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Helriegel

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[54] **MIXING DEVICE**

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[52] **U.S. Cl.** ..... **23/259;** 23/230 B; 23/253 R; 23/292; 259/89

[51] **Int. Cl.** **B01l 3/00;** B01f 9/02

[58] **Field of Search** ..... 23/259, 230 B, 253 R, 292; 259/81 R, 89; 195/140

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[57] **ABSTRACT**

A device for mixing test reagents comprising a curved, concave test surface rotatably mounted on an inclined support is described. The reagents are mixed in the cavity of the concave test surface with a predetermined circular motion which results in uniform mixing of the reagents.

6 Claims, 5 Drawing Figures

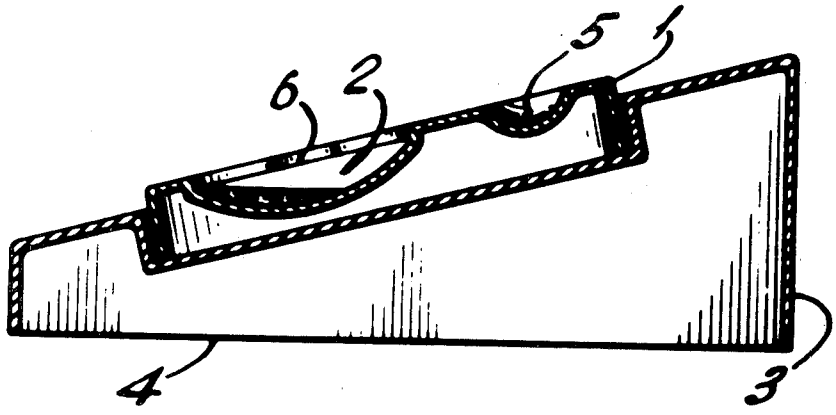


Fig.1.

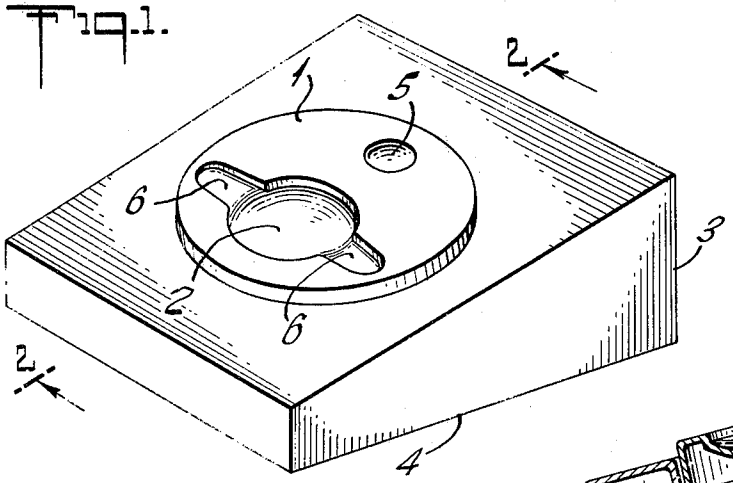


Fig.2.

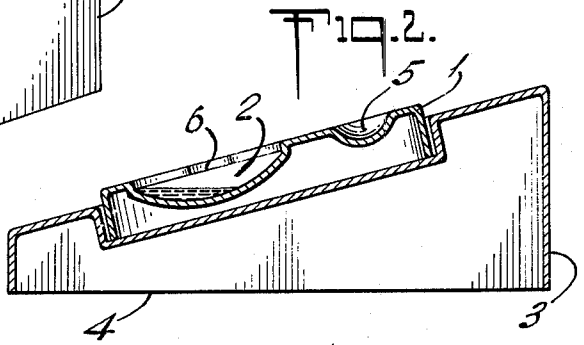


Fig.3.

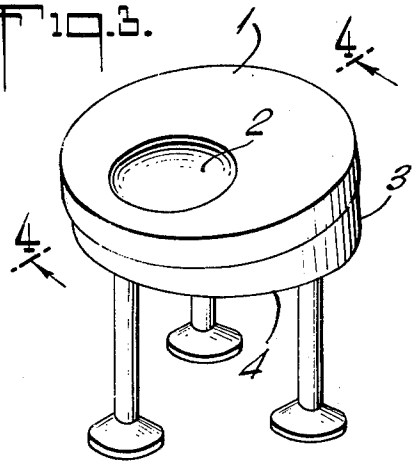


Fig.4.

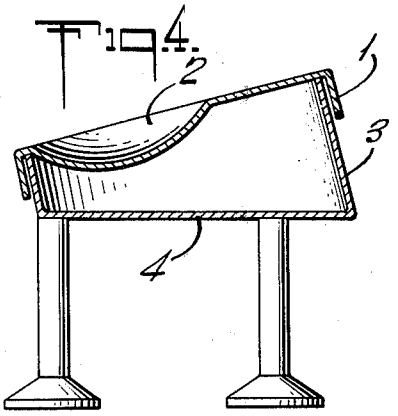
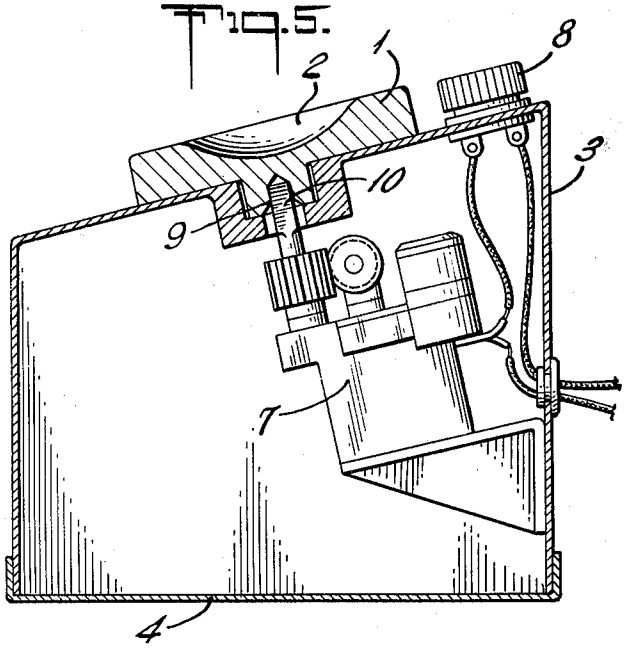


Fig.5.



MIXING DEVICE

The present invention relates to a device for mixing reagents. More particularly, the invention relates to a dial turntable device for performing immunochemical and serodiagnostic test reactions which utilizes a predetermined circular motion to bring about uniform mixing of the reagents. The uniform mixing of the test reagents results in an easy, reproducible reaction which enables the user to achieve a more accurate reading of the test result.

Immunochemical and serodiagnostic test reactions are most commonly laboratory tests which have as their objective the determination of the presence or absence of antigens or antibodies in body fluids, such as, for example serum and urine. The results of the determination are used as an aid in the diagnosis of certain physiological or pathological conditions in humans and animals. The immunochemical reaction may result in the formation of a precipitate at the end point, in which case it is known as a precipitation reaction. Where the reaction is between substances distributed in a liquid medium and at least one of the substances is a solid which becomes agglomerated, the reaction is known as an agglutination reaction. Tests for blood group, pregnancy, mononucleosis and similar phenomena are just a few of the immunochemical tests which may be carried out in this manner. The difficulty encountered with most of these tests, however, is that a trained eye is usually required to determine unequivocally whether a proper test reading has been obtained.

It is known in the art that certain immunochemical tests, such as pregnancy tests, for example, can be carried out on slides wherein the end point is determined by the presence or absence of agglutination. As indicated above, immunochemical tests carried out in this manner often result in inconclusive readings due to the difficulties encountered in determining the end point.

In U.S. Application Ser. No. 328,219, filed Jan. 31, 1973, a method is described wherein the immunochemical tests are carried out on a concave test surface which, in many cases results in the formation of an easily discernible pattern at the end point which can be easily detected even by an untrained eye. This is particularly true in the case of the pregnancy test where a mosaic like pattern forms at the end point.

In all of the immunochemical tests involving agglutination, the reagents are mixed on the slide, usually with a rod or spatula etc., the slide is gently rocked and the presence or absence of agglutination is determined. The success of these tests often depends upon the extent to which the reactants are mixed. An inconclusive test reading may result from improper mixing of the reagents as well as other factors. Therefore, in order to obtain uniform results, it is desirable to have a means by which the reagents can be uniformly mixed each time so that the results obtained will be reproducible and, as a result, more reliable.

GENERAL DESCRIPTION OF THE INVENTION

The uncertainty involved in obtaining a proper test reading when performing immunochemical and serodiagnostic test reactions, due to improper mixing of the reagents, has now been largely eliminated by the present invention. By means of the present invention, a mixing device is provided which achieves uniform mixing of the test reagents via the predetermined motion

of a curved, concave test surface. The reagents are mixed on a concave surface, which is rotatably mounted on a support, and the surface is rotated in a circular motion so as to form a wave traversing 360°. This circular motion results in uniform mixing of the reagents ultimately producing an end point which is easily discernible and reproducible.

The mixing device, which is the subject of this invention, is comprised of a curved, concave test surface for the receipt of the reagents, and means for supporting the test surface in a position such that the angle formed between the planar surface of the support means and the horizontal is no less than 5° and no greater than 45°. When an angle greater than 45° or less than 5° is employed, generally poor or ambiguous test results are obtained. Optimum results are obtained when the planar surface of the support means is maintained at an angle of about 15° with the horizontal. The cavity in the test surface may be eccentrically located from the axis of rotation of the test surface. The curved test surface is mounted on the support means so as to be rotatable around its axis. The test surface is rotated on the support means in a circular fashion and the angle of rotation causes the liquid medium to form a wave-like pattern which results in thorough mixing of the reagents.

Any means which can be used to support the test surface such that the test surface may rotate freely will serve as the support means. For example, the support means may comprise a planar surface having a raised portion set at an angle between 5° and 45° with the base. The raised portion should be adapted so that the test surface can be rotatably mounted thereon. The test surface may be mounted in the raised portion of the planar surface. Any convenient way for mounting the test surface on the support may be employed. It is only necessary that the angle formed between the support means and the horizontal be no greater than 45° and no less than 5°.

Although the test surface has been described as being rotatably mounted on a support, in another embodiment of the invention the test surface is comprised of a single unit such as, for example, a portion of a sphere. The sphere like test surface is then manually or mechanically rotated at the desired angle on a hard surface such as, a desk, for example, in order to mix the reagents.

The dimensions of the curved, concave test surface are not critical. The surface need only be curved sufficiently to retain the test reagents. The test surface may be any shape so long as it contains a cavity for the receipt of the test reagents. It is preferred, however, to use a semispheroidal test surface. The concavity in the test surface may occupy all or only a portion of the semispheroid. In one embodiment of the invention the test is carried out directly in the cavity of the test surface. Alternatively, a slide or disc, such as a watch glass, for example, which is adapted to fit into the curvature of the test surface, may be used for receipt of the test reagents. When such a slide is employed, the slide rests in the cavity of the test surface while the surface is rotated. It is advantageous to use a slide or disc for the reaction since the slide or disc can be disposed of after each test, thus allowing the test surface to be used indefinitely.

The dimensions of the disposable, concave slide are not critical; the cavity need only be large enough to receive the particular reagents employed. Both glass and

plastic materials may be employed for the disposable slide. Where a plastic material is employed, the surface of the plastic should be wettable. Suitable plastic materials for this purpose are general-purpose styrene and acrylic resins. Other materials such as waxed paper or other specially treated paper products, for example, also may be employed as the test surface. The test surface and the support may be made from various materials known in the art. For example, any of the known plastics, cardboard, metals, etc. would be suitable materials for this purpose.

Slides having varying dimensions and concavities may be employed. The dimensions of the particular slide employed will depend upon the particular test to be made and the amount of material to be employed. It is convenient, however, to employ a watch glass having a diameter between about 40 mm. and 65 mm. and a concavity ranging from about 3.08 mm. to about 7.30 mm. The particular dimensions of the slide employed are not critical. Similar dimensions may be employed conveniently for the cavity in the test surface where a disposable slide is not employed.

The test surface may optionally contain means for effecting rotation of the surface in a circular motion. Such means may consist of a raised knob suitable for guiding the disc with the finger or some instrument. The means may also consist of a small concavity in the test surface, such as a finger hole, for example, suitable for guiding the slide in a circular motion.

The support surface may also include means for supporting the equipment used in carrying out the test. Such equipment may consist of a liquid dispenser such as an eye dropper, for example, and/or a container for the reagents to be employed. These means may consist of a concavity in the body of the support large enough to hold the dispenser and the container for the reagent. Neither means, however, is essential to the operation of the device.

Although the rotatable test surface may be rotated manually, it is also contemplated that the surface may be rotated by mechanical means, such as, for example, by a shaft driven by a motor attached to the support.

The invention will be more fully understood by reference to the drawings in which

FIG. **1** is a perspective view of one embodiment of the invention.

FIG. **2** is a partial view in cross section of the mixing device of FIG. **1** taken on lines **2—2** of FIG. **1.**

FIG. **3** is a perspective view of a second embodiment of the invention.

FIG. **4** is a partial view in cross section of the mixing device of FIG. **3** taken on lines **4—4** of FIG. **3.**

FIG. **5** is a cross section of the mixing device and illustrates the test surface mounted so as to be operated mechanically.

Referring specifically now to the drawings, the mixing device, illustrated in FIGS. **1** & **2**, comprises a test surface, **1**, rotatably mounted on a support, **3**, such that the angle formed between the planar surface of the support means and the horizontal is no less than 5° and no greater than 45°. The test surface has a curved, concavity, **2**, for receipt of the reagents. A means by which the test surface can be turned manually is depicted, as a concavity, **5**, in the plane of the test surface. It is to be understood, however, that any suitable means may be employed for turning the test surface.

Finger holes, **6**, in FIG. **1** are not essential to the operation of the test surface. They are generally employed in those cases where a disposable slide or disc is employed in conjunction with the test surface and are useful for easy removal of the slide or disc.

In the embodiment of the invention depicted in FIGS. **3** and **4**, the test surface, **1**, is rotatably mounted over the support, **3**. Although a support resting on three legs is shown, it is understood that the particular support means employed is not critical as long as the axis of the test surface forms an angle no greater than 85° and not less than 45° with the horizontal, **4**.

In FIG. **5**, the test surface, **1**, is mounted on the surface of a support, **3**, and is mechanically rotated by means of a motor, **7**. In this particular embodiment, the motor is operated by a switch, **8**, and the test surface, **1**, is rotated by means of a shaft, **10**, through the opening, **9**. Although a motor is shown in FIG. **5**, it should be understood that any conventional means may be employed to effect mechanical rotation of the test surface.

In utilizing the mixing device, the user will place the reagents and the sample of body fluid in the concavity of the test surface. Primary mixing of reagents is done manually, by means of a mixing stick, for example. The immunochemical reaction is then carried out by turning the test surface in a circular motion for the prescribed number of revolutions. The exact number of revolutions employed will depend upon the particular test to be carried out. For example, when the test for pregnancy is carried out on the test surface, best results are obtained when the surface is rotated about 25 times for about half a minute. The reaction mixture is then observed to determine whether the result is positive or negative.

It is also contemplated that the test surface may contain two or more concavities for the purpose of carrying out multiple test reactions.

I claim:

1. A device for mixing test reagents which comprises a test surface having at least one concave portion for the receipt of said reagents and support means for supporting said test surface, said support means having at least one planar surface and fixedly supporting said test surface in a position such that the angle formed between the planar surface of the support means and the horizontal is no less than 5° and no greater than 45°, said test surface being mounted on said support means so as to be rotatable around an axis central of and normal to said test surface.

2. The device of claim **1** wherein mechanical means for rotating the test surface are additionally present.

3. The device of claim **1** wherein the angle formed between the planar surface of the support means and the horizontal is 15°.

4. The device of claim **1** wherein the angle formed between the planar surface of the support means and the horizontal is 45°.

5. The device of claim **1** wherein the concave portion of the test surface is a semi-spheroid.

6. The device of claim **5** wherein the concavity of the semi-spheroid has a depth of between 3.08 mm. and 7.30 mm.

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