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Hamel

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[54] **MIXING ROTOR FOR FAST ANALYZER OF ROTARY CUVETTE TYPE WITH MEANS FOR ENHANCING THE MIXING OF SAMPLE AND REAGENT LIQUIDS**

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[52] **U.S. Cl.** **356/246,** 23/259, 250/576, 356/197

[51] **Int. Cl.** **G01n 1/10,** G01n 21/24

[58] **Field of Search** 356/39, 181, 196, 197, 356/246; 250/576; 23/259; 233/10, 26

[56] **References Cited**

UNITED STATES PATENTS

3,555,284 1/1971 Anderson 356/246

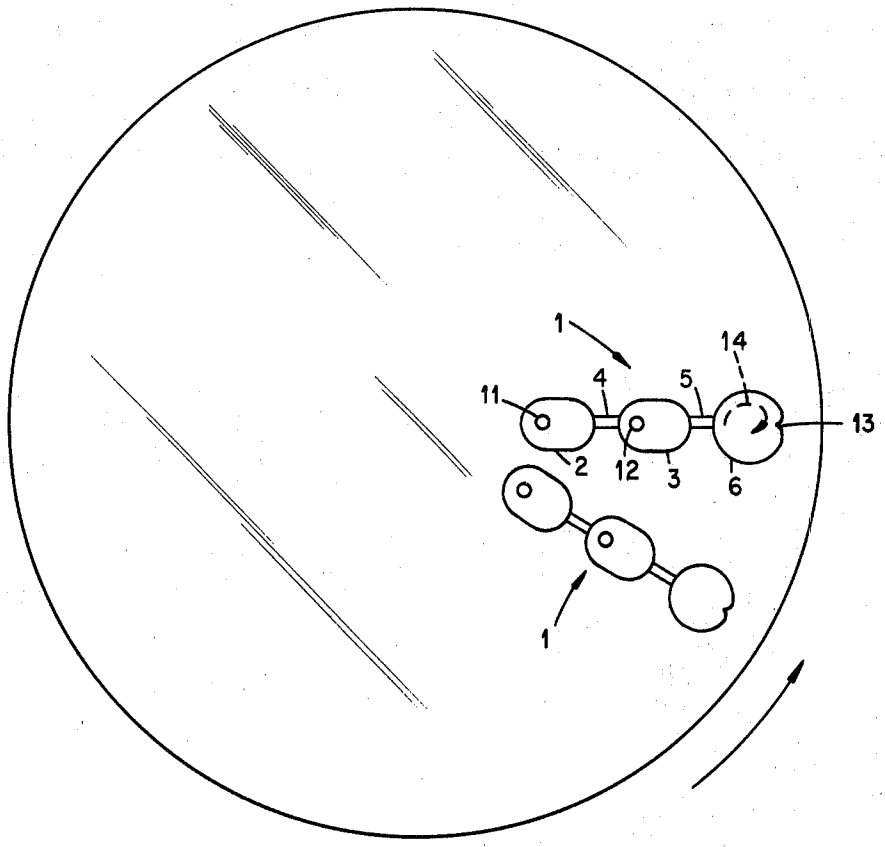
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[57] **ABSTRACT**

A rotor design which provides improved mixing of sample and reagent liquids in a fast photometric analyzer of the rotary cuvette type is described. According to the preferred embodiment, one or more ramp-like projections are provided along the wall of each sample analysis cuvette to enhance mixing.

2 Claims, 2 Drawing Figures



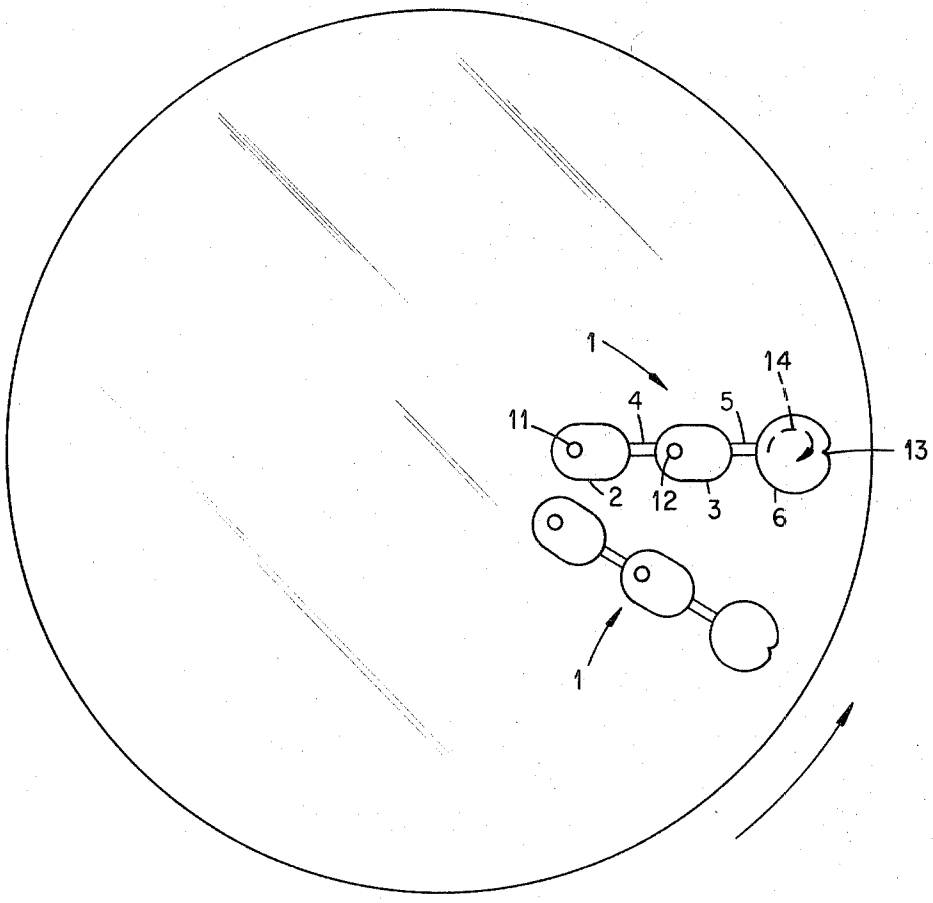


Fig. 1

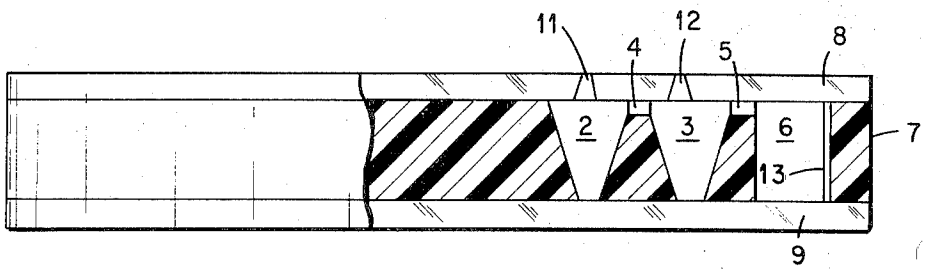


Fig. 2

MIXING ROTOR FOR FAST ANALYZER OF ROTARY CUVETTE TYPE WITH MEANS FOR ENHANCING THE MIXING OF SAMPLE AND REAGENT LIQUIDS

BACKGROUND OF THE INVENTION

The invention described herein relates generally to photometers and more particularly to an improved rotor for fast analyzers of the rotary cuvette type characterized by improved mixing of sample and reagent liquids in its sample analysis cuvettes. It was made by an employee of the U.S. Atomic Energy Commission in the course of his employment.

The general design and operation of fast photometric analyzers of the rotary cuvette type are generally described in U.S. Pat. No. 3,555,284, issued Jan. 12, 1971, to common assignee in in the name of Norman G. Anderson. In the analyzer described in that patent, a central loading disk is provided for statically receiving sample and reagent liquids prior to a photometric analysis operation. The sample and reagent liquids are then brought together dynamically by rotation induced forces in a separate mixing chamber or directly in respective sample analysis cuvettes. Complete and rapid mixing of the sample and reagent liquids is essential to ensure accurate photometric analysis of the cuvette contents.

Several techniques inlcuding tangential insertion of sample and reagent liquids into the cuvettes, the drawing of air bubbles through the cuvettes, rapid rotor acceleration and decleration, and parallel transfer of sample and reagent liquids have been used to enhance mixing with some degree of success. However, the recent introduction of miniaturized fast analyzers with correspondingly miniaturized rotors and sample analysis cuvettes, loading cavities, and sample and reagent volumes has resulted in decreased turbulent mixing because of the relatively increased effects of surface tension on the fluid flow of small liquid volumes.

It is, accordingly, a general object of the invention to provide a rotor design for a fast analyzer of the rotary cuvette type whereby sample and reagent mixing is enhanced.

Another object of the invention is to provide a rotor design for a fast analyzer of the rotary cuvette type wherein the sample analysis cuvettes are designed to enhance mixing.

SUMMARY OF THE INVENTION

A rotor design characterized by improved mixing of sample and reagent liquids is provided for fast analyzers of the rotary cuvette type. At least one ramp-like projection is provided along the wall of each sample analysis cuvette to induce mixing of sample and reagent liquids upon rotation of the rotor. The use of such projections eliminates the need for supplemental mixing techniques and is especially desirable in miniature rotors where surface tension effects seriously inhibit turbulent mixing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of a rotor made in accordance with the invention.

FIG. 2 is a vertical section view of the rotor of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, a typical single sample analysis station **1** comprises two sample and reagent static loading cavities **2** and **3** serially connected by means of passages **4** and **5** with each other and with a sample analysis cuvette **6.** As shown in FIG. **2,** the rotor is of laminated construction with a central opaque disk **7** sandwiched between transparent plates **8** and **9.** Apertures **11** and **12** in plate **8** facilitate static loading of cavities **2** and **3** prior to dynamic transfer of sample and reagent liquids from those cavities to respective cuvettes **6.** Other loading cavity arrangements such as described in copending application Ser. No. 203,248, filed Nov. 30, 1971 and now U.S. Pat. No. 3,744,974, of common assignee may be used without departing from the invention, which is restricted, rather, to an improved sample analysis cuvette design characterized by improved mixing of sample and reagent liquids discharged thereto.

As shown in the top view of FIG. **1,** each cuvette **6** is provided with at least one axially and radially extending ramplike projection **13.** A preferred configuration of projections **13** incorporates generally concave side portions which effectively direct liquid in the cuvette inward as shown by the broken flow arrows **14.** Such flow effectively mixes the contents of cuvettes **6** by forcing liquid near the cuvette walls inward.

In theory, the mixing action depends upon the inherent relative rotation which develops between the cuvette walls and liquid contained therein during and briefly following acceleration of the rotor which defines the sample analysis cuvettes. The magnitude of this relative rotation decreases to a minimum following initial acceleration of the rotor since the cuvette contents are also accelerated by the propelling effect of the confining cuvette walls until it approaches the rotational speed of the cuvette walls with the rotor operating at constant speed. Acceleration and deceleration of the rotor will increase the mixing action of projections **13** by causing further relative rotation of the cuvette walls and the cuvette contents.

The foregoing description of one embodiment of the invention is offered for illustrative purposes only and should not be interpreted in a strictly limiting sense. For example, sample and reagent loading arrangements other than the one shown may be used without departing from the scope of the invention. Also, more than one projection per sample analysis cuvette may be used. It is intended, rather, that the invention be limited only by the scope of the claims attached hereto.

What is claimed is:

1. In a rotor for use in a fast photometric analyzer of the rotary cuvette type comprising a disk-shaped member of laminated construction with a central opaque disk sandwiched between top and bottom transparent walls, and wherein said disk-shaped member defines a circular array of sample analysis cuvettes extending axially through said central opaque disk and means for loading and injecting sample and reagent liquids into said sample analysis cuvettes; the improvement wherein each of said sample analysis cuvettes has a generally cylindrical side wall defined by said opaque disk with a projection extending axially along said side wall between said top and bottom transparent walls and radially inward toward the center of said cuvette for enhancing the mixing of sample and reagent liquids therein.

2. The improvement of claim **1** wherein said projection defines two axially extending, intersecting, concave surfaces, each having a radius of curvature which is smaller than that of said sample analysis cuvette.

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