Sept. 17, 1963 C. DI BENEDETTO 3,104,225

CONTINUOUS FLOW CENTRIFUGE ROTOR AND LINER ELEMENT

Filed Jan. 29, 1960

FIG. 1.

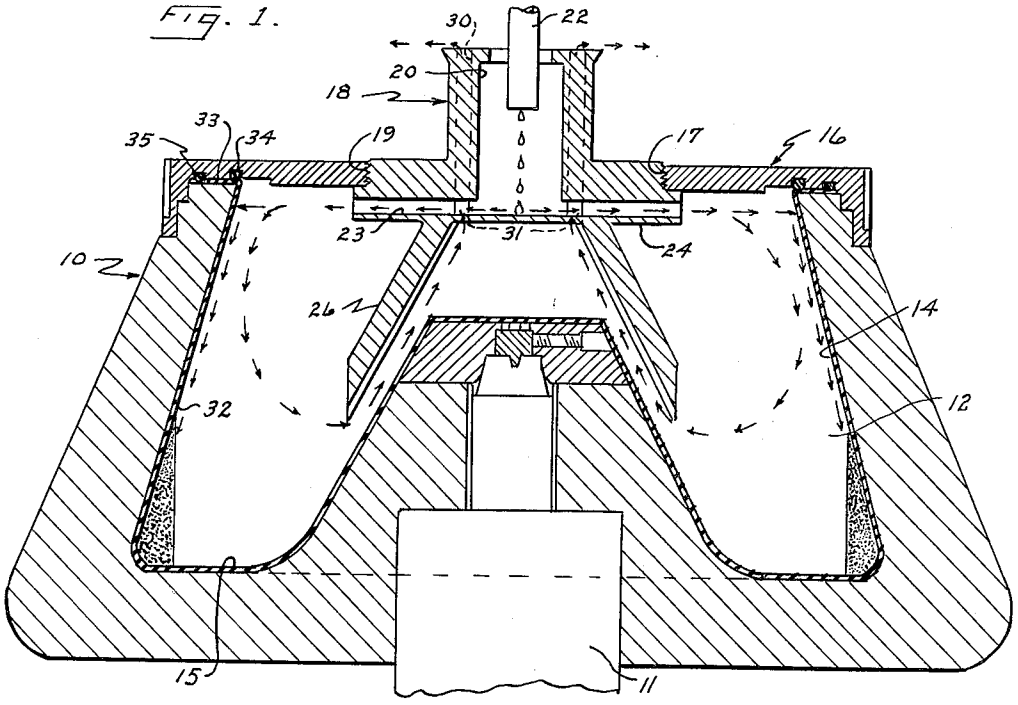
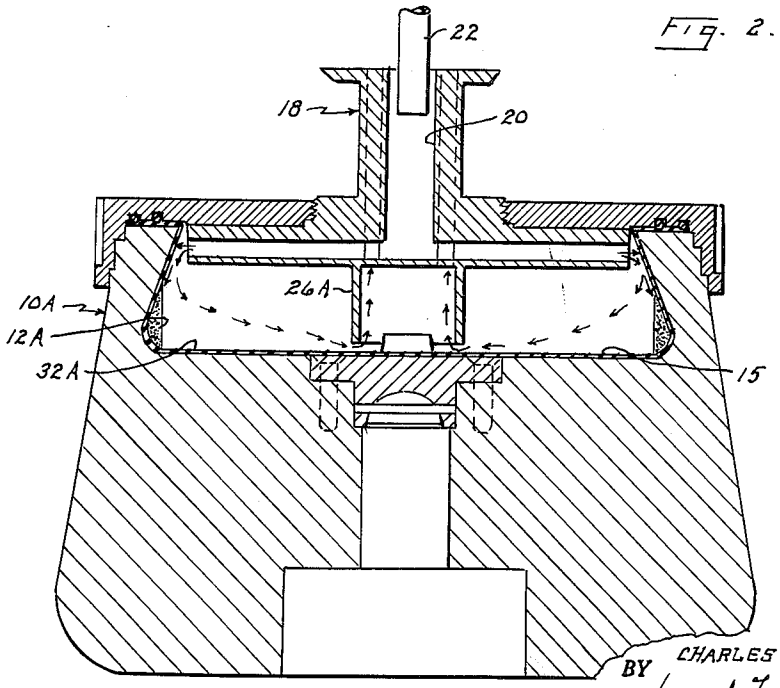


FIG. 2.



INVENTOR.
CHARLES DI BENEDETTO
BY Howard J. Jeanbon
AGENT

United States Patent Office 3,104,225 Patented Sept. 17, 1963

3,104,225
CONTINUOUS FLOW CENTRIFUGE ROTOR AND LINER ELEMENT

Charles Di Benedetto, Brooklyn, N.Y., assignor to Lourdes Instrument Corporation, Brooklyn, N.Y.

Filed Jan. 29, 1960, Ser. No. 5,533
7 Claims. (Cl. 233—28)

This is a continuation in part of the abandoned application, Serial No. 718,893, filed March 3, 1958.

This invention relates to a continuous flow centrifuge and more particularly to the rotor and liner element.

The word centrifuge as used throughout this specification is to be understood as primarily a laboratory instrument wherein a rotor or central bowl is rotated at extremely high r.p.m. (2,000–20,000). With this high r.p.m. there is an enormous centrifugal force developed. This centrifugal force is utilized for the separation of mixtures.

A high speed continuous flow centrifuge is not entirely new in the art. However, the attempts to devise such a device have been poorly designed and lacking in foresight. For example, if the rotor bowl or mixture container is not lined or protected there is a delay in cleaning the rotor bowl after each operation.

The prior art for one type shows that the rotor must be stopped and the rotor must be taken from centrifuge and the materials removed from rotor, then rotor must be cleaned to be reassembled for next run. If refrigeration is required, then rotor must be first chilled before it is ready for the next run. All of this provides a considerable delay, this delay may also be harmful to the mixture being separated.

In another type used in the prior art in which test tubes are used for collection, these require more time for disassembly, cleaning and reassembly and the capacity is considerably less.

With continuous flow of the mixture to be separated in this invention, there is a definite relationship between the inlet and outlet. The inlet must be centrally positioned and should be inserted sufficiently within the central aperture to permit feeding the charge to the rotor to provide the best circulation from inlet to outlet to permit centrifugal force to act upon the density of the mediums in the mixture, the denser mixture being thrown outward while the lighter medium circulates from the inlet to the outlet, or the denser particles will be thrown outward and downward while the remaining fluid or medium flows according to the induced circulation. This circulation must also be carefully controlled, that is, the feed must be slow where mediums have similar density and feed may be increased where there is a greater difference in density.

It is an object of this invention to provide a continuous flow centrifuge in which the high speed rotor is formed generally in the shape of a circular bowl to receive a continuous flow of a mixture from a central inlet port and in which the rotor receiving this flow is in turn connected to an outlet port.

It is a further object of this invention to provide a continuous flow centrifuge in which the high speed rotor is formed generally in the shape of a circular bowl and is provided with a plastic removable liner that will abut with the entire internal surface of the bowl shaped element to receive a continuous flow of mixture from a central inlet port and in which the rotor receiving this flow is in turn connected to an outlet port.

It is a further object of this invention to provide a continuous flow centrifuge in which the high speed rotor is formed generally in the shape of a circular bowl and is provided with a plastic removable liner such as polyethylene that will abut with the entire internal surface of the bowl shaped element and in which the liner is provided with an enlarged lip around the mouth of said liner to assist in sealing said baglike liner within the rotor, to receive a continuous flow of a mixture from a central inlet port and in which the rotor receiving this flow is in turn connected to an outlet port.

It is a further object of this invention to provide a continuous flow centrifuge in which the high speed rotor is formed generally in the shape of a circular bowl and is provided with a coating of plastic covering the entire internal surface of the bowl shaped element to receive a continuous flow of a mixture from a central inlet port and in which the rotor receiving this flow is in turn connected to an outlet port.

It is a further object of this invention to provide a continuous flow centrifuge in which the high speed rotor is formed generally in the shape of a circular bowl to receive a continuous flow of a mixture through a central stationary inlet port and the rotor is in turn connected to rotating outlet ports which discharge by centrifugal force into a stationary surrounding collector.

It is a further object of this invention to provide a continuous flow centrifuge in which the high speed rotor is formed generally in the shape of a circular bowl to receive a continuous flow of a mixture from a central stationary inlet tube and in which a discharge cap is mounted concentrically about said stationary inlet and in which the discharge cap is formed with an enlarged enclosure about the periphery of the outlet portion to insure a predetermined pattern of circulation.

It is a further object of this invention to provide a continuous flow centrifuge in which the high speed rotor is formed generally in the shape of a circular bowl and is provided with a removable flexible container that is concentric in form that will fit within the entire internal surface of the bowl shaped element to receive a continuous flow of a mixture from a central inlet port and in which the rotor receiving this flow is in turn connected to an outlet port.

It is a further object of this invention to provide a continuous flow centrifuge in which the high speed rotor is formed generally in the shape of a circular bowl, the circular bowl is provided with an angular shaped wall, and is provided with a plastic removable liner such as polyethylene that will abut with the entire internal surface of the bowl shaped element and in which the liner is provided with an enlarged lip around the mouth of said liner to assist in sealing said liner within the rotor, to receive a continuous flow of a mixture from a central inlet port, and in which the denser mixture or particles will impinge on the wall and flow downward.

Further objects of this invention shall be apparent by reference to the accompanying detailed description and the drawings in which:

FIGURE 1 is a cross sectional view of the centrifuge rotor, and

FIGURE 2 is a further embodiment of this invention.

Referring to the drawings, and particularly FIGURE 1, there is illustrated a rotor **10** that is designed to be inserted on a central shaft **11** of a centrifuge. The rotor **10** is provided with a circular bowl shaped interior **12** and in cross section the interior of the bowl assumes the outline of a pair of pockets but actually the pockets are joined into a single concentric configuration as shown in the drawing. The wall **14** is angularly disposed, so that the bottom or floor **15** of the bowl is further from the central axis than the upper inlet portion of the bowl. The reason for this formation is that when the rotor **10** is rotated at high speed the mixture being fed into this bowl will be thrown outward by centrifugal force and the heavier par-

ticles or denser medium will imping with the angular internal wall and thus flow downward towards the floor or bottom **15** of the bowl. The rotor **10** is provided with a sealing cover **16** to close the bowl area. Cover **16** is in turn provided with a central threaded aperture **17**. A discharge cap **18** is provided and is formed with thread **19**. This thread **19** is of a diameter and thread to fit the threaded aperture **17** of element **16**. The discharge cap **18** has an internal bore **20**. The mouth of bore **20** is of a diameter to fit loosely about the periphery of a stationary inlet tube **22**. Inlet tube **22** may be supported by means not shown. The opposite end of bore **20** is connected with smaller diameter apertures **23**, which extend radially from bore **20** and the lower end of bore **20** is closed or sealed. Element **18** in cross section is formed generally in the form of an inverted T. The lower enlarged end **24** is provided with the plurality of bores **23** which extend from the periphery of the bore **20** to a point within the rotor bowl. Element **18** is also provided with a cone shaped extension **26**, extending from the lower surface of the inverted T-shaped element **18** to a point below and in close proximity to the raised central portion of the rotor. The stationary tube **22** passing through the discharge cap **18** extends down into the internal bore **20**. While the bores **23** lead from bore **20** comprising the outlet, at the upper end of element **18** there are provided a plurality of ports **30** which are connected by tubular elements **31** to the area within the cone shaped element **26** above the center of the rotor **10**, thus providing the outlet ports for the fluid or mixture leaving the rotor. The collector to enclose these ports to accumulate the outlet mixture is not shown and is not part of this invention.

With a structure such as that described and illustrated in FIGURE 1, a centrifuge operation is possible, that is, if a mixture to be separated is fed through tube **22** and the rotor **10** is rotated at the desired r.p.m. The mixture entering through inlet port or bore **20** will feed downward to the bottom of bore **20**, where it will be thrown outward by centrifugal force through the plurality of bores **23** to impinge on the angular walls **14** of the rotor **10**. However, the particles being thrown outward will actually impinge against the internal surface of an inserted liner **32**. The heavier particles or denser fluids will move downward as indicated by arrows and as the bowl becomes filled with the mixture the lighter particles or medium of lesser density will be displaced by the heavier particles or medium, forcing the lighter medium through the outlet area between the rotor center and the covering cone shaped element **26**, this rotating medium of lesser density will be forced upward through this area and into the connecting tubular elements **31** and on upward until the medium reaches the outlet ports **30**, where the medium of lesser density will be thrown outward by centrifugal force into the collector (not shown). As more of the mixture is introduced through port **22**, it will build up a circulation from port **22** indicating a flow of heavier particles towards the internal surface of bag **32** and a flow of lighter medium toward ports **30**. Thus the separation will take place immediately under centrifugal force and as the head or rise due to the feed of additional mixture forces the lighter medium through tubes **31**, the mixture will build up until it reaches the outlet port **30**. Thus, as the mixture is fed in through tube **22** it will be separated and will continue to expel the lighter medium or particles along the circulation path described until there is a build-up of the heavier particles or medium in the bowl. The rotor must be stopped when the heavier particles show at the discharge.

This invention includes the use of a plastic liner **32**. The liner is preferably of an exact size but may be either flexible or stretchable to permit the bag shaped liner under centrifugal force to conform with the entire internal surface of the rotor. The liner **32** is also provided with an enlarged lip **33** and the under surface of the cover **16** is provided with two O ring seals, **34** and **35**. The circular seals press on the lip of the baglike liner that rests on the upper surface of the rotor, thus the sealing cap **16** may be threadably secured to the rotor **14** and will impress sufficient force on the lip **33** to provide a perfect seal. The liner **32** may be formed of polyethylene and will thus be capable of being sterilized with gas before each operation rather than having to sterilize the internal surface of the bowl. Likewise, the liner **32** may be quickly removed from the rotor after one operation, and a second liner may be quickly inserted and a second operation may be started without delay.

It is apparent that various materials may be handled by this centrifuge with a bag liner that could not normally be handled because of the effect of their contact with the metal of the rotor.

A further embodiment of this invention would be to provide a container with a certain degree of flexibility but preformed to fit the internal bowl of the rotor and a still further embodiment of this invention would be to coat the entire internal surface of the rotor bowl with a plastic protective coating, such as Teflon (polytetrafluoroethylene).

A still further embodiment of this invention is illustrated in FIGURE 2 in which the rotor **10A** is formed with a different shaped interior bowl **12A**. Thus, the liner **32A** may be a flexible plastic liner as in the prior embodiment or it may be a semi-rigid preformed container of concentric form that is easily bent or distorted to snap into and to fit the internal bowl **12A**. However, in this embodiment, the rotor is not provided with a raised central portion and the base of the T-shaped element **18** is provided with a concentrically formed tubular extension **26A**, which extends to a position in close proximity to the bottom **15** of the bowl shaped area. Otherwise, this embodiment is similar in every other aspect to the prior embodiment. This particular embodiment provides a rotor for small volume sediment collection.

It is to be noted in both the embodiments described that the fluid mixture to be separated actually starts its separation the instant it is introduced into the rotor and impinges with the bottom surface of the rotating bore **20**. The enormous centrifugal force developed by the rotor spins the impinging mixture and throws it radially outward to again impinge against the angularly formed internal wall of the rotor. As already described, the greater force induced into the heavier particles will cause them to cling to and slide down the angularly formed wall of the rotor to gather in the base of the bowl as shown in the drawings. The lighter particles or fluid will of course first tend to fill the bowl of the rotor, but as the charge of material continues, the lighter portion of the mixture will be forced toward any outlet in the bowl. Since tubes **31** are the only outlets on which the centrifugal force is not acting, then the lighter fluid will be forced up through these tubes to be expelled from the rotor. Actually the fluid rising from the tubes **31** will again be effected by the centrifugal force to be thrown off in a radial pattern into a collector (not shown). The pattern of circulation developed permits a continuous feed of fluid mixture and a continuous expulsion of the lighter medium until the bowl of the rotor becomes loaded with the heavier particles. When the bowl is filled with the heavier particles the rotor is stopped, the liner is easily removed and a new liner inserted, and the operation is then continued without the usual delays found with all other rotors.

Various changes may be made to this invention, such as the size or shape of the bowl of the rotor, without departing from the spirit of this invention, and various liner materials may be utilized without departing from the spirit of this invention, and this invention shall be limited only by the appended claims.

What is claimed is:

1. A rotor that is charged to provide continuous flow centrifugation and which includes a hollow rotor, a cover and a discharge cap, said rotor formed as a circular bowl

with an open top and circular walls and the internal surface of said walls slanted in an angular formation with the top of a smaller diameter than the base of said rotor, said rotor on its under side formed with a mounting and driving socket for the insertion of a drive shaft, said rotor also provided with a raised central portion within said bowl shaped area, said cover threadably secured to the open top of said rotor and provided with a central aperture, said discharge cap threadably secured in said central aperture on the under side of said cover to extend into said rotor, said discharge cap provided with a central aperture through which a stationary inlet tube may be mounted to convey material into the rotor, said central aperture of said discharge cap extending into said cap to a point below said cover and a plurality of bores extending radially from said central aperture at this point, said radial bores extending into the interior of the rotor bowl toward the upper portion of the internal surface of the walls of said rotor, said discharge cap formed at its lowest penetration into said rotor bowl with a cone shaped extension that surrounds and is in close proximity to the raised central portion of said rotor bowl, said discharge cap provided with laterally spaced discharge tubes that extend from within the cone shaped extension at the bottom surface of the cap to the top surface.

2. In a device according to claim 1, in which the internal surface of said walls of said rotor is provided with an easily removable, stretchable, flexible liner, formed generally bag shaped, to adjust its shape under centrifugal force to the internal contours of said rotor.

3. In a device according to claim 1 in which the internal surface of said walls of said rotor is provided with a liner of polyethylene to protect said rotor internal bowl from the harmful effects of any fluid mixture.

4. In a device according to claim 1 in which the discharge cap is provided with a flat top surface, the said laterally spaced discharge tubes carrying the separated fluid rising therein to said flat top surface to be thrown off radially from said surface by centrifugal force.

5. A rotor that is charged to provide continuous flow centrifugation and which includes a hollow rotor, a cover and a discharge cap, said rotor formed as a circular bowl with an open top and circular walls and the internal surface of said wall slanted in an angular formation with the top of a smaller diameter than the base of said rotor, said rotor on its under side formed with a mounting and driving socket for the insertion of a drive shaft, said cover threadably secured to the open top of said rotor and provided with a central aperture, said discharge cap threadably secured in said central aperture on the under side of said cover to extend into said rotor, said discharge cap provided with a central aperture through which a stationary inlet tube may be mounted to convey material into the rotor, said central aperture of said discharge cap extending into said cap to a point below said cover and a plurality of bores extending radially from said central aperture at this point, said radial bores extending into the interior of the rotor bowl toward the upper portion of the slanted internal surface of the walls of said rotor, said discharge cap formed at its lowest penetration into said rotor bowl with a cylindrical extension that surrounds and is in close proximity to the central portion of said rotor bowl, said discharge cap provided with laterally spaced discharge tubes that extend from within the cylindrical extension at the bottom surface of the cap to the top surface.

6. In a device according to claim 5 in which the internal surface of said walls of said rotor is provided with a semi-rigid preformed container of concentric form that is easily distorted to snap into and fit the internal bowl of said rotor.

7. In a device according to claim 5 in which the bottom surface of the central aperture forms a spinning disc for the separation of a fluid mixture as it impinges thereon.

References Cited in the file of this patent

UNITED STATES PATENTS

447,530	Wahlin	Mar. 3, 1891
596,508	Hohnsbehn	Jan. 4, 1898
631,680	Staahlgren	Aug. 22, 1899
636,780	Evans et al.	Nov. 14, 1899
732,886	Odell et al.	July 7, 1903
2,084,487	Haraldson	June 22, 1937
2,186,836	McGlaughlin	Jan. 9, 1940
2,321,144	Jones	June 8, 1943
2,822,126	Cohn	Feb. 4, 1958
2,883,103	Whitehead et al.	Apr. 21, 1959

FOREIGN PATENTS

971,978	France	Aug. 23, 1950