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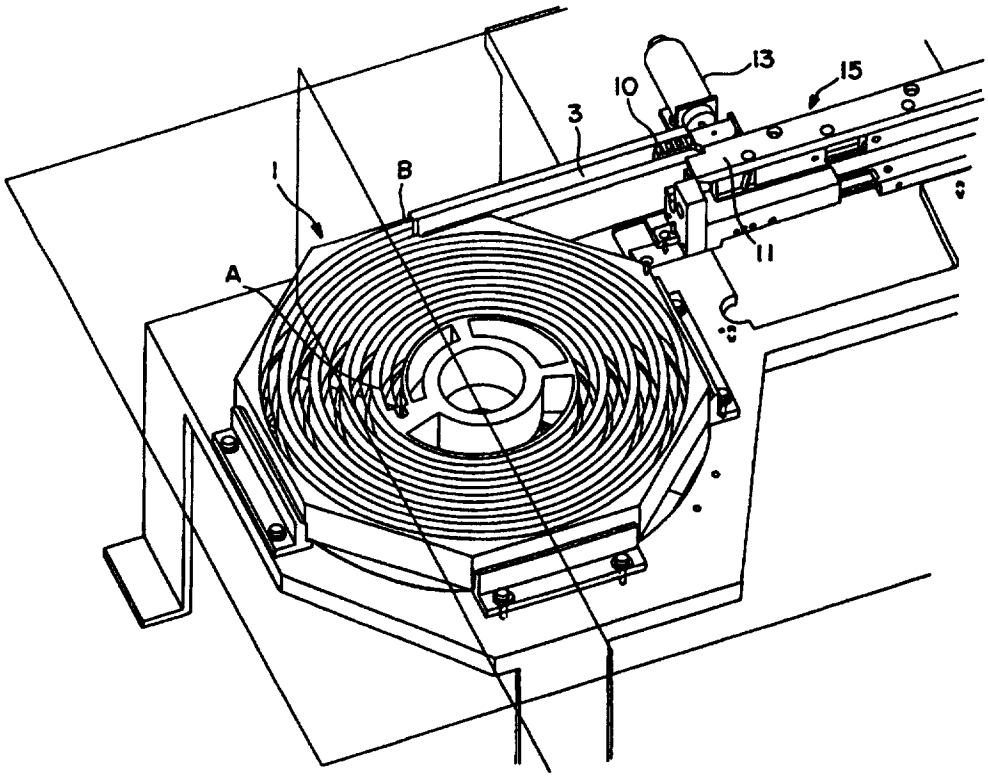
(54) Title: SPIRAL CUVETTE LOADING DEVICE FOR AN AUTOMATED SAMPLE TESTING MACHINE

(57) Abstract

A cassette (1) for holding an dispensing containers (10), which includes a housing having a base and cover and an aperture for the containers to be released from the casette (1). The housing also includes a spiral track for holding the containers (10) where each of the containers (10) comprises a structural assymetry which has a corresponding assymetry in the spiral track so as to require loading and positioning of the containers in a particular orientation within the track. The spiral track can also be formed so as to be gradually increasing in width as the track spirals inward towards the center of the cassette. An automated apparatus can include the cassette (1) for holding and dispensing containers (10), the cassette (1) having a spiral track within a housing, as well as a connecting track (3) for advancing containers from the housing to a container loading position (11), the container loading position (11) for loading containers (10) onto a conveyor (15), and the conveyor (15) for conveying the containers (10) from the loading position.



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SPIRAL CUVETTE LOADING DEVICE OF AN AUTOMATED SAMPLE TESTING MACHINE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application relates the subject matter of U.S. patents 5,236,665, filed August 17, 1993 and 5,456,884, filed October 10, 1995, the subject matter of these patents being incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. The Field of the Invention

This invention relates to the field of laboratory testing of fluid samples and, more particularly, to a means for quickly and effectively loading sample reaction chambers into an automated sample handling/testing device.

2. Description of the Related Art

In the field of laboratory testing of fluid samples, such as medical testing of blood and urine samples, hospitals and testing laboratories have largely turned to automated machines to perform routine chemistry testing on body fluids. Several factors have weighed very heavily in influencing this decision. First, testing of the fluid samples is often very repetitive in nature, yet it requires a high level of concentration to avoid errors which might lead to

critical mistakes in treatment. Second, manual handling of fluid samples increases risk to the laboratory technician for contracting a communicable disease, e.g., AIDS, hepatitis, etc. Third, automated sample handling and testing frees up the laboratory technician to carry out other less routine functions when human decision making skills can be uniquely utilized.

To obtain these and other advantages in laboratory testing of fluid samples, automated sample handling/testing machines have been employed. When properly calibrated and adequately maintained, these automated devices can efficiently perform repetitive testing procedures with great accuracy and precision.

Chemical analysis of the fluid sample by the automated sample handling/testing device often occurs in a reaction chamber called a cuvette. These transparent cuvettes are somewhat analogous to a test tube employed in manual testing. Typically, the automated sample handling/testing device dispenses a fluid sample into a cuvette along with one or more test specific reagents and diluents. After thorough mixing of the solution and a precisely timed delay, a photometric analysis can be employed to detect changes in the solution. The degree and/or rate of change can be equated to a numerical test result and compared to a normal range of test results as determined from healthy individuals.

One of the key concerns in automated testing of fluid samples is a device for storing and reliably dispensing cuvettes as needed to the automated sample handling/testing device. There is a need to provide a loading device and container for quickly and effectively loading an automated instrument with a supply of cuvettes to provide continuous processing of fluid samples so as to free the laboratory technician to perform other tasks in the lab.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a cassette for storing and reliably dispensing cuvettes.

It is another object of the present invention to provide an environmentally closed cassette for storing and delivering a supply of disposable cuvettes.

It is a further object of the present invention to provide an automated handler of fluid samples which utilizes a cassette for reliably dispensing cuvettes, the fluid sample handler using a single axis motor drive for dispensing cuvettes from the cassette, which cassette eliminates errors in the loaded position of the cuvettes so as to greatly increase the mean time between failure during cuvette dispensing in the fluid sample handler.

The above and other objects of the invention are accomplished by provisions of a cassette for holding and

dispensing containers, which includes a housing having a base and cover and an aperture for the containers to be released from the cassette. The housing also includes a spiral track for holding the containers where each of the containers comprises a structural assymetry which has a corresponding assymetry in the spiral track so as to require loading and positioning of the containers in a particular orientation within the track. The spiral track can also be formed so as to be gradually increasing in width as the track spirals inward towards the center of the cassette.

The above and other objects of the invention are further accomplished by provision of an apparatus having a cassette for holding and dispensing containers, the cassette having a spiral track within a housing, a connecting track for advancing containers from the housing to a container loading position, a container loading position for loading containers onto a conveyor, and a conveyor for conveying the containers from the loading position for sample testing.

The invention will be understood in greater detail with reference to the specific embodiments thereof which are illustrated in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an overhead plan view of the spiral cassette loaded in the automated analyzer;

Figure 2 is an overhead view of the spiral cassette;

Figure 3 is a cross-section taken along line A-A from Figure 2;

Figure 4 is a cross-section of one track in the spiral cassette taken along line C-C in Figure 2;

Figure 5A is a cross-section taken along line B-B from Figure 2, and Figure 5B is detail B from Figure 2;

Figure 6 is a side view of the cuvette to be held within the spiral cassette; and

Figure 7 is a plan view of the cuvette for the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In describing the illustrated embodiment of the invention, corresponding parts in different figures are designated with the same reference numerals in order to minimize repetitive descriptions.

Referring now to the drawings, Figure 1 illustrates a spiral cassette 1 positioned within a cassette loading area of an automated analyzer. Cuvettes can be positioned from an inner point A consecutively in line and extending to an outer point B. A track 3 allows for cuvettes to advance from the spiral cassette 1 to a cuvette loading position 11. As can be seen in Figure 1, a cuvette 10 is positioned adjacent the cuvette loading position 11. When cuvette 10 is positioned in

the cuvette loading position, a solenoid 13 is activated to push the cuvette onto a track 15. The cuvette is then advanced along track 15 by a belt conveyor, screw conveyor or other conveying mechanism, with the testing of samples in the cuvette wells taking place along the track.

Figure 2 is an overhead view of the spiral cassette loader. The shape of the cassette is octagonal, though circular or other polygonal shapes are also possible. Based on the dimensions (in inches) as set forth in Figure 2, ninety-four cuvettes (of substantially rectangular cross-section such as illustrated in Figures 6 and 7) can be filled into the cassette. Of course, depending on the size of the cuvettes and the size of the cassette, greater numbers of cuvettes could be held by the cassette.

The cuvettes are loaded into the cassette at the same opening (point B in Figures 1 and 2) as they exit from being advanced for testing on an automated analyzer. If an asymmetrical cuvette 10 is used, such as illustrated in Figures 6 and 7, then it is possible to insure that the cuvettes are loaded in the proper orientation into the cassette. As can be seen in Figure 7, two ridges 50a and 50b can be provided so as to define therebetween a groove 51. Looking at Figure 4, which is a cross-section C-C from Figure 2, a single track 25 is illustrated having on an interior wall 27

thereof, a projection 60. Projection 60 in Figure 4 fits with groove 51 of the cuvette in Figures 6 and 7, thus insuring that the cuvette is loaded into the cassette in a proper orientation. Of course, other means for insuring the proper orientation of the cuvette are possible, such as a projection on the cuvette with a corresponding groove in the track of the cassette.

In order for the elongated rectangular cuvettes to advance smoothly within the spiral cassette, the track in the cassette is formed so as to be gradually increasing in width as the track spirals inward towards the center of the cassette. As can be seen in Figure 3 (a cross-section taken along line A-A from Figure 2), the width of the track gradually increases from the cross-section of the track taken at point 25a towards the cross-section of the same track taken at point 25e. It was found that for the rectangular cuvette illustrated in Figures 6 and 7, the track could be made to vary in width based on the equations $x = (2.124 + (t*3.005))*\cos(t*1534)$, and $y = (2.124 + (t*3.005))*\sin(t*1534)$, where for a Cartesian coordinate system, the parametric equation in terms of t, will vary from 0 to 1 for x, y and z.

Figure 5b is detail B from Figure 2 showing dimensions thereof, and Figure 5a is a cross-section taken along line B-B from Figure 2. The shape of this detail B is designed for minimizing materials and

maximizing strength, though other designs would also be possible.

Conventional cassettes, such as the ones set forth in U.S. patent 5,456,884, hold the cuvettes in the formation of rows and columns. This typical way of storing rectangular item, forces the dispensing of such items to be carried out by pushing mechanisms in both row and column configurations, using motorized drives. Manufacturing such a conventional cassette can involve the molding of a number of plastic parts, the insertion of a pushing mechanism and cuvettes in a particular manner (e.g., in rows and columns, which can make it difficult to assure that the cuvettes are oriented properly), inspection and/or verification, and final assembly including the insertion of a door and the placement of a top cover. In the present invention, manufacture of the cassette can involve the molding of as few as one or two plastic parts (if two plastic parts are molded, they can be ultrasonically welded together). The cuvettes can then be loaded by in-line insertion through the cuvette aperture in the cassette. The final step is to seal the aperture with, for example, a peel-off label.

The cassette holding the cuvettes, is inserted into the automated analyzer, potentially at a slight angle providing a self aligning and locking of the cassette into the instrument. The instrument can be provided

with a sensor to detect the presence of the cassette. The cassette load sensor, when it detects the presence of the cassette, can start the advancement of the cuvettes thus pushing all cuvettes around the spiral until the leading cuvette encounters a linear-track stop. The system mechanics can overdrive the train of cuvettes by means of a friction clutch thus maintaining the leading cuvette at its instrument load position. A solenoid-based plunger then loads the first cuvette into the instrument test track. When the last cuvette is delivered, a controller detects that the cassette is empty.

The present invention is beneficial in that it provides an environmentally closed design to avoid contamination of the cuvettes. The cassette has a low number of parts and is easy to manufacture thus resulting in reduced assembly time. Also, the cassette is user friendly and eliminates/reduces loading position errors. Of course, while there has been described the preferred embodiment of the invention, it will be apparent to one skilled in the art that numerous changes can be made to the structure set forth and the foregoing embodiment without departing from the invention as described herein and as defined in the appended claims.

WE CLAIM:

1. A cassette for holding and dispensing containers, comprising:

a housing having a base and cover, the housing having an aperture for said containers to be released from said cassette;

a spiral track within said housing for holding said containers, said spiral track extending from a point at or near a center of said cassette to said aperture in said housing;

wherein each of said containers comprises a structural asymmetry which has a corresponding structural asymmetry in said spiral track so as to require loading and positioning of said containers in a particular orientation within said track.

2. The cassette of claim 1, wherein said containers are positioned within said spiral track consecutively in line from said center point to said aperture, each container abutting containers adjacent thereto.

3. The cassette of claim 2, wherein said housing is constructed such that said containers are loaded and dispensed consecutively from said spiral track via said aperture.

4. The cassette of claim 1, wherein said structural asymmetry of each said container is a groove and said structural asymmetry of said track is a pin for fitting with said container groove.

5. The cassette of claim 2, wherein said containers within said spiral cassette are cuvettes.

6. A cassette for holding and dispensing containers, comprising:

a housing having a base and cover, the housing having an aperture for said containers to be released from said cassette;

a spiral track within said housing for holding said containers, said spiral track extending from a point at or near a center of said cassette to said aperture in said housing;

wherein said spiral track is formed so as to gradually increasing in width as the track spirals inward towards the center of the cassette.

7. The cassette of claim 6, wherein the track width varies based on the equations $x = (2.124 + (t * 3.005)) * \cos(t * 1534)$, and $y = (2.124 + (t * 3.005)) * \sin(t * 1534)$, where for a Cartesian coordinate system, the parametric equation in terms of t, will vary from 0 to 1 for x, y and z.

8. The cassette of claim 6, wherein said containers are positioned within said spiral track consecutively in line from said center point to said aperture, each container abutting containers adjacent thereto.

9. The cassette of claim 8, wherein said housing is constructed such that said containers are loaded and dispensed consecutively from said spiral track via said aperture.

10. The cassette of claim 8, wherein said containers have a rectangular cross section with the shorter end of said rectangle defining the abutting sides of said containers.

11. The cassette of claim 10, wherein said containers are cuvettes, each cuvette having a plurality of test wells.

12. An apparatus comprising:

a cassette for holding and dispensing containers, the cassette comprising a housing having a base and cover, the housing having an aperture for said containers to be released from said cassette, said cassette further comprising a spiral track within said housing for holding said containers, said spiral track

extending from a point at or near a center of said cassette to said aperture in said housing;

a connecting track for the advancement of containers from said aperture in said housing to a container loading position;

a container loading position where said containers are loaded onto a conveyor;

a conveyor for conveying said containers from said container loading position;

wherein each of said containers comprises a structural asymmetry which has a corresponding structural asymmetry in said spiral track so as to require loading and positioning of said containers in a particular orientation within said track;

and wherein said spiral track is formed so as to gradually increase in width as the track spirals inward towards the center of the cassette.

13. The apparatus of claim 12, wherein said containers are cuvettes for holding fluid samples for analysis, and said conveyor conveys said cuvettes through a testing portion of said apparatus where said fluid samples are analyzed.

14. The apparatus of claim 13, wherein when said containers are positioned within said spiral track, the containers are disposed consecutively in line from said

center point to said aperture of said housing, each container abutting containers adjacent thereto.

15. The apparatus of claim 14, wherein said cassette housing is constructed such that said containers dispensed to said connecting track consecutively from said spiral track via said aperture.

16. The apparatus of claim 15, wherein said structural asymmetry of each said container is a groove and said structural asymmetry of said track is a pin for fitting with said container groove.

17. The apparatus of claim 6, wherein the track width of said cassette varies based on the equations $x = (2.124 + (t * 3.005)) * \cos(t * 1534)$, and $y = (2.124 + (t * 3.005)) * \sin(t * 1534)$, where for a Cartesian coordinate system, the parametric equation in terms of t, will vary from 0 to 1 for x, y and z.

18. The apparatus of claim 14, wherein said containers have a rectangular cross section with the shorter end of said rectangle defining the abutting sides of said containers.

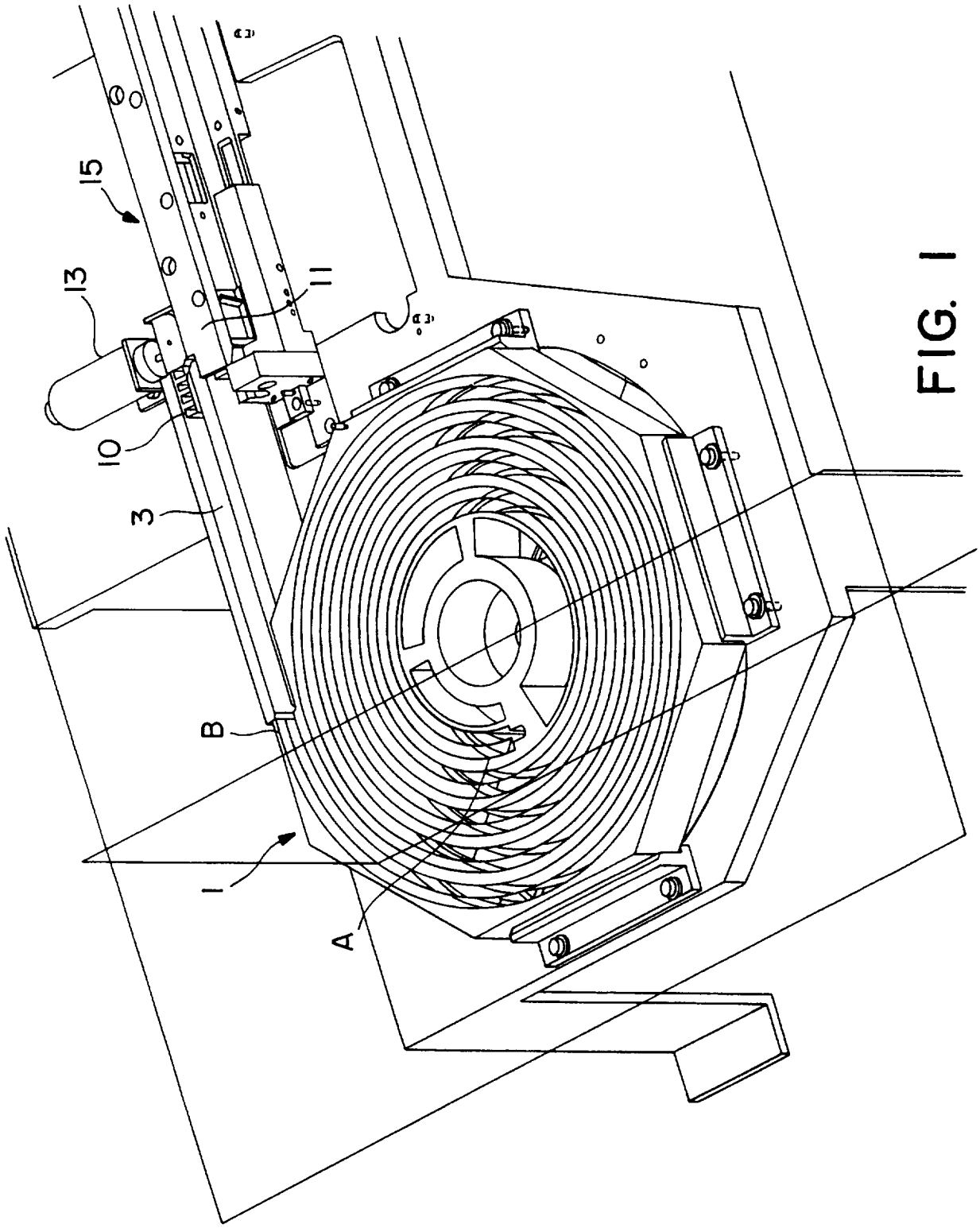

FIG. 1

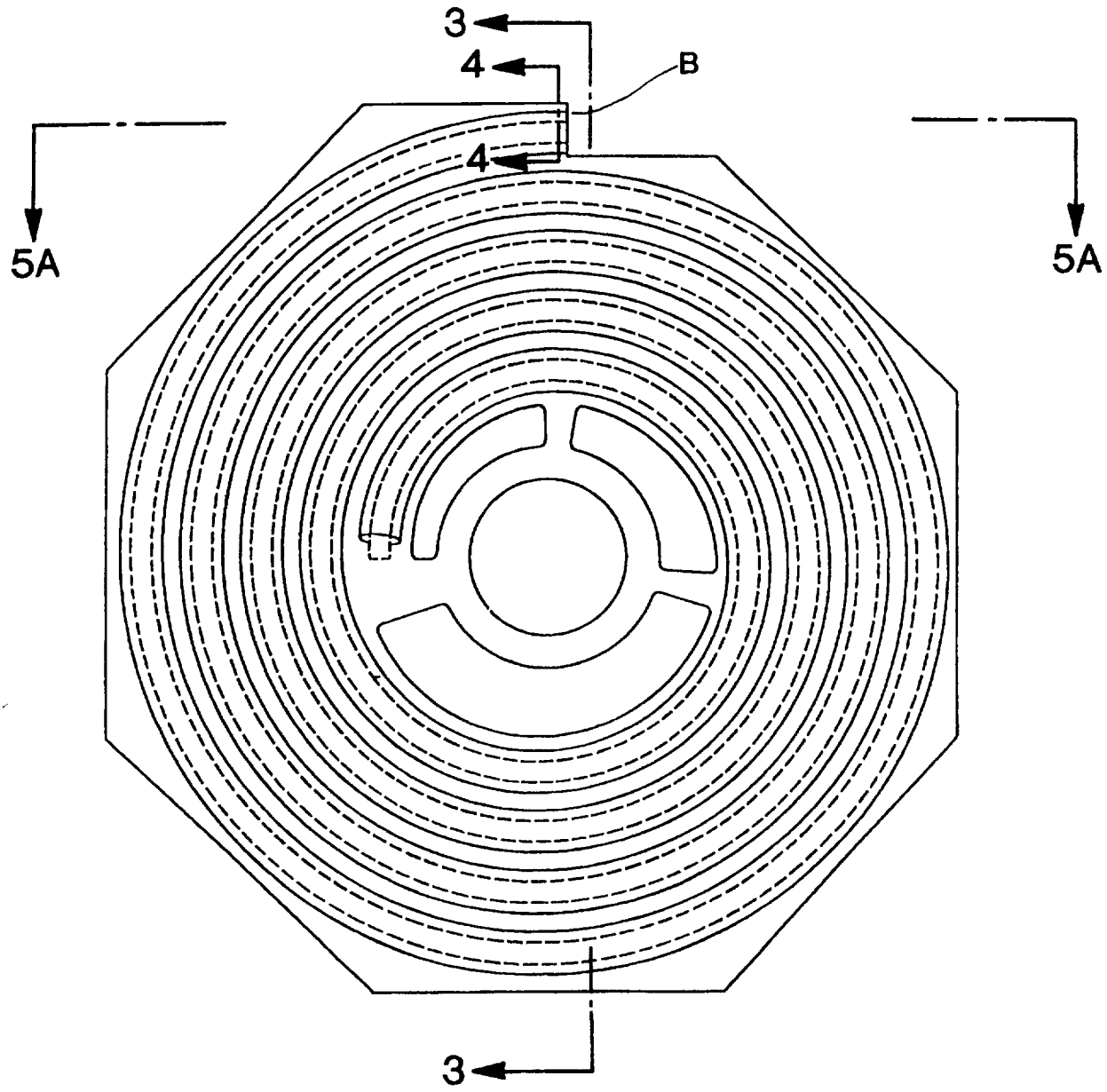

FIG. 2

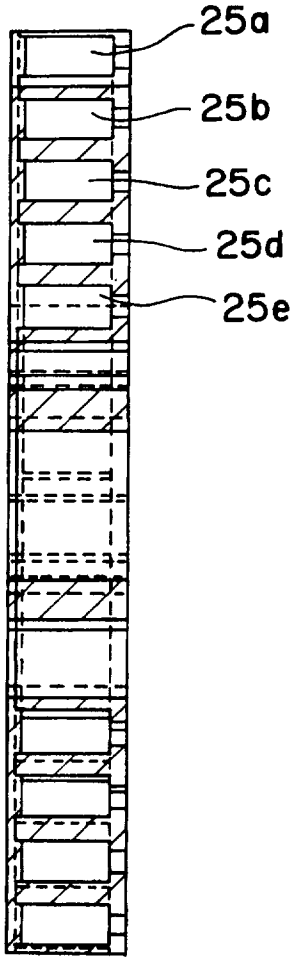

FIG. 3

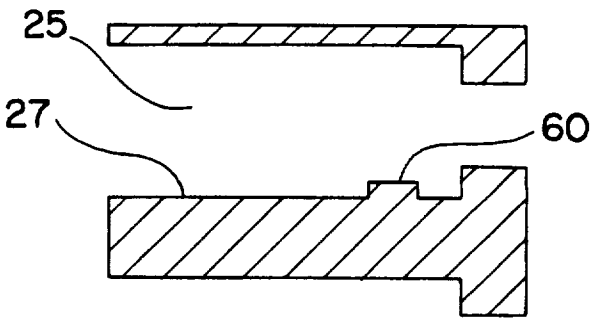

FIG. 4

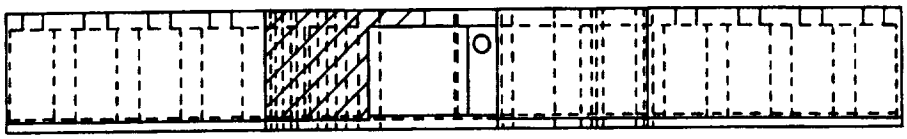

FIG. 5A

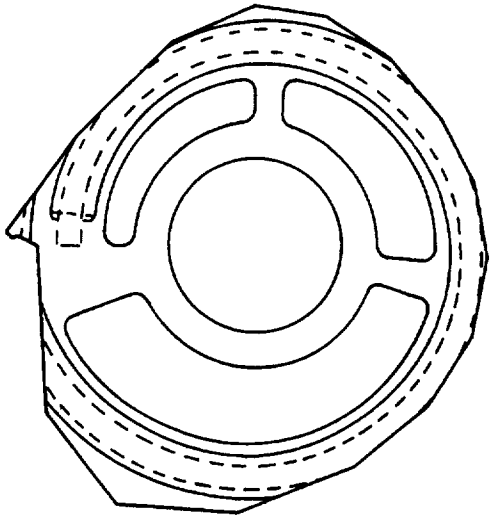

FIG. 5B

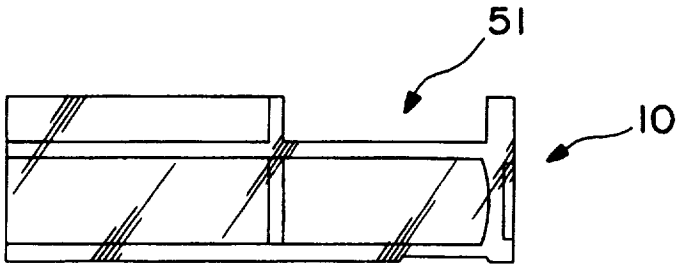

FIG. 6

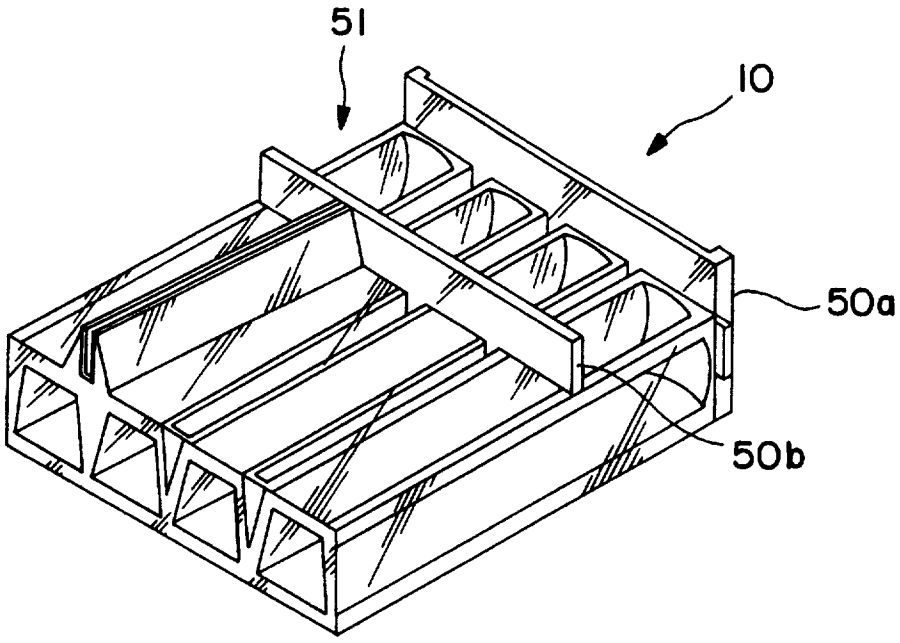

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G01N 35/04
US CL :422/63, 65, 104; 436/43, 47, 48; 211/197, 277
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)

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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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,456,884 A (LEWIS et al.) 10 October 1995, whole document.	1, 6, 12
Y	US 4,163,643 A (HUNTER et al.) 07 August 1979, figures 1-8.	1-18
Y, P	US 5,609,823 A (HARTTIG et al.) 11 March 1997, figures 2a and 2b.	1-18
A	US 4,495,975 A (HARSTROM et al.) 29 January 1985, figure 2.	1-18
A	US 4,528,159 A (LISTON) 09 July 1985, figure 2.	1-18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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