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Rosenwald

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[54] **CELL FOR COLLECTING AND MIXING FLUIDS**

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[52] **U.S. Cl.**..... **73/421 R,** 73/422, 259/DIG. 46

[51] **Int. Cl.** **G01n 1/10**

[58] **Field of Search**.... 73/422 R, 422 GC; 222/226, 222/243; 259/DIG. 46, 72, 98

[56] **References Cited**

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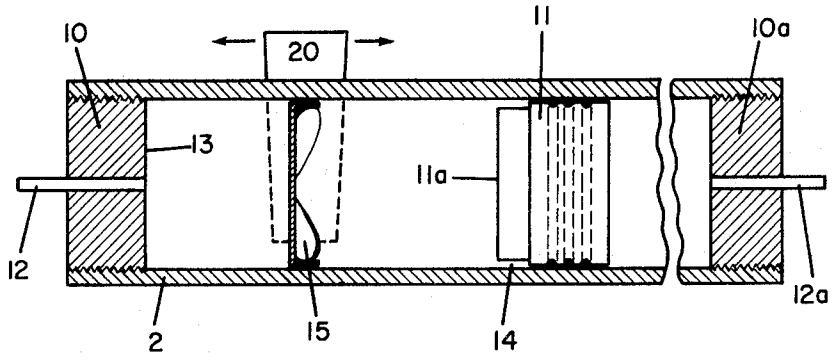
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[57] **ABSTRACT**

Apparatus is disclosed for homogeneously blending a crude mixture of fluids prior to analysis of the mixture for accurately determining the quantity of each component therein.

7 Claims, 5 Drawing Figures



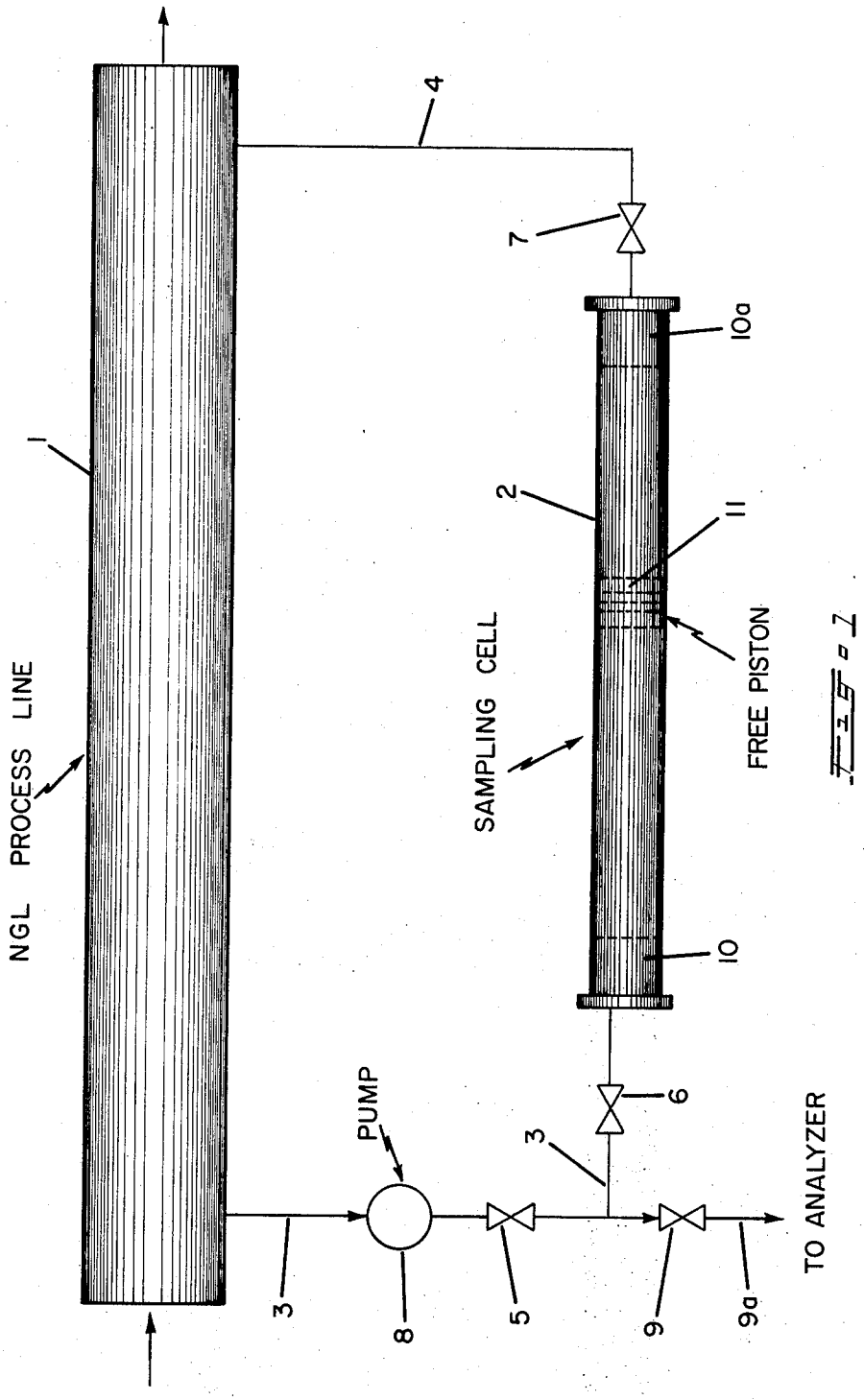

NGL PROCESS LINE
1
SAMPLING CELL
2
FREE PISTON
11
10a
10
4
7
6
3
PUMP
8
5
9
9a
TO ANALYZER

FIG. 1

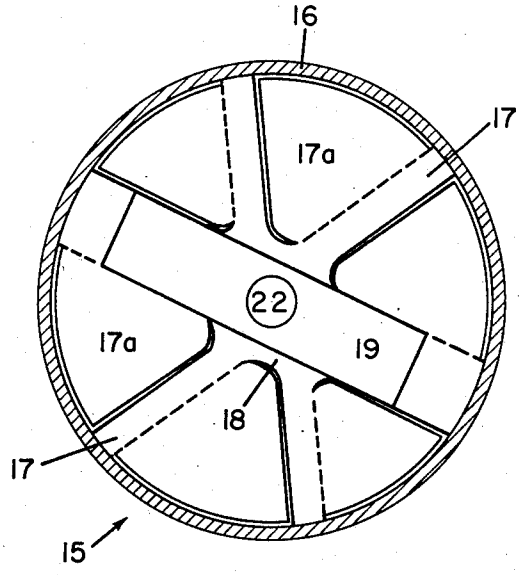


FIG. 2

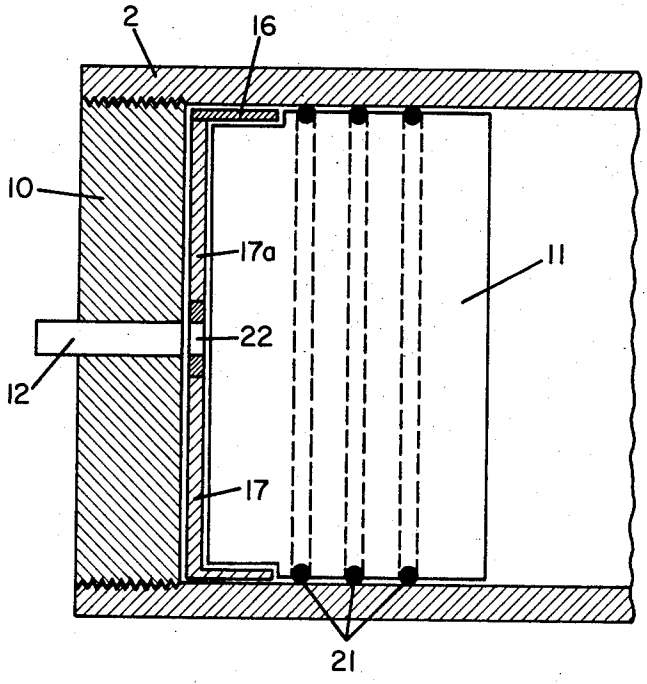


FIG. 3

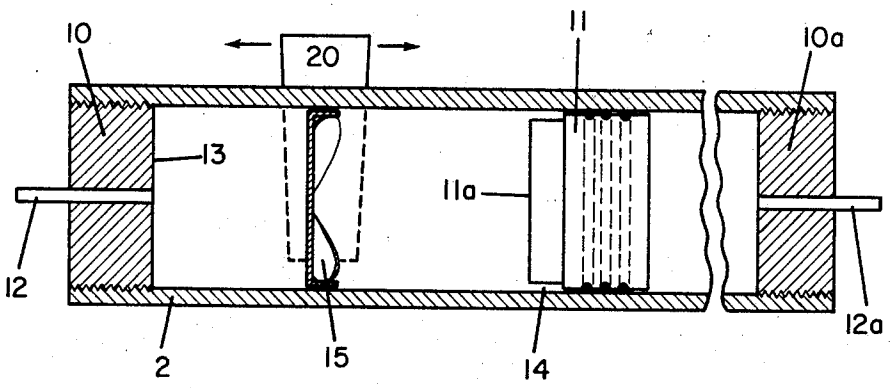


Fig. 4

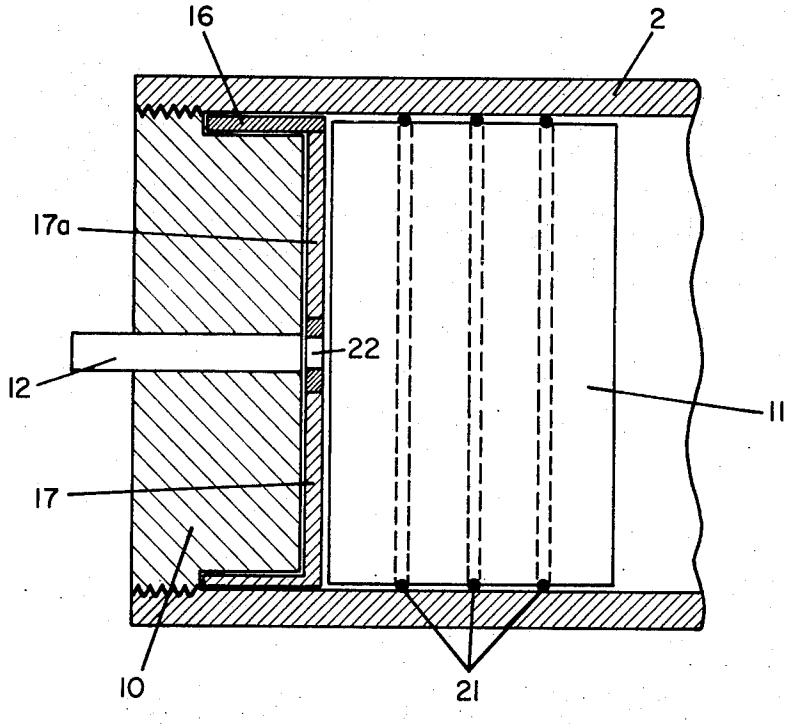


Fig. 5

CELL FOR COLLECTING AND MIXING FLUIDS

BACKGROUND OF THE INVENTION

In the production of natural gas liquids such as ethane, propane, and butane, a stream of the mixed liquids is sampled to determine the quantity of each component contained in the stream. In accordance with prior practice, small samples are taken from the stream periodically. Multiple samples have been required for buyer, seller, transporter and a referee. Attempts to collect separate yet identical samples for analysis by the different parties has required many pieces of hardware and electronic devices which need frequent maintenance, and has also resulted in disagreement between the parties regarding analytical results of the supposedly identical samples.

By taking numerous small samples into a collecting cell incrimentally over a long period of time, a large component sample can thus be accumulated and later subdivided into numerous smaller portions. Many problems could thus be eliminated provided the large composite sample is homogeneously mixed and is thus representative of the composition of the stream over the entire sampling period.

It was learned prior to the present invention that homogeneous blending of the fluid components in such large composite samples does not occur readily by diffusion alone; complete blending cannot be assured in the absence of mechanical agitation within the collecting cell. This problem is further complicated by the fact that a cell which contains internal means for agitating the fluids must nonetheless be designed so that the fluid sample can be completely displaced therefrom mechanically.

It is therefore an object of this invention to provide a cell for collecting samples of mixed fluids, which also includes means whereby the fluids can be quickly and easily blended once they have been drawn into the cell, and also completely displaced from cell after the mixing has been completed. Other objects and advantages of the invention will become apparent from the following description and the appended claims.

SUMMARY OF THE INVENTION

The present invention is a collecting cell for mixed fluids which includes means whereby crudely mixed fluids are homogeneously blended within the cell prior to quantitative analysis of a collected sample.

The present collecting-mixing cell comprises a cylinder having a free piston coaxially aligned therein, a head plug in one end of the cylinder and a tail plug in the other end thereof, and with the piston being located between the plugs. Each plug has a passageway for fluids which leads from the interior of the cylinder to the outside. A bladed agitator is located inside of the cylinder between the head plug and the piston. The agitator is adapted to slide coaxially back and forth within the cylinder when the piston is displaced away from the head plug. The blades of the agitator are conformable to opposed faces of the plug and piston when the faces are approximated by moving the piston toward the head plug, and are adapted to abut and cover substantially all of the surface area of both of these faces when the piston is displaced against the head plug. Both the head plug and the tail plug can be further provided with means for starting and stopping a flow of pressurized fluid through the fluid passageway of each plug.

In a preferred embodiment, the head plug has a flat inner face and the piston is also provided with a flat face which opposes that of the head plug. In such a case the agitator can comprise an outer cylindrical skirt aligned coaxially within the cylinder of the collecting cell and the skirt can have an outside diameter which is slightly smaller than the inside diameter of the cylinder. Collapsible agitator blades are attached to the skirt and extend inwardly from the skirt toward the longitudinal axis of the cylinder, and which when collapsed become flattened to form a disc which occupies practically all of the cross-sectional area inside of the skirt. Additionally, there is provided an annular receptical into which the skirt of the agitator is inserted when the piston is driven toward the flat face of the head plug, the void volume of the receptical being equivalent to the inserted volume of the skirt. Upon insertion of the skirt into the receptical by movement of the piston toward the head plug, the void volume within the cylinder between the plug and piston can be reduced to nearly zero, thus assuring substantially complete emptying of the cell prior to incremental injection of small samples, and also upon fully discharging the composite sample from the cylinder.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an apparatus arrangement whereby samples of fluids are drawn into and discharged from the collecting cell of this invention.

FIG. 2 is an end view of an agitator having collapsible fanlike blades which is located within the cylinder of the collecting cell.

FIG. 3 is a sectional view of one end of the collecting cell and shows the cylinder, the head plug, the free piston, and the agitator of FIG. 2 with the agitator blades in a collapsed state between the faces of the piston and plug.

FIG. 4 is a sectional view of the collecting cell showing the free piston withdrawn from the head plug, the agitator with the blades in an expanded state, and an external magnet for moving the agitator back and forth within the cylinder.

FIG. 5 is an alternative form of the apparatus shown in FIG. 3, the plug **10** being chamfered to form an annular recess between the wall of the cylinder and the end plug.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1 a pipe line for natural gas liquids is shown at **1**. The cylinder of the collecting cell is shown at **2**. Fluid from the pipe line is fed into the cylinder through tap lines **3** and **4**, which are provided with stopcock valves **5, 6,** and **7**. To draw a sample into the cylinder **2**, stopcock valves **5, 6,** and **7** are opened and pump **8** is activated. By means of the intensified pressure provided by the pump, fluid from line **1** is driven into the sample cylinder **2**, displacing the free piston **11** from a seated position against the head plug **10** and toward the tail plug **10a** at the opposite end of the cylinder. To accomplish filling of the cylinder in this fashion, valves **5, 6,** and **7** must be open. Once the desired quantity of fluids has been injected into the cylinder, valves **5** and **6** are closed to seal the fluid within the cylinder and the pump is then stopped. Subsequent incremental injection of samples into the cylinder is accomplished by restarting the pump and opening valves **5, 6,** and **7**, fol-

lowed by sealing off of the cylinder, as previously explained.

The fluid sample is removed from the cell and passed to an analyzer by closing valve **5** and opening valves **6** and **9** so that the sample can be discharged from the cell into an analyzer through line **9***a*. (Valve **9** remains closed during the filling sequences.) Complete discharge of fluid from the cylinder is accomplished by driving the piston against the head plug **10** with pressure supplied from the line **1** through line **4** and valve **7**.

Referring to FIGS. **3** and **4**, the cylinder of the cell is shown at **2**. Head plug **10** and tail plug **10a** are threadably inserted into one end of the cylinder and each has a fluid passageway, **12** and **12***a* respectively, which extends through the body of the plug from the interior of the cylinder to the outside. A free piston **11** is fitted within the cylinder **2**. A flat face **11***a* on the piston opposes a matching flat face **13** on the interior surface of the head plug. The end of piston toward the head plug is chamfered to provide an annular recess **14** between the circumferential surface of the piston and the inner surface of the cylinder **2**.

An agitator having fan-like blades is generally represented at **15**. The agitator has a circular skirt **16** and agitator blades which extend from the skirt toward the central axis thereof. Each of the agitator blades has a rigid portion **17** and a flexible portion **17***a*. The rigid portions of the blades are attached to the skirt **16** at their outer ends and the inner ends are integral with center disc **18** having the same thickness as the blades, thus forming a rigid "spider" from which the integral, flexible portions of the blades extend laterally. Normally, the flexible portions of the blades are curved backward or forward, at least slightly, with respect to the longitudinal axis of the skirt **16**, thus providing a pitch to the blades. Being flexible, the blade portions **17** are subject to collapse upon application of pressure longitudinally with respect to the cylinder axis. Spacing between the flexible blade edges when collapsed and the adjacent rigid blade portions and the skirt is deliberately minimized but is nonetheless sufficient to permit reexpansion of the blades after they have been collapsed. This minimizes the void volume which exists between the rigid and flexible portions of the blades and between the blades and the skirt when the flexible portions are collapsed. Therefore, upon collapse of the flexible blades, they become flattened to form a disc which occupies practically all of the cross-sectional area inside of the skirt.

This is more fully apparent from FIG. **3** which shows the piston **11** driven all the way over toward the head plug **10**, thus resulting in the insertion of the skirt **16** into the annular recess between the piston and the cylinder, and also flattening of the flexible blades of the agitator between the flat faces of the head plug and the piston.

Prior to commencing the incrimental injection of small samples into the collecting cell for the gathering of a large composite sample, the piston **11** is displaced toward the head plug **10** in order to engage the skirt **16** and flatten the blades, thereby fully exhausting air from the cylinder or any fluid which may remain therein from a previous sampling operation. As the sampling sequence proceeds, the piston is displaced from the head plug, and disengages from the agitator skirt, thus permitting the collapsed flexible blades to expand, and leaving the agitator **15** free to move back and forth within the cylinder **2** between the piston **11** and the head plug **10**.

Since the agitator blades are pitched like a propeller, it will be appreciated that the agitator can be moved back and forth within the cylinder and caused to rotate merely by rocking ends of the cylinder up and down. In such a case the agitator is caused to move by the influence of gravity on its mass; i. e., it will "fall" back and forth within the cylinder, and rotation is accomplished naturally by passage of fluid over the pitched blades. Such movement and rotation of the agitator can also be accomplished by briskly moving the sampling cell back and forth along the longitudinal axis of the cylinder.

In an alternative method for moving and rotating the agitator within the cylinder, magnetic means can be employed. More specifically, a permanent bar magnet **19** having the same thickness as the blades can be affixed to the agitator between the blades as is illustrated in FIG. **2**. A movable electro-magnet **20**, wherein polarity is continuously reversed or alternated, e. g., a field coil, can then be moved back and forth over the exterior of the cylinder to cause both longitudinal movement and rotation of the agitator. In such a case the cylinder and agitator (other than the agitator magnet) should be constructed of a material which is either nonmagnetic or only slightly magnetic.

Whether the agitator be moved by the influence of gravity, inertia, or magnetically, the agitator blades and skirt can be stamped from metal or molded from plastic. A relatively heavy metal construction is preferred since it facilitates gravitational or inertial movement of the agitator and helps to maintain movement and rotation accomplished magnetically. Suitable nonmagnetic or only slightly magnetic metals include copper, brass, certain stainless steels and alloys of copper.

In the embodiment of the invention shown in FIGS. **2**, **3**, and **4**, the piston **11** is chamfered to provide an annular recess **14** for the skirt **16**. Alternatively, the head plug **10** can be chamfered to provide a recess **14***a* between the plug and cylinder wall as is illustrated in FIG. **5**, and in which case the agitator skirt extends in the opposite direction from that shown in FIG. **4**. In still another embodiment, both the plug and the piston can be recessed, with the blade attachment to the skirt being toward the center thereof rather than at one edge or the other.

Best sealing between the piston **11** and the cylinder **2** can be accomplished by means of piston rings. Rubber O-rings **21** are preferred and at least two rings or more can be used to assure stabilization of the piston with respect to maintaining coaxial alignment within the cylinder **2**.

A center opening **22** can be provided in the center disc **18** of the blade structure in order to facilitate discharge of fluids from behind the agitator when engaged with the piston for complete emptying of the cell. This feature is optional, however, since fluids will in any event find their way from behind the fluid passageway **12** through the small openings which exist between the blades.

Considerable description has been given herein to agitators having flexible blades which can be collapsed and will re-expand by application and release of pressure. However, it will be understood that the agitator blades need only be conformable to the opposed faces of the piston and the head plug when the faces are ap-

proximated by moving the piston toward the plug, and should be shaped so as to abut and cover substantially all of the surface area of both of these faces when the piston is fully displaced toward the face of the head plug. The blades of agitator can thus be altogether rigid and shaped to be easily guided and fitted into matching grooves in the head plug and/or the piston, and in such a case the agitator can be skirtless provided the outer blade edges have sufficient thickness to maintain axial alignment thereof within the cylinder during the back and forth movement of the agitator.

While the present invention has been described with reference to particular materials, apparatus and arrangements thereof, it will nonetheless be understood that still other embodiments will become apparent which are within the spirit and scope of the invention defined in the following claims.

What is claimed is:

1. Sample collecting cell comprising:

a. a cylinder having a free piston coaxially aligned therein,

b. a head plug in one end of the cylinder and a tail plug in the other end thereof, said piston being located between the plugs, each of the plugs having a passageway for fluids which leads from the interior of the cylinder to the outside, the head plug having a flat inner face and the piston having a flat face which opposes that of the head plug,

c. an agitator inside of said cylinder which is located between the head plug and the piston, said agitator being adapted to slide coaxially back and forth within the cylinder when said piston is separated from the head plug, said agitator having an outer cylindrical skirt aligned coaxially within the cylinder of the collecting cell, said skirt having an outer diameter smaller than the inside diameter of the cylinder, normally expandable but collapsible agitator blades which collapse and conform to opposed faces of said plug and piston when the faces are approximated by moving the piston toward the head plug, said blades being attached to said skirt and extending inwardly toward the central axis thereof and which when collapsed between the faces of the piston and head plug become flattened to form a disc which occupies practically all of the cross-sectional area inside of the skirt, and

d. an annular receptical into which the skirt of the agitator is inserted when the piston is driven toward the flat face of the head plug, the void volume of the receptical being equivalent to the inserted volume of the skirt.

2. Apparatus as in claim **1** wherein the collapsible agitator blades are attached to the cylindrical skirt of the agitator at the end thereof which is proximal to said piston, and the annular receptical for the skirt is defined by an annular space between the piston and the inner surface of the collecting cylinder.

3. Apparatus as in claim **1** wherein the collapsible agitator blades are attached to the cylindrical skirt of the agitator at the end thereof which is proximal to the head plug, and the recess for the skirt is defined by an annular space between the head plug and the inner surface of the collecting cylinder.

4. Apparatus as in claim **1** wherein a bar magnet is attached to the bladed agitator and extends transversely with respect to the agitator blades, and further comprising an electromagnet outside of the sample cylinder, the electromagnet being movable with respect to the longitudinal axis of the cylinder of the collecting cell, and the polarity of the electromagnet is alternative.

5. The apparatus of claim **1** and further comprising:

a. valve means for starting and stopping a flow of pressurized fluid through the passageway in the head plug, and

b. valve means for starting and stopping a flow of pressurized fluid through the passageway of the tail plug.

6. Apparatus as in claim **1** and including at least two piston rings which seal between the piston and the wall of the cylinder.

7. Apparatus as in claim **6** wherein the rings are O-rings.

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