture, a disposal station wherein the disposable reaction container is eliminated from the system, and means to transport the disposable reaction container from its storage area in the magazine through the system to the disposal station. The heart of the system is the disposable reaction container which, in its broad aspects, has at least one lower compartment for the admixing and reaction of reagents and sample, and an upper section having a plurality of reagent storage chambers in communication with each reaction compartment. At least one wall or end portion of the reaction compartment may be optically transparent so that upon completion of the desired chemical reaction the compartment can be utilized as a cuvette for optical analysis. Optionally, none of the walls need be optically transparent as a probe photometer, such as the one disclosed in Gale 3,164,663, may be inserted into the reaction mixture and electromagnetic radiation from a source passed through a radiation conductor, the reaction mixture and back through the radiation conductor to a detection means, without the necessity of passing through the compartment walls.

In copending application Ser. No. 602,018 (also filed Dec. 15, 1966) there is disclosed a similar, though conceptually and structurally different, analytical apparatus and system. The disposable reaction container in this application has a flexible lower compartment, i.e. one having at least one flexible wall, so that during analysis a light source and a detection means pressed against the flexible wall or walls defining the lower cuvette(s) will cause the walls to yield a distance sufficient to define a fixed optical path between the light source and the detection means through the reaction mixture. The auto-

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matic analytical apparatus includes monitoring means having a light source and a means responsive to the variations in light transmittance caused by different concentrations of a constituent under analysis in the reaction mixture. The light source and the responsive means are pressed against opposite sides of the reaction compartment or cuvette during analysis to define a fixed optical path through the reaction mixture. Thus, there is provided an automatic analytical apparatus having the optical path defining means built into a detection station. Production requirements for the disposable reaction container are less severe than when the fixed optical path is defined by the rigid walls of the reaction compartment. The reaction container can be mass produced and disposed of after use without significant cost.

In copending application Ser. No. 645,665, filed June 13, 1967, there is disclosed a disposable reaction container of improved design. Specifically, the lower section of the disposable reaction container comprises positioned walls adapted to channel the material added thereto to a portion of the lower compartment defined by a substantially rectangular volume. Optionally, a still lower compartment can be provided for the storage therein of a magnetic stirring bar so that thorough mixing of added materials can be achieved through use of urging means magnetically coupled to said magnetic stirring bar.

In co-pending application Ser. No. 693,400 filed Dec. 26, 1967, there is disclosed a disposable reaction container wherein each storage chamber in the upper section has a plurality of longitudinal ribs adapted to securely hold the reagent tablets in place thereby preventing premature movement of the prepackaged reagents from their respective storage chambers. By that design, the previously provided restraining layer which completely covered the opening of the storage chamber can be omitted without undesirable effects.

Even though this latter design had many advantages, it also had various disadvantages. For example, the ribs which supported the tablet had sufficient columnar strength to make dislodgement of the tablet a difficult and sometimes non-reproducible operation. The placement of the tablet within the pod had to be precisely achieved or it would turn and wedge into the pod in such a way that it could not easily be dislodged. The quantities of chemicals comprising each reagent tablet vary widely and for many of the difficult-to-tablet recipes there is an optimum thickness-to-diameter ratio. Thus, when dealing with a disposable container having uniform diameter pods, some tablets would have to be made very thin, others would be brittle, some flaky or crumbly because the optimum thickness-to-diameter ratio could not be obtained. Such problems limited the utility of said improved package even though it had distinct advantages over prior designs.

Summary of the invention

Now in accordance with the present invention, there is provided a further improved disposable reaction container for use with the aforementioned analytical apparatus and systems. The improved disposable reaction container has at least one lower compartment for the admixing and reaction of reagents and sample material added thereto, and an upper section having at least one reagent storage chamber in communication with each reaction compartment. At least two walls on opposite sides of each reaction compartment are inclined to the vertical whereby material added to the reaction compartment is caused to flow into the bottom portion thereof. The inclined walls terminate at a point intermediate the open top portion of the lower section and the bottom wall of the reaction compartment; the walls continuing in a

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plane perpendicular to a plane passing through the flange portion extending about the outer perimeter of the lower section to define a substantially rectangular volume having substantially perpendicular and parallel side walls, said volume adapted for use as a cuvette for optical analysis of the material held therein.

In the improved design of the present invention, each storage chamber in the upper section has a concentric finger upon which a donut-shaped tablet is placed. The end of the finger is appropriately tapered to guide the tablet or tablets onto the finger. The finger is hollow on the open or exposed portion of the container. Thus, in operation, a probe of appropriate size and shape is inserted into the hollow finger whereby the reagent tablet or tablets stored thereon are fractured and fall into the reaction compartment or cuvette placed below. By this design, the previously provided restraining layer (for example layer 16 as shown in FIGURE 1 of Ser. No. 645,665) can be omitted without undesirable effects. As an additional advantage, less force is necessary to dislodge the reagent tablet from the storage chamber as only small distortions of the hollow finger are necessary to fracture the tablet and drop it into the lower compartment. Further, no force is necessary to break the restraining layer as such layer is omitted.

Thus, in one embodiment, each storage chamber has one finger therein with at least one reagent tablet securely mounted thereon. The exact number of storage chambers utilized will depend upon the analytical test being conducted with the disposable container and the number of reagent tablets which are needed in the course of that test. In a further embodiment, a single hollow finger is provided in a single storage chamber with all of the reagent tablets placed thereon. Depending upon the number of tablets needed, one or more tablets may be placed upon the hollow finger. In still a further embodiment, a single storage chamber can be provided with a plurality of hollow fingers positioned therein. One or more tablets can be placed upon each finger. Various permutations and combinations of the aforementioned embodiments can be chosen depending upon the requirements for the analytical test being conducted and the number, physical and chemical characteristics, etc. of reagent tablets which must be stored within the disposable container. Such modifications will be apparent to those skilled in the art in view of this disclosure.

Other embodiments include the provision of ribs on the internal portion of the hollow finger (i.e. on the tablet side) such that the surface contact between the tablet and the package will be minimized. Additionally, the diameter of the hollow finger can be varied at different portions thereof to accommodate reagent tablets having differently sized hole diameters. In this variation, the configuration of the probe can suitably be modified to assist in fracturing the differently sized reagent tablets.

The walls of the reaction compartment can be transparent and rigid, the distance between one pair of opposite walls defining a fixed optical path through the reaction mixture. This fixed optical path or fixed distance between the pair of opposite walls is equal, within certain tolerances, for each disposable reaction container representing a single chemical analysis whereby uniformity and reliability of analytical data and results can be achieved.

In a different design, at least one pair of opposite walls are flexible so that a fixed optical path to the reaction mixture can be defined by pressing a light source against one wall and a detection means against the other wall. The walls yield a distance sufficient to define a fixed optical path between the light sources and the detection means through the reaction mixture. Alternately, higher than atmospheric pressure means can be positioned over the upper storage section so that a relatively inert gas, such as nitrogen, can be admitted to the reaction compartments through holes made in the upper section dur-

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ing sample addition. The side walls will be bowed outwardly and can be made to press up against accurately positioned optical path defining means. Thus, in each instance, there is provided within each detection station means to define an optical path which will be maintained constant for each disposable reaction container representing like chemical testing units.

Optionally, a small circular compartment can be provided in the lower portion of each reaction compartment for the storage of a magnetic stirring bar which can be rotated during incubation, by means magnetically coupled thereto, to thoroughly mix the materials added to the reaction compartment.

Brief description of the drawings

The nature of the invention will be more easily understood when it is considered in conjunction with the accompanying drawings wherein:

FIGURE 1 is a sectional side view of the improved storage chamber of the present invention;

FIGURE 2 is an exploded side view of an exemplary disposable reaction container of the present invention, the cross-section being taken on section line 2—2 of FIGURE 3;

FIGURE 3 is a top view of the disposable container of FIGURE 2;

FIGURE 4 is an end view of the disposable container of FIGURE 2;

FIGURE 5 is a top view of the lower section of the disposable container of FIGURE 2;

FIGURE 6 is a side-sectional view of an upper section storage chamber showing a plurality of hollow fingers therein and the reagent tablets stored thereon;

FIGURE 7 is a cross-sectional view of an upper section storage chamber showing a hollow finger having a plurality of longitudinal ribs and a reagent tablet thereon, the cross-sectional view being taken along section line 7—7 of FIGURE 8;

FIGURE 8 is a top cross-sectional view of the storage chamber of FIGURE 7 taken along section line 8—8 of FIGURE 7; and

FIGURE 9 is a side sectional view of an upper section storage chamber showing a hollow finger adapted for the storage of donut-shaped reagent tablets having different internal diameters.

Referring to FIGURE 1, there is seen an upper section storage chamber 10 having a bottom flange 12 and a top wall 14. In the center of the storage chamber 12 is a hollow, concentric finger 16 extending from the plane of top layer 14 to just below the plane of flange 12. The lower end of finger 16 is provided with a tapered guide 18 and slight buckle 20 where the tapered guide 18 meets the cylindrical portion of finger 16. During assembly, a donut-shaped tablet 22 is pressed over the buckle 20 onto the finger 16 and held in place thereon by the friction fit between the finger and the internal surface area of the tablet. The tapered guide 18 helps guide the tablet 22 onto the finger without precise positioning being required. In use, a probe 24 having a tapered guide 26 on the lower end thereof is inserted into the hollow 28 of finger 16. The outside diameter of the probe 24 is slightly larger than the hollow 28 of the finger and thus expands the tablet 22 and fractures it, permitting it to drop into the container or cuvette (not shown) below. If desired, the probe 24 can be slightly oval-shaped but of essentially the same circumference as the circumference of the hollow of the finger so that instead of expanding the finger to break the tablet, it can distort the finger into an oval shape and achieve the same result.

The storage chamber of the present invention with its hollow finger and donut-shaped tablet or tablets thereon has many advantages over the disposable containers disclosed in the aforementioned co-pending applications. Initially, it eliminates the need for the previously provided restraining layer (for example, layer 16 as shown in FIG-

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FIGURE 1 of Ser. No. 645,665) or other means for holding the reagent tablets in place in the storage chambers.

The present invention permits a single disposable container design for differently sized reagent tablets, and, accordingly, permits optimum thickness-to-diameter ratio for each tablet. Because the optimum size characteristics can be achieved, the optimum storability properties can also be achieved. That is, at optimum characteristics the reagent tablet will be such that it may be stored for greater periods of time without fear of deterioration, crumbling, flaking, dusting, etc.

Previous designs required that the storage chamber be inverted to dispense the reagent tablet stored therein into the lower compartment or cuvette. Additionally, a certain amount of force was necessary to break the restraining layer if one was provided. The present invention minimizes the force required to dislodge the tablet as it is now only necessary to expand the tablet sufficiently to fracture it whereby the pieces may fall into a properly positioned compartment. Further, since the tablet is fractured into many pieces, much greater surface area is available for quicker dissolving. This advantage may be further enhanced by pre-scoring the donut-shaped tablet so that when it fractures, it fractures into even a greater number of pieces.

The finger hanging down within the storage chamber provides isolation and cushioning of the tablet from the rest of the disposable container whereby the tablet is protected from even the most severe vibration and rough handling. Since the storage chamber does not have to be collapsed or inverted as in prior designs, the storage chamber can be made quite stiff and rigid and thus relatively inflexible to minor vibration and jarring. Because of the nature of thermo-forming, however, the finger will automatically be much thinner and thus more flexible than the remainder of the storage chamber. The thicker storage chamber will permit stacking of the packages without danger of accidental dislodgement of the tablet.

In view of this disclosure, other advantages and features of the present invention will be apparent to those skilled in the art.

Referring to FIGURES 2-5, there is seen a disposable reaction container 50 having a lower section 52 and an upper section 54 having a plurality of reagent storage chambers 56, 58, 60, etc. Lower section 52 has two separate lower compartments 62 and 64. Each lower compartment has a bottom wall 66, exterior side walls 68, 70, and 72 and interior wall 74. The wall portions of compartment 62 and 64 terminate in an horizontal flange 76 which encircles the outer perimeter of the two compartments and holds them together as a distinct unit. Bottom wall 66 is parallel with horizontal flange 76 with walls 68, 70, 72, and 74 being perpendicular thereto, the five walls thus defining a rectangular volume having slightly rounded edges and corners. The rectangular volume does not extend all the way from bottom wall 66 to flange 76 but terminates intermediate these two elements. The lines of termination of the rectangular solid along each wall define a plane which is parallel to the plane of horizontal flange 76. From this point the walls diverge upwardly and outwardly as at 68', 70', 72', and 74' until they intersect with horizontal flange 76 to define a rectangular opening beneath the plurality of reagent storage chambers when upper section 54 is in position on flange 76. As shown, walls 70' terminate in a short leg 70'' just prior to its intersection with flange 76, leg 70'' being perpendicular to flange 76. If desired, this leg can be omitted whereby walls 70' will diverge upwardly and outwardly from the plane at the top of the rectangular volume until they intersect with flange 76. The shape of the opening is not critical as long as it will not interfere with the introduction of sample and reagents into the lower compartment. The sloping walls channel all material downward toward the bottom of the reaction compartment. Interior walls 74 extend to the

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plane of horizontal flange 76 and are connected to each other at line 78 thereby forming a distinct barrier between compartments 62 and 64.

Resting on flange 76 and barrier line 78 is an upper storage section 54 which comprises a unitary member 80 formed into a plurality of reagent storage chambers 56, 58, 60, etc. in the form of "top-hats." Each storage chamber has a hollow finger 16 therein for holding the reagent tablet 22 in place thereon. A cut-away view of storage chambers 56 and 58 is shown in FIGURE 2 wherein donut-shaped tablets 22 can be seen as they are held in place on their respective hollow fingers. As will be shown later with reference to FIGURE 6, a plurality of donut-shaped tablets can be stored on each hollow finger if desired. Insertion of a properly sized probe into the hollow portion of the finger will cause fracturing of the stored tablet with the resultant deposition thereof into the lower compartment.

Upper section 54 has a flange 82 which encircles the lower perimeter thereof, one side of which extends the length of the disposable reaction container and is slightly wider than the border which encircles the remainder of the upper storage section 54. This wider portion is indicated at 84. Flange 76 which encircles the upper perimeter of the lower section is also wider along this side. Thus, the rectangles with slightly rounded edges formed by flange 76 encircling the upper perimeter of lower section 52 and flange 82 encircling the lower perimeter of upper section 54 are of equal size and dimension so that the two members can be suitably joined to provide a unitary disposable container. Preferably, each member is formed out of a plastic material which can be heat sealed to the other member to provide an exceptionally strong bond which cannot be broken under normal use. Flanges 76 and 82 are sufficiently wide along the wider portions 84 so that a code area or areas 86 can be provided on flange 82 between inner bond 88 and outer bond 90. Any suitable type of coding can be placed on this code area to indicate or record any information which desirably should be known during a chemical analysis, such as the actual test which has been pre-stored in the particular disposable reaction container, the patient number, instructions for the associated automatic analytical apparatus and system, analytical results, etc. Typical codes include binary coding in the form of light and dark areas, magnetic coding, etc.

In operation, container 50 is taken from a supply magazine and passed to a sample addition station where the proper amount of sample diluted with distilled water is aliquoted into compartment 62. This addition is accomplished by injecting the sample solution through a needle which has been inserted through upper section 54. Preferably, this insertion is made at a point which will not cause undue rotation of the supported container. For example, with a container as shown in the figures, the insertion for each compartment can be made at a point approximately equidistant from the centers of the four storage chambers 56, etc. The sample-holding container is then passed to a reagent addition station where insertion of the probe into the hollow of the finger will cause the reagent tablet stored thereon to be emptied into the appropriate compartments. Reagent addition can be done in one operation or it can be done sequentially as it is necessary to complete the analytical procedure. If done sequentially, the addition can be done during or after incubation. In essence, reagents can be added any time prior to final detection as determined by the particular analytical procedure utilized. Container 50 is passed to a mixing station where it is maintained for a time sufficient to ensure the dissolution of all solid materials in the liquid contained in the lower compartments. The container next passes to an incubation station where appropriate reaction conditions are imposed upon the materials within the container for a time sufficient to complete the desired reaction which is then measured at a

detection station. If necessary the package passes to a further reagent addition mixing and incubation stations as dictated by the analytical procedure. It is not necessary that the mixing and incubation stations be separate and distinct as it is contemplated that these operations may be performed in a single station.

At a detection station, light of appropriate wavelength is passed from a light source through the reaction mixture to detection means situated on the opposite side of the reaction mixture from the light source. The amount of light transmitted (or, conversely, the amount of light absorbed) at the testing wavelength will be representative of the amount of the constituent under analysis in the test solution.

Preferably, the disposable container as shown in the drawings is used in conjunction with a double-beam detection mechanism. In one compartment there is providing a solution of the material being tested with all the reagents which will bring the reaction mixture to the desired point for analysis. The other compartment contains a solution of the material being tested in the absence of reagents. In certain instances, one or more reagents can be added to this latter solution, provided the reagents do not carry the reaction to completion or do not adversely affect, in any other way, the optical analysis. This latter solution is called a "critically incomplete blank" and will enable the analytical system to compensate for the effects of the sample and the reagents added thereto. To maintain the detection mechanism in calibration, standard solutions are passed through the detection mechanism at intervals so that the latter can adjust for deviations which occur during operation.

To dispense with the necessity of passing standard solutions through the detection mechanism at regular intervals a disposable container having three compartments, and the plurality of storage chambers associated with each compartment where reagents need be added, is provided for use with a triple-beam detection mechanism. The standard solution can be injected into the disposable container at any point in the system prior to optical analysis and will obviate the need for passing distinct disposable container holding standards through the system. Alternatively, standard-containing tablets can be stored in the upper section, dispensed into the lower compartment and diluted to give the desired concentration. The detection mechanism will analyze the standard and adjust for deviations from the known value. The analysis of the materials in the other two compartments is conducted in accordance with the teachings of both. If one wishes to conduct an extremely precise analysis and take into consideration every possible influencing factor, additional lower compartments can be built into the disposable container for the introduction of such factors and the analysis thereof. Thus, adjustments can be made which will compensate for the effect which these materials have upon the particular analysis.

Optionally, light from the light source and light which has passed through the reaction mixture can be conducted to the disposable container and the detection means, respectively, through light conduits which are pressed against an opposite pair of rigid walls which comprise a portion of the lower compartment. In this embodiment, the optical path is defined by the distance between the opposite walls of the lower compartment against which the light conduits are pressed. Since it is preferred to maintain this optical path constant for all like analytical procedures, strict production requirements must be met in the production of disposable containers having rigid lower compartment walls.

This optional form of optical analysis is shown in FIGURE 4 wherein a disposable reaction container 50 having flexible walls 68 and 72 has light source means and detection means pressed against opposite walls of the lower reaction compartment. Thus, in the detection station as illustrated in FIGURE 4, light conduits 92 and

94 are pressed against walls 68 and 72, respectively, of each lower compartment. Conduit 92 is connected at the opposite end to a light source (not shown) which can be filtered to provide light of a desired wavelength or wavelengths. Conduit 94, directly opposite conduit 92, is connected to an appropriate detection means (not shown) for monitoring the intensity of the light passed through the liquid mixture in the lower compartment. During the actual analysis, conduits 92 and 94 are moved toward each other whereby the flexible walls of the compartment will deform and assume the position as shown by the dotted lines thus defining a fixed optical path L between the interior sides of deformed walls 68 and 72 and through the reaction mixture. By providing a fixed optical path L in this manner, it is easier to mass produce the disposable container as a certain critical feature, the optical path, has been eliminated as a strict production requirement. The optical path defining means is now built into the detection station and, as would be expected, significantly less detection stations should be produced than disposable containers. Since a fixed optical path is defined by the detection station and will be the same for each container passing therethrough, highly accurate and reliable data can be obtained with this system.

It is also contemplated that the disposable reaction container 50 as shown in FIGURE 4 can be used in conjunction with a double-beam detection mechanism, as described above.

Alternatively, higher than atmospheric pressure means can be positioned over the upper storage section so that a relatively inert gas, for example nitrogen, can be admitted to the reaction compartment through holes made in the upper section during sample addition. The side walls will be bowed outwardly and can be made to press up against accurately positioned optical path defining means. Thus, in this embodiment as in the preceding embodiment, there is provided within each detection station means to define an optical path which will be maintained constant for each disposable reaction container representing like chemical testing units.

Referring to FIGURE 6, there is seen a further embodiment of the present invention wherein a single storage chamber 100 has a plurality of depending hollow fingers 102, 104, and 106 therein. Fingers 104 and 106 have a single tablet 108 and 110, respectively, stored thereon whereas finger 102 holds two tablets 112 and 114. This figure illustrates that more than one depending finger can be provided in each storage chamber and that more than one tablet can be stored thereon.

Referring to FIGURES 7 and 8, there is shown a storage chamber 120 having a single hollow finger 122 therein. A plurality of longitudinal ribs R are disposed about the hollow finger and extend into the interior portion 124 of the storage chamber. A reagent tablet T is shown in place as it is stored about the longitudinal ribs. This embodiment provides for a minimum of contact between the reagent tablet and the disposable container. This is highly desirable where it is contemplated that the tablets will be placed within the disposable container long (generally on the order of months) prior to their use in the actual analysis.

Referring to FIGURE 9 there is shown a storage chamber having a hollow finger adapted for the storage of donut-shaped tablets having different internal diameters. As previously indicated, for difficult-to-tablet reagents or compositions, there is an optimum thickness-to-diameter ratio which gives the best storage characteristics. Under certain circumstances, to achieve this optimum thickness-to-diameter ratio, it may be necessary to provide reagent tablets having varying internal diameters. The storage of such tablets can be achieved either by providing different sized hollow fingers and storing each tablet separately or as shown in FIGURE 9 wherein the hollow finger also has portions of different diameter. Also, by properly designing the probe, the plurality of tablets stored upon the

single finger can be added sequentially. As shown, storage chamber 130 has a single hollow finger 132 therein, lower portion 134 of finger 132 having a smaller diameter than upper portion 136. Reagent tablet 138 of appropriate diameter is stored on lower portion 134 whereas reagent tablet 140 is stored on portion 136. As probe 142 is lowered, it comes to the position as shown. Further insertion will initially cause the fracturing of tablet 138 with the resultant deposition thereof into the lower compartment. Additional insertion of probe 142 will cause the wider portion 144 thereof to fracture tablet 140. Thus, there will be provided the sequential addition of reagents to the lower compartment. Obviously, simultaneous deposition can be provided by the complete insertion of the probe.

The number of reagent tablets necessary will depend upon the particular analysis being pre-packaged into the disposable container as well as the compatibility of the different reagents. In certain instances, it is possible to tablet more than one reagent in a single tablet. However, where it is contemplated that the disposable containers will be prepared long before their actual use, the compatibility of the reagents over this long period of time must clearly be established. If this cannot be done, then it is desirable to tablet the reagents separately. In turn, the number of storage chambers and hollow fingers will depend upon the number of reagent tablets utilized. It will also depend upon the particular embodiment disclosed herein chosen, that is, whether a single or plurality of storage chambers are utilized and whether one or more reagent tablets are stored upon different hollow fingers.

A more complete discussion of further modifications in the disposable storage techniques, the automatic analytical apparatus and systems with which the disposable reaction containers of the present invention are to be utilized, etc., is given in Serial Nos. 602,018 and 602,025. Reference is made thereto for said complete discussion and such portions of those applications which are necessary to a complete understanding of the present invention are incorporated herein by reference.

As previously indicated, a magnetic stirring bar may be disposed within the reaction compartment for thorough mixing of materials added thereto through magnetic coupling with properly positioned urging means. If desired the compartment for storage of the magnetic stirring bar can be in the upper storage section, appropriate means being provided to hold the stirring bar in place until needed. Optionally, a cylindrical recess can be provided below the bottom wall 66 of each lower compartment and in communication with each reaction compartment for the storage of such a magnetic stirring bar. The shape of the storage recess is not critical as long as the magnetic stirring bar can easily drop into the recess when the bar is not in use. With the reaction mixture in the lower compartment, the disposable container is moved to a mixing station where an external magnetic field is applied, such as by a rotating magnetic bar. The rotation of the magnetic bar within the disposable container creates a vortex and by regulating the rotational speed of the magnetic stirring bar it is possible to thoroughly mix all the reagents with the sample as well as to clean the walls of the reaction compartment and the storage chambers of undissolved reagents. This insures that all reagents are present in the reaction mixture in proper amounts. Upon completion of the mixing operation, the stirring bar will settle into its storage recess out of the way of optical analysis which proceeds through the side walls forming the rectangular volume of each reaction compartment. An exemplary stirring bar comprises a small cylindrical section of stainless steel wire. Should the magnetic material have a deleterious effect on the assay, then the stirring bar should be entirely covered with a material which will not interfere in the analytical procedure, such as a complete coating of glass or inert plastic.

While the invention has been described with reference to its preferred embodiments, it will be understood by

those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the invention without departing from its essential teachings.

What is claimed is:

1. A disposable reaction container comprising a lower section having at least one compartment for the admixing of materials added thereto, an upper section securely mounted on said lower section and having at least one separate reagent storage chamber adjacent each of said compartments, each of said storage chambers having at least one hollow finger extending into said storage chamber from the top portion thereof and adapted for the storage of at least one reagent tablet thereon.
2. The disposable reaction container of claim 1 wherein each storage chamber has one hollow finger therein.
3. The disposable reaction container of claim 1 wherein each storage chamber has one hollow finger therein, said finger being adapted for the storage of one reagent tablet thereon.
4. The disposable reaction container of claim 1 wherein each storage chamber has one finger therein, said finger being adapted for the storage of a plurality of reagent tablets thereon.
5. The disposable reaction container of claim 1 wherein each storage chamber has a plurality of hollow fingers therein.
6. The disposable reaction container of claim 1 wherein each hollow finger has a plurality of ribs thereon, said ribs adapted to reduce the surface area contact between said hollow finger and a reagent tablet stored thereon.
7. The disposable reaction container of claim 6 wherein there are three ribs disposed on said hollow finger, said ribs being substantially equidistant from each other.
8. The disposable reaction container of claim 1 wherein the lower portion of said hollow finger is tapered to form a guide to assist in the positioning of a reagent tablet thereon.
9. The disposable reaction container of claim 1 wherein different portions of each hollow finger have different diameters, said different portions being adapted for the storage of donut-shaped tablets having different internal diameters.
10. The disposable reaction container of claim 1 wherein said upper section comprises a unitary plastic sheet which has been formed into said storage chamber(s) and said hollow finger(s).
11. The disposable reaction container of claim 1 wherein said lower section has a plurality of separate admixing compartments.
12. The disposable reaction container of claim 1 wherein each of said storage chambers is substantially cylindrical and has a concentric hollow finger therein.
13. The disposable reaction container of claim 1 wherein at least one set of opposite walls defining a portion of each admixing compartment is optically transparent so that upon completion of the desired chemical reaction each compartment can be utilized as a cuvette for optical analysis.
14. The disposable reaction container of claim 13 wherein each set of optically transparent walls is parallel to the longitudinal axis of said container.
15. The disposable reaction container of claim 6 wherein said plurality of ribs are vertically positioned on each of said hollow fingers.
16. The disposable reaction container of claim 1 wherein said upper section and said lower section are heat sealed together.
17. The disposable reaction container of claim 1 wherein said upper section has a flange which encircles the lower perimeter of said upper section and surrounds said reagent storage chambers, said upper section flange

being wider along one portion thereof and capable of having information stored thereon.

18. The disposable reaction container of claim 1 wherein the side walls of each admixing compartment are slightly flexible.

19. The disposable container of claim 18 wherein said side walls are parallel to the longitudinal axis of said container.

20. The disposable reaction container comprising a lower section having a plurality of separate compartments for the admixing of materials added thereto, said lower section having a flange which encircles the upper perimeter of said plurality of admixing compartments, the lower portion of each compartment comprising a bottom wall and parallel and perpendicular side walls which define a substantially rectangular volume, said rectangular volume terminating in a plane parallel to said flange each of said parallel and perpendicular side walls diverging upwardly and outwardly from said plane substantially until each of said walls intersect with said flange, an upper storage section securely mounted on said lower section, said upper section having at least one separate reagent storage chamber in communication with each of said plurality of admixing compartments, each of said storage chambers having at least one hollow finger extending into said storage chamber from the top portion thereof and adapted for the storage of at least one reagent tablet thereon.

21. The disposable reaction container of claim 20 wherein said upper section comprises a unitary plastic sheet having said storage chamber(s) and said hollow finger(s) formed therefrom.

22. The disposable reaction container of claim 20 wherein each storage chamber has one hollow finger therein.

23. The disposable reaction container of claim 22 wherein there are four storage chambers in communication with each admixing compartment.

24. A storage section for use with a disposable reaction container comprising a unitary plastic layer formed into at least one substantially cylindrical storage chamber having at least one hollow finger extending into said storage chamber from the top portion thereof and adapted for the storage of at least one donut-shaped reagent tablet thereon.

25. The storage section of claim 24 wherein each storage chamber has one hollow finger therein, said hollow finger being concentric with said storage chamber.

26. The storage section of claim 24 wherein each storage chamber has a plurality of hollow fingers therein.

27. The storage section of claim 24 wherein each hollow finger has a plurality of vertically disposed ribs thereon, said ribs adapted to reduce the surface area contact between said hollow finger and a reagent tablet stored thereon.

28. The storage section of claim 27 wherein there are

three ribs disposed on said hollow finger, said ribs being substantially equidistance from each other.

29. The storage section of claim 24 wherein the lower portion of said hollow finger is tapered to form a guide to assist in the positioning of a reagent tablet thereon.

30. The storage section of claim 24 wherein different portions of each hollow finger have different diameters, said different diameter portions being adapted for the storage of donut-shaped tablets having different internal diameters.

31. The storage section of claim 30 wherein said different diameter portions increase in diameter with increasing distance from the open end of said storage chamber into which said hollow finger is depending.

32. The storage section of claim 24 in combination with means insertable into the exterior, hollow portion of said hollow finger for causing the fracturing of a reagent tablet stored thereon.

33. A storage section for use with a disposable reaction container comprising a unitary plastic member formed into a plurality of substantially cylindrical storage chambers surrounded by an encircling flange, said storage chambers having a top portion and an open lower portion, said lower portion being coplanar with said flange, each storage chamber having at least one hollow finger therein, said hollow finger being open at the top portion thereof which is coplanar with said top portion of said storage chamber, said hollow finger being adapted to receive through the open, top portion thereof means to expand the walls of said hollow finger sufficiently to cause the fracturing of a reagent tablet stored thereon.

34. The storage section of claim 33 wherein the lower portion of each of said hollow fingers is tapered to form a guide to assist in the positioning of a reagent tablet thereon.

35. The storage section of claim 34 wherein said tapered guide begins above and terminates below the plane of said flange.

36. The storage section of claim 33 in combination with means insertable into the hollow portion of said hollow finger for causing the fracturing of a reagent tablet stored thereon.

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