A blood analysis system includes a plasma analysis unit, a plasma separator, a first conduit for supplying whole blood to the plasma separator, and a second conduit for transferring plasma from the separator to the analysis cell for analysis. A controller operates the separator and the analysis unit concurrently for subjecting a plasma sample to analysis while the separator is preparing another plasma sample for analysis.
A BLOOD ANALYSIS SYSTEM INCLUDING A PLASMA SEPARATOR

SUMMARY OF INVENTION

This invention relates to methods and apparatus for the processing of "liquid" materials and more particularly to aspects of separation and analysis of a constituent of such materials. The invention has particular application in connection with the rapid separation of the cellular portions of whole blood from the plasma portions.

Chemical assay of certain blood constituents is an aid to the diagnosis of many disease states and a number of such blood chemistry determinations are performed on the plasma or liquid portion of the blood. To prepare plasma samples for analysis, the red and white cellular components are typically separated in an enhanced gravitational field in a clinical or laboratory centrifuge. Laboratories conventionally use centrifuge systems that have a multiplicity of chambers, thus enabling the separation of a large number of samples in each run. In a typical system of that type, the blood samples are transferred to vessels suitable for insertion into the centrifuge rotor, the vessels being inserted symmetrically about the rotor to maintain the dynamic balance of the system. The rotor is brought to operating speed, and maintained at that speed for a sufficient period of time to assure the complete sedimentation of the blood cells. After sedimentation is complete, the rotor is decelerated smoothly so that the sedimented cells are not stirred up or resuspended. When the rotor is stopped, the individual vessels are removed and the plasma is decanted or otherwise transferred to other vessels since continued contact with the cellular portion changes the concentration of certain of the chemical constituents of the plasma for subsequent analysis.

It is an object of this invention to provide novel and improved methods and apparatus for rapidly obtaining plasma from samples of whole blood for chemical analysis.

Another object of the invention is to provide novel and improved methods and apparatus for sequentially processing samples of precious fluids to separate a constituent of the precious fluid for subsequent processing of such separated constituent.

A further object of the invention is to provide novel and improved separation apparatus for processing fluid samples which facilitates the rapid and efficient separation and extraction of a constituent of each fluid sample.

Still another object of the invention is to provide novel and improved separation apparatus which facilitates the processing of successive fluid samples.

A further object of the invention is to provide novel and improved methods and apparatus for separation of constituents of biological fluids by centrifugation and subsequent in-line analysis.

In accordance with a feature of the invention, there is provided a blood analysis system that includes a plasma analysis cell, a plasma separator, a first conduit for supplying whole blood to the plasma separator, and a second conduit for transferring plasma from the separator to the analysis cell for analysis. In a preferred embodiment a controller operates the separator and the analysis cell concurrently for analyzing a first plasma sample in the analysis cell while the separator is preparing a second plasma sample for analysis.

In accordance with another feature of the invention, samples of precious fluids such as blood are sequentially processed in centrifugal separation operations. A fluid sample is placed in a separator apparatus which is then operated to separate the sample into at least two constituents. At least a portion of one of the separated constituents is removed from the separator apparatus along a first path and another constituent is removed from the separator apparatus along a separate second path, and then a rinse solution is flowed along the first path, countercurrent to the removal direction, into and through the separation apparatus and out through the second path to clean the apparatus in preparation for the next sample processing cycle.

In accordance with another and related feature of the invention, the separation apparatus has a centrifuge rotor that includes separation chamber structure offset from the axis of rotation of the rotor and second chamber structure. First port structure on the rotation axis is in communication with the second chamber structure and second port structure is disposed at the end of the separation chamber structure remote from the rotation axis. The processing sequence includes the steps of introducing a first fluid sample into the rotor chamber structure through the first port structure, spinning the rotor to distribute the fluid sample to the separation chamber structure and to separate the fluid sample into distinct components in the separation chamber structure, slowing the rotor to allow a portion of the material in the separation chamber structure to flow into the second chamber structure, removing material from the second chamber structure through the first port structure, opening the second port structure to remove another portion of the sample from the rotor chamber structure through the second port structure, and flowing rinse solution through the first port structure into and through the rotor chamber structures and out the second port structure to clean the rotor chamber structure in preparation for the next sample processing cycle.
rial from the sump portion. In this embodiment, the walls of all the chamber structures are of fixed configuration, thus providing a stable, compact rotor structure which may be accelerated rapidly to high rotational speeds.

In a particular embodiment, two tubular separation chambers, each inclined at an angle of less than 50° to the rotor axis, are disposed opposite one another and the discharge port structure is located at the end of each separation chamber remote from the rotor axis. The only movable component of the rotor structure is valve structure which normally closes the discharge port structure. Valve actuator structure is mounted independently of the rotor for controlling the valve structures. Latch structure associated with the valve actuator structure allows reset of the valve actuator structure to a position spaced from the valve structure so that the rotor may be driven in rotation independently of the actuator structure. In another embodiment a single inclined separation chamber is employed, the rotor being driven by a flexible shaft and accelerated through its critical speed so that effectively at its maximum operating speed a new center of mass is established and the system is in balance.

The invention enables the processing of small volumes of whole blood (approximately one milliliter in size) in a rapid cycle to obtain about one-third milliliter of plasma in an in-line system between a source of whole blood samples and a plasma analysis cell. Sequential samples of plasma can be obtained rapidly. The centrifuge rotor employed in the system has one or more integral, inclined, tubular chambers that are connected to a second chamber for receiving the separated plasma, the second chamber having a recessed bottom which facilitates the removal of the available plasma.

Tubular separation chambers extend below the second chamber such that the cellular components of the blood pack into the separation chamber or chambers below the points of intersection with the second chamber. In a particular embodiment this relationship has been selected to retain the separated cells in these chambers even in the case of the highest probable hematocrit in the blood sample being processed. The separate tubular separation chamber arrangement also restrains the blood during acceleration and deceleration so that a plasma sample can be rapidly obtained without remixing or increasing hemoglobin levels in the plasma during rapid deceleration. The round configuration of the rotor minimizes air friction during operation and a depending lip acts to prevent contamination of the mounting and bearing structure.

The sample removal probe in a particular embodiment is inserted into the top of the rotor along the axis of rotation to a bottoming position on the lower surface of the second chamber, the probe being biased to insure bottoming without requiring precise adjustments of the allowed travel of the probe. The discharge port valves are members mounted for movement parallel to the axis of rotation of the rotor such that in the moment of inertia due to valve action is minimized, and are moved by a valve actuator disc which is latched in position out of contact with the rotor at all times except actual movement of the valve members.

Other objects, features and advantages of this invention will be seen as the following description of a particular embodiment progresses, in conjunction with the drawings, in which:

FIG. 1 is an elevational view, partly in section, of separation apparatus in accordance with the invention;
FIG. 2 is a top plan view of the rotor of the separation apparatus shown in FIG. 1;
FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2;
FIG. 4 is a sectional view taken along the line 4—4 of FIG. 2;
FIG. 5 is an enlarged view showing details of discharge valve in the open position;
FIG. 6 is a view similar to FIG. 5 showing the discharge valve in the closed position;
FIG. 7 is a diagramatic view of a system for processing blood in accordance with the invention;
FIG. 8 is a timing diagram indicating a sequence of operations of the system shown in FIG. 7; and
FIGS. 9-12 are a series of diagrammatic views indicating different steps of the centrifuge during a sequence of operations of the system shown in FIG. 7.

DESCRIPTION OF PARTICULAR EMBODIMENT

The centrifuge apparatus shown in FIG. 1 includes a housing 10 in which a rotor 12 is supported for rotation about axis 14. Secured to rotor 12 is a shaft 16 supported by bearings 18, 20 mounted in support member 22. Shaft 16 is driven by % HP permanent split capacitor motor 24 that has a smooth acceleratior curve via toothed pulleys 26, 28 and belt 30.

Housing 10 includes lower and upper housing members 40, 50, respectively. Lower housing member 40 includes an outlet port 42, an annular upstanding baffle wall 44, and outwardly of baffle 44 an inclined surface 46 that drains toward outlet port 42 and a cylindrical outer wall 48. Upper housing member 50 includes a top wall 52 which defines port 54 through which material may be introduced into and removed from the rotor 12 and a cylindrical wall 56 of dimensions similar to wall 48. Baffle plate 58 is interposed between lower and upper housing members 40 and 50. Associated with port 54 is an inlet conduit 60 and a sampling conduit 62. Conduit 62 is mounted for movement into and out of the housing and rotor 12 on arm 64 which is supported on shaft 66 of actuator 68. Spring 70 biases conduit 62 to an upper position as indicated in FIG. 1 and spring 72 permits probe 62 to move relative to arm 64.

The rotor 12, details of which may be seen with reference to FIGS. 2-4, is a unitary member manufactured of a suitable material such as a transparent (e.g. acrylic) plastic, aluminum or titanium, and includes a cylindrical base 100 about one inch high and % inches in diameter in which are defined two discharge passages 104, 106. Depending skirt 102 has a depth of about % inch. Formed in the base and extending radially outward are two discharge passages 104, 106, each % inch in diameter, and intersecting each discharge passage is a vertical passage 108, 3/16 inch in diameter which receives a valve member 110 (FIG. 1). At the inner end of each discharge passage is a chamber port 112, 0.03 inch in diameter.

The rotor structure above base 100 includes a conical chamber portion 114, that is % inch in height and that tapers from a dimension of 2 inches at its base to a dimension of % inch. Above conical portion 114 is a cylindrical entrance port portion that is % inch in diameter and % inch high. Formed in cylindrical portion 116 is an access port 118, the diameter of which is slightly less than one-half inch. A common chamber 120 and
two separation chambers 122, 124 are formed in the conical section of the rotor. Common chamber 120 is of sector configuration and has a base surface 126 that has a radius of about one inch from point 128 and a width of about 3/16 inch. The two separation chambers are cylindrical bores, the axes of which intersect at point 128 and are inclined at an angle of 30° to rotor axis 14. Each separation chamber extends about 0.7 inch below the separation lip or dam 130 at each end of the base surface 126 of common chamber 120. Thus the rotor provides a compact structure which includes a common chamber 120 whose volume and orientation is related to the volumes of the separation chambers 122, 124 in an arrangement in which a known fraction of the separated material is maintained in chambers 122, 124 separate from material in the common chamber 120. Probe 62 is used to remove material from the common chamber.

Additional details of the nature of the chamber outlet valves and valve actuator pins may be seen with reference to FIGS. 5 and 6. Surrounding the outlet orifice of each discharge port 112 is an annular flat surface 150 and, outwardly thereof, an annular conical surface 152 inclined at an angle of 15°. Disposed in each passage 104, 106 is a seal disc 154 of resilient material, an aligning ring 156 and a glass actuating sphere 158. The valve actuator 110 is a cylindrical glass filled nylon pin that has an upper flat 160 and a lower flat 162 connected by a transition ramp 164 that has a length of 3/4 inch. The difference in height from flat 160 to flat 162 is 0.045 inch. A notch 166, 3/4 inch deep and 5/32 inch high receives stainless steel actuator disc 170 that is 1/16 inch in thickness. Each valve actuator pin are moveable between an upper position shown in FIG. 5 in which the valve is open and a lower position, shown in FIG. 6, in which the valve is closed. In the lower position, land 160 is in engagement with valve sphere 158 and presses that valve sphere against seal disc 154 to compress it against surface 150 and close the discharge port 112. When the valve pin is shifted to its upper position, the sphere 158 and disc 154 are free to move radially outward, allowing discharge port 112 to open. Fluid in the chamber flows through the discharge port past the valve disc 154 and the ball 158 to the discharge passage 106 for discharge into the outer chamber of the lower section of the housing and subsequent flow out through drain port 42 (FIG. 1).

The valve actuator, as indicated above, is a stainless steel disc which is supported on two actuator rods 172 as indicated in FIG. 1. Rods 172 are positioned by bushings 174 secured in bores 176 in support member 22. A drive bar 178, attached to the bottom ends of rods 172, is in turn connected to shaft 180 of actuator 182. A stop, 184, attached to one of rods 172 cooperates with a latch member 186 whose position is controlled by actuator 188.

In operation, valve actuator 182 moves between two positions, an upper and lower position, the upper position moving the valve pins 110 to the position shown in FIG. 5, and the lower position moving the valve pins 110 to the position shown in FIG. 6. While the pins are being moved, latch 186 is withdrawn. When the pins 110 have been moved to either position, latch 186 is advanced and the actuator 182 is reversed to place stop 184 against latch 186 as indicated in FIG. 1. In such position actuator plate 170 is spaced from either side of the notches 166 in the valve pins and thus the valve actuator 170 is disconnected from the rotor 12.

A diagram of a system employing the separation apparatus shown in FIG. 1 for processing blood samples is shown in FIG. 7. The system inlet tube 60 is connected to the outlet of peristaltic sample pump 200, the inlet 202 of which is connected to sample tip 204 used to aspirate a sample of whole blood from container 206 in sample rack 208, or a saline rinse solution, for example, from container 210. The sample probe 62 is connected via line 214 to peristaltic pump 216, the outlet 218 of which is connected through valve 220 to line 222 which supplies analysis cuvette 224 or to drain line 226. Associated with analysis cuvette 224 in this embodiment is a radiation source 228 and a photensor 230 for colorimetric analysis of the plasma. The system is controlled by a suitable controller 232 such as a minicomputer of the type manufactured by Digital Equipment Corporation or Data General Corporation, the controller providing signals over lines 234 to the system components to place a sample of whole blood in the separator 12, operate the centrifuge to separate plasma from the blood, transfer a sample of separated plasma to the analysis cuvette 224 for analysis, clean the centrifuge 12 and then load another sample of whole blood for another plasma separation sequence. Preferably analysis is initiated while the centrifuge is being cleaned and the cuvette is cleaned and loaded with reagent as required during the plasma separation sequence, the analysis, cuvette cleaning and reloading sequence also being controlled by signals from controller 234.

When the system is not in use, the valves 110 may be left in open position (FIG. 5). When the system is called into operation, controller 232 supplies a signal to energize actuator 182 to move rods 172 downward and close the valves (point 240—FIG. 8). Latch 186 is moved into position and the actuator 182 is reversed to move disc 170 clear of notch surfaces of actuator pins 110. A specific volume 238 of blood, in this case about one milliliter, is then introduced into the chambers of the rotor by operation of pump 200 through sample tip 204, inlet tube 60 and ports 54 and 118—line 242 in FIG. 8. In order to insure equal filling of separation chambers 122, 124, blood may be introduced with the rotor moving at a low speed, or blood may be introduced while the rotor is stationary and the rotor then driven briefly (about 5 seconds—line 244) to cause the blood to move outward and fill separation chambers 122, 124. The rotor is then braked (for example, about 3 seconds—line 246) and the blood allowed to distribute equally. At this stage, the centrifuge system is in the condition indicated in FIG. 9.

The centrifuge rotor is then accelerated to 17,000 r.p.m., the rotor coming up to speed in about 9 seconds—line 248—and is operated at full speed for about 30 seconds—line 250. The blood constituents are rapidly separated in the narrow elongated chambers 122, 124 under the influence of the centrifugal force. As indicated in FIG. 10, the cellular components 254 (typically 40 to 50% hematocrit but up to about 70% hematocrit) are at the lower outer portions of the chambers 122, 124 as they are heavier in weight and the plasma components 256 are above and inside the cellular components as indicated in FIG. 10. The rotor is then braked to a full stop in about 6 seconds—line 258, and when the rotor is stopped (line 260) plasma probe 62
is inserted into the rotor common chamber 120 through ports 52 and 118 until it bottoms on surface 126. The tip configuration of the probe is such that openings are provided on opposite sides for the entrance of plasma, spring 64 on probe 62 allowing the probe to move relative to support arm 64 and thus avoiding a requirement of precise coordination between the travel of shaft 66 and the spacing of the probe tip from surface 126. Plasma is removed from the sump region as defined by lips 130 as indicated in FIG. 11 and transferred to analysis cuvette 224 through operation of peristaltic pump 216 for an interval of about 12–15 seconds—line 260. The dimensions of this system are such that about one-third milliliter of plasma is extracted from common chamber 120.

When the plasma removal operation is completed, latch 186 is released, actuator 182 is operated to raise the valve pins 110, opening the valves and the actuator disc is then latched in offset position. The rotor is then again accelerated (line 262) and the cellular components 254 and the remaining plasma 256 are forced out centrifugally through passages 112, 104 and 106. Cleaning solution is introduced from container 210 through pump 200 and the inlet 60 to clean the whole blood inlet system, and the outer surface of the sample probe 62. This cleaning solution flows into the rotor and may be pumped through the discharge line 214, pump 216, valve 222, and drain line 226. Also, the rotor may be driven in rotation so that the cleaning solution flows out through the discharge ports 112, thus cleaning the rotor and housing. The rotor is then stopped and reset for introduction of the next sample of whole blood. Concurrently with this cleaning process, analysis of the plasma sample may be carried out under the control of controller 232, the signal from sensor 230 being processed by the controller and an output provided to the display device 236. After analysis, valve 270 is opened, the contents of cuvette 224 are drained, cleaning solution flowed through the cuvette, the valve closed, and the cuvette loaded with reagent for the next plasma analysis sequence. The cuvette cleaning and reloading is concurrent with the plasma separation sequence.

Thus the invention enables sequential processing of small samples of precious fluids such as whole blood. In this particular embodiment, each sample being approximately one milliliter in size, in an in line arrangement between sample input and analysis chamber. The sample produces approximately ½ milliliter of plasma, each separation and cleaning cycle being less than two minutes in duration.

While a particular embodiment of the invention has been shown and described, modifications thereof will be apparent to those skilled in the art and therefore it is not intended that the invention be limited to the disclosed embodiment or to details thereof and departures may be made therefrom within the spirit and scope of the invention.

What is claimed is:

1. A blood analysis system comprising a plasma analysis unit, a plasma separator, said plasma separator comprising a rotor mounted for rotation about a fixed axis, separation chamber structure and second chamber structure within said rotor, said rotor having a port through which blood to be processed may be introduced, said second chamber structure being adjacent said rotor axis and in communication with said port and said separation chamber structure being offset from said rotor axis, restriction structure between said separation chamber and said second chamber structure for retaining a cellular portion of the material in said separation chamber structure after separation while permitting a plasma portion to flow from said separation chamber structure into said second chamber structure, discharge port structure located adjacent said lower portion of said separation chamber structure on the side thereof remote from said rotor axis, valve structure for normally closing said discharge port structure, a first conduit for supplying whole blood to said plasma separator through said second port, probe structure for removing said plasma portion from said second chamber structure, and a second conduit connected to said probe structure for transferring plasma from said plasma separator to said analysis unit for analysis.

2. The system as claimed in claim 1 and further including a controller for operating said separator and said analysis unit concurrently for subjecting a plasma sample to analysis in said analysis unit while said separator is preparing another plasma sample for analysis in said analysis unit.

3. The system as claimed in claim 1 wherein said second chamber structure has a sump portion therein and said probe structure is mounted for movement into said second chamber structure for withdrawing material from said sump portion.

4. The system as claimed in claim 1 wherein the walls of all of said chamber structures are of fixed configuration, thus providing a compact rotor system which may be accelerated rapidly to high rotational speeds.

5. The system as claimed in claim 1 and further including valve actuator structure mounted independently of said rotor for controlling said valve structure.

6. The system as claimed in claim 5 and further including structure associated with said valve actuator structure for allowing reset of said valve actuator structure to a position spaced from said valve structure so that said rotor may be driven in rotation independently of said actuator structure.

7. The system as claimed in claim 1 wherein said separation chamber is an integral, inclined, tubular chamber that is connected to said separation chamber structure, said second chamber having a recessed bottom for receiving said separated second portion.

8. The system as claimed in claim 7 wherein said tubular separation chamber extends below said second chamber such that said cellular portion packs into the separation chamber below the point of intersection with said second chamber.

9. The system as claimed in claim 1 wherein said sample removal probe is mounted for insertion into said rotor along said axis of rotation to a bottoming position on the lower surface of the second chamber, said probe being biased to allow bottoming without requiring precise adjustment of the allowed travel of said probe.

10. Separation apparatus comprising a rotor mounted for rotation about a fixed axis, separation chamber structure and second chamber structure within said rotor, said separation chamber structure being offset from said rotor axis, restriction structure between said separation chamber structure and said second chamber structure, said separation chamber structure being inclined to said rotor axis so that an upper portion is adjacent said restriction structure and a lower portion is spaced further from said rotor axis.
than said upper portion, said restriction structure being adapted to retain a first portion of the material in said separation chamber structure after separation while permitting a second portion to flow from said separation chamber structure into said second chamber structure, discharge port structure located adjacent said lower portion of said separation chamber structure on the side thereof remote from said rotor axis, valve structure for normally closing said discharge port structure, and second port structure for introducing material into and removing material from said second chamber structure.

11. The apparatus as claimed in claim 10 and further including a sump portion in said second chamber structure, and probe structure mounted for movement through a port of said second port structure into said second chamber structure for withdrawing material from said sump portion.

12. The apparatus as claimed in claim 10 wherein the walls of all of said chamber structures are of fixed configuration, thus providing a compact rotor system which may be accelerated rapidly to high rotational speeds.

13. The apparatus as claimed in claim 10 wherein said valve structure includes a valve member movable along a path parallel to said rotor axis between a first position in which said discharge port structure is open and a second position in which said discharge port structure is closed.

14. The apparatus as claimed in claim 10 and further including valve actuator structure mounted independently of said rotor for controlling said valve structure.

15. The apparatus as claimed in claim 14 and further including structure associated with said valve actuator structure for allowing reset of said valve actuator structure to a position spaced from said valve structure so that said rotor may be driven in rotation independently of said actuator structure.

16. The apparatus as claimed in claim 10 wherein said separation chamber is an integral, inclined, tubular chamber that is connected to said second chamber structure, said second chamber having a recessed bottom for receiving a separated component.

17. The apparatus as claimed in claim 16 wherein said tubular separation chamber extends below said second chamber such that said first portion packs into the separation chamber below the points of intersection with said second chamber.

18. The apparatus as claimed in claim 10 and further including a sample removal probe mounted for insertion through a port of said port structure into said rotor along said axis of rotation to a bottoming position on the lower surface of the second chamber, said probe being biased to allow bottoming without requiring precise adjustment of the allowed travel of said probe.

19. The apparatus as claimed in claim 18 wherein the walls of all of said chamber structures are of fixed configuration, thus providing a compact rotor system which may be accelerated rapidly to high rotational speeds.

20. The apparatus as claimed in claim 19 and further including valve actuator structure mounted independently of said rotor for controlling said valve structure, and structure associated with said valve actuator structure for resetting said valve actuator structure to a position spaced from said valve structure so that said rotor may be driven in rotation independently of said actuator structure.

21. The apparatus as claimed in claim 10 wherein said separation chamber structure includes a plurality of integral, tubular chambers that are uniformly spaced about the axis of said rotor and that are inclined at an angle of less than 50° to the rotor axis and that are connected by said second chamber structure, said second chamber having a recessed bottom for receiving said second portion, said tubular separation chambers extending below said second chamber such that said first separated portion packs into the separation chambers below the points of intersection with said second chamber.

22. The apparatus as claimed in claim 21 and further including valve actuator structure mounted independently of said rotor for controlling said valve structure, and structure associated with said valve actuator structure for resetting said valve actuator structure to a position spaced from said valve structure so that said rotor may be driven in rotation independently of said actuator structure.

23. The apparatus as claimed in claim 22 wherein said restriction structure is a raised lip at the edge of said second chamber structure.

24. A process for sequentially subjecting samples of precious fluids such as blood to centrifugal separation operations comprising the steps of placing a fluid sample in separation apparatus which is then operated to separate the sample into at least two constituents, removing at least a portion of one of the separated constituents from said separation apparatus along a first path and another constituent from the separation apparatus along a second path, and then flowing a rinse solution along said first path, countercurrent to the removal direction, into and through said separation apparatus and out through said second path to clean said apparatus in preparation for the next sample processing cycle.

25. The process as claimed in claim 24 wherein said separation apparatus includes a centrifuge rotor that includes common chamber structure disposed on the axis of rotation of said rotor and separation chamber structure offset from said rotation axis, said port structure on said rotation axis in communication with the common chamber structure, and second port structure disposed at the end of said separation chamber structure remote from said rotation axis, and said processing sequence includes the steps of introducing a first fluid sample into the rotor chamber structure through said first port structure, spinning said rotor to distribute the fluid sample to said separation chamber structure and to separate the fluid sample into distinct components in said separation chamber structure, slowing said rotor to allow a portion of the material in said separation chamber structure to flow into said common chamber structure, removing material from said common chamber structure through said first port structure, opening said second port structure to remove another portion of the sample from said rotor chamber structure through said second port structure, and flowing rinse solution through said first port structure into and through said rotor chamber structure and out said second port structure to clean said rotor chamber structure in preparation for the next sample processing cycle.

26. The process as claimed in claim 24 wherein one of said constituents is transferred to an analysis unit, and concurrently subjecting said transferred constituent to analysis in said analysis unit while operating said separation apparatus to separate a constituent of another sample for subsequent analysis in said analysis unit.