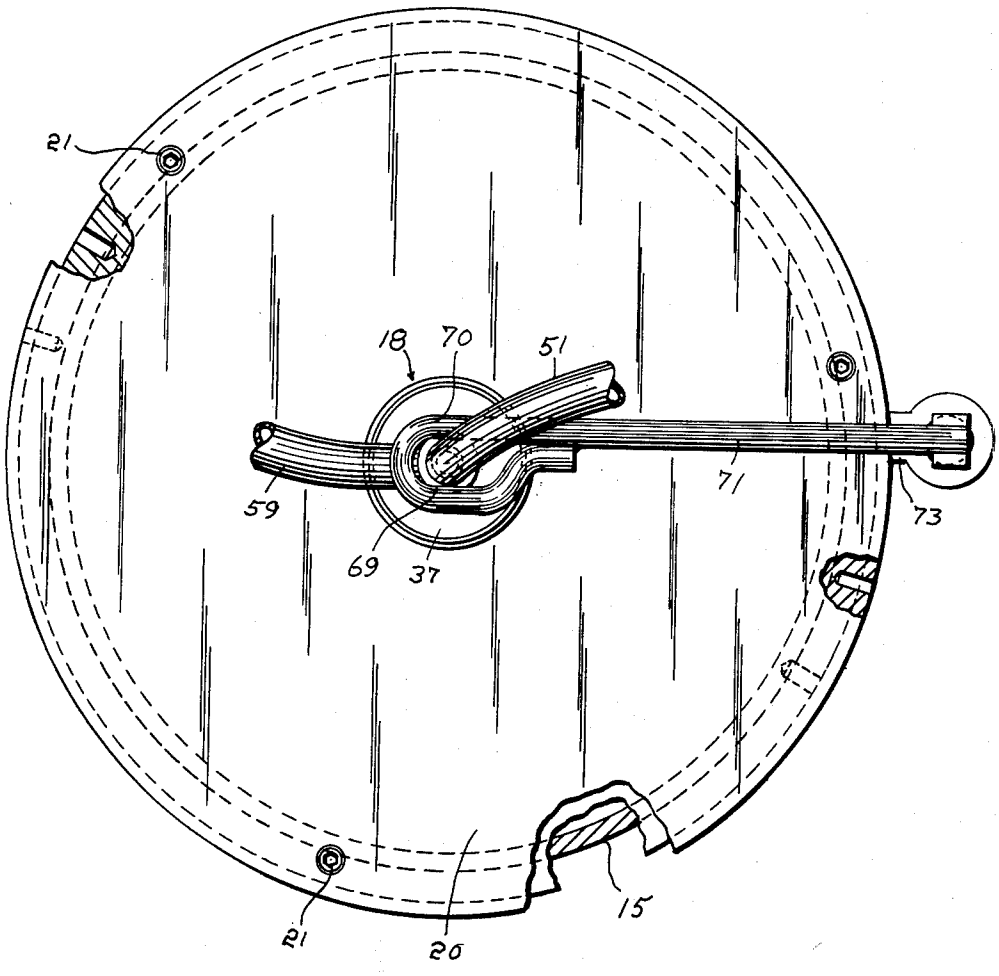
March 31, 1964 D. F. MITCHELL 3,127,342

CONTINUOUS FLOW CENTRIFUGE APPARATUS

Filed Jan. 15, 1962 4 Sheets-Sheet 1

Fig. 1.



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CONTINUOUS FLOW CENTRIFUGE APPARATUS

Filed Jan. 15, 1962 4 Sheets-Sheet 2

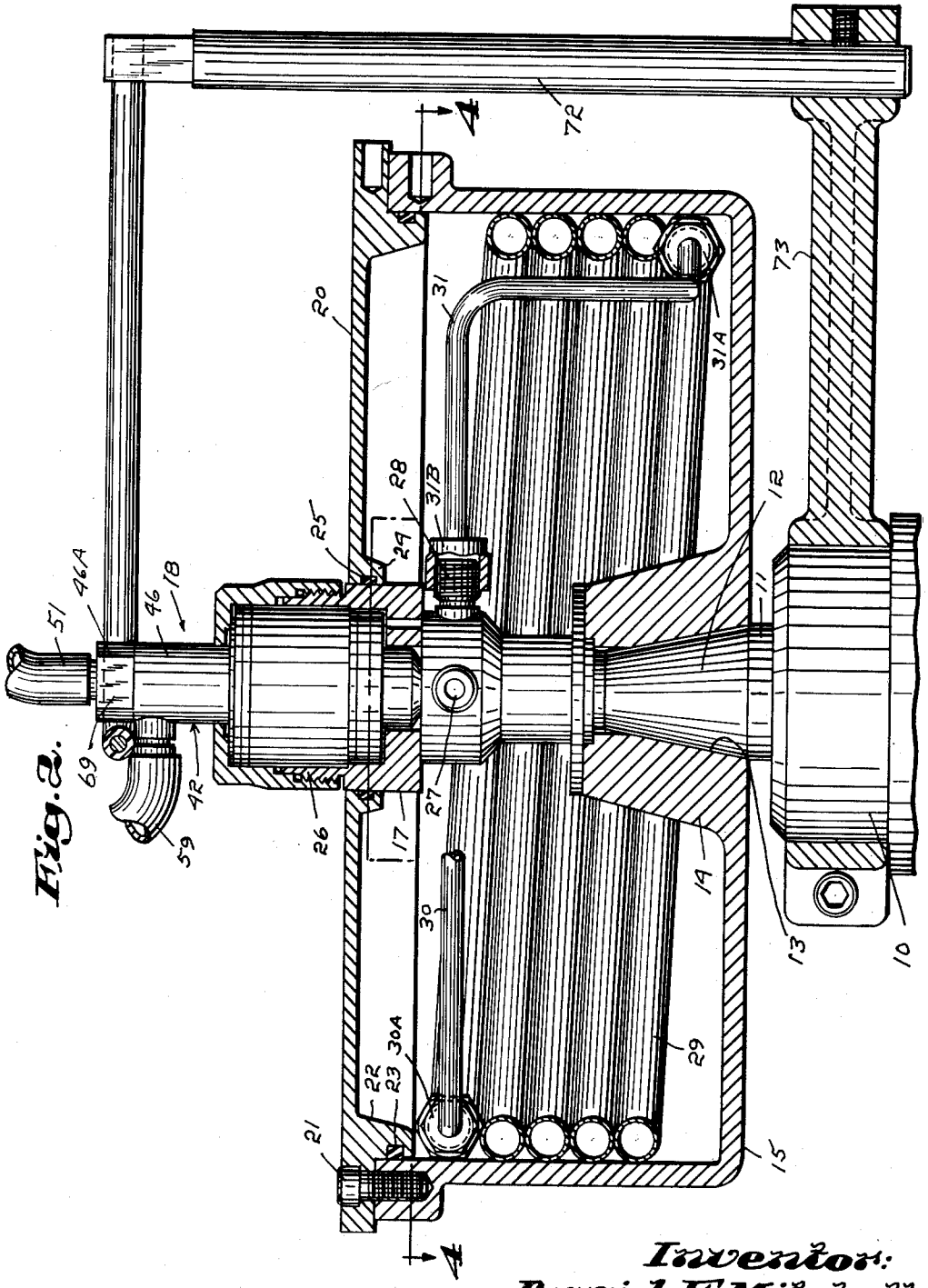


Fig. 2.

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CONTINUOUS FLOW CENTRIFUGE APPARATUS

Filed Jan. 15, 1962 4 Sheets-Sheet 3

Fig. 3.

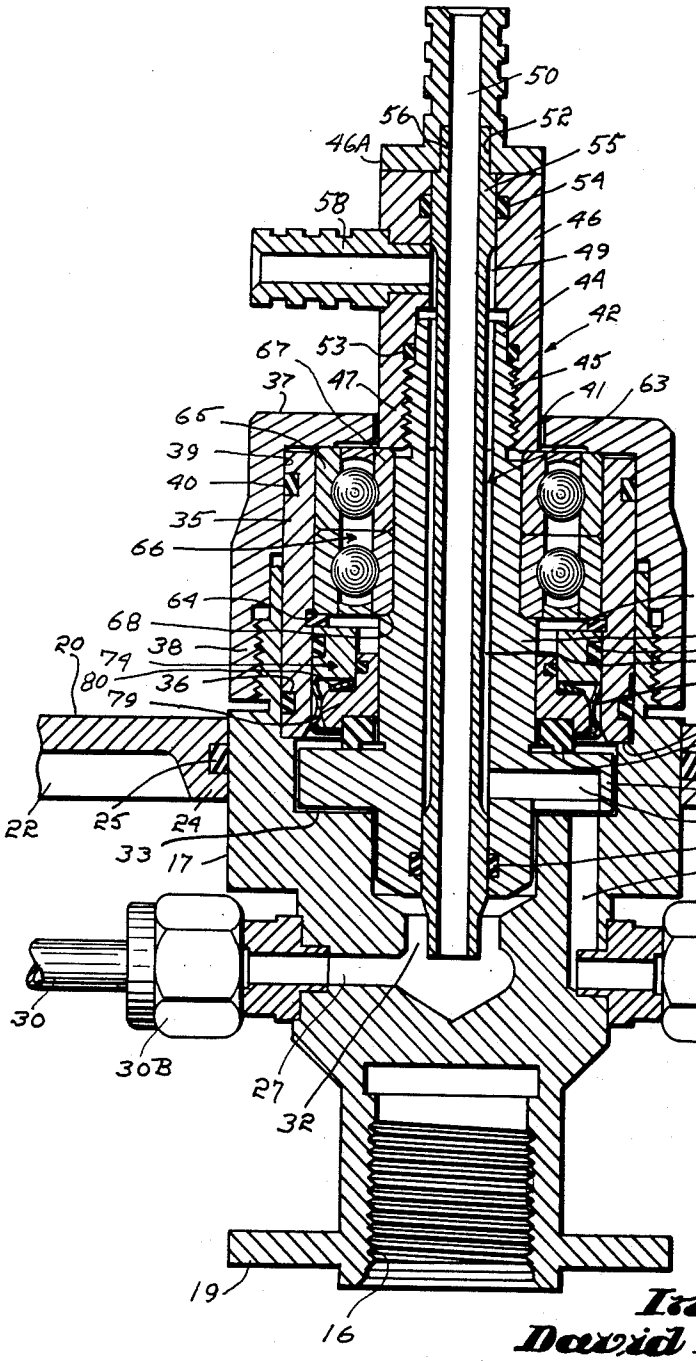
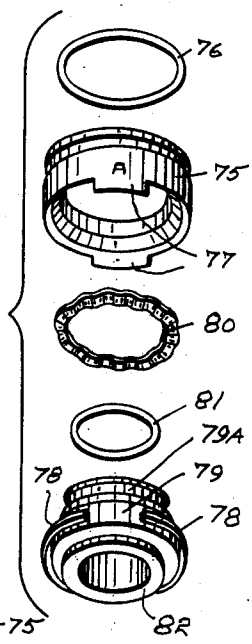


Fig. 5.



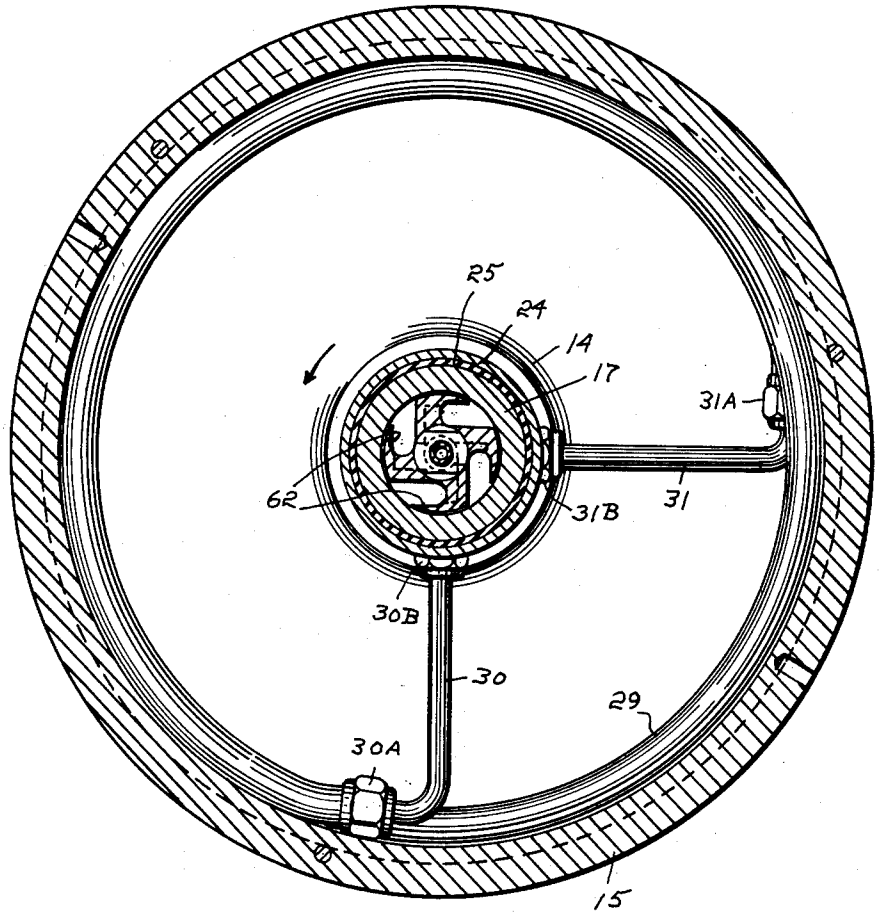
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March 31, 1964 D. F. MITCHELL 3,127,342

CONTINUOUS FLOW CENTRIFUGE APPARATUS

Filed Jan. 15, 1962 4 Sheets-Sheet 4

Fig. 4.



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3,127,342

CONTINUOUS FLOW CENTRIFUGE APPARATUS

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Filed Jan. 15, 1962, Ser. No. 166,038
6 Claims. (Cl. 233—21)

This invention relates to continuous flow centrifuges and to devices for use in such apparatus including rotor and stator sections providing concentric delivery and return passageways.

In a continuous flow centrifuge, it is necessary to provide for the delivery of a liquid into the centrifuge basket from an externally located delivery conduit and for the return of liquid therefrom to a return conduit which is also located outside the basket. Usually, but not necessarily, the basket is provided with a coil whose inlet is connected to the delivery conduit and whose outlet is connected to the return conduit. Continuous flow centrifugation presents a wide range of problems such as the prevention of an aerosol effect, the necessity of structures that facilitate cleaning, sterilizing, and servicing operations, and the control of the flow to prevent pressure build-ups that might cause tubing ruptures or interfere with desired centrifugal effects due to excessive "heads" on the coil contents.

The general objective of the present invention is to overcome these difficulties and, in accordance with it, that objective is attained by providing, in apparatus of the above summarized type, a device comprising co-axial rotor and stator sections, the rotor section, in use, extending axially into and being rotatable with the centrifuge basket. The rotor section has, in its lower end, spaced delivery and return ports. The lower rotor section end also has a chamber provided with an annular shoulder located above its bottom with the delivery port opening into the chamber below the shoulder and with the return port opening therein above that shoulder.

The stator section has a circular flange pendant above the chamber shoulder and includes a pair of concentric, axial conduits whose upper ends extend above the rotor section. One conduit opens into the chamber below the shoulder thereof and has, adjacent its upper end, a delivery port for connection with the delivery conduit and is a delivery passageway. The other conduit has return ports, one above the rotor section for connection with the return conduit and one opening through the flange and is a return passageway.

A particular object of the invention is to provide the flange of the stator section with one and preferably a series of surfaces, disposed to intercept fluid in the chamber above the shoulder, which fluid is under the influence of centrifugal force when the centrifuge is in service. These intercepting surfaces divert the fluid into the return passageway, utilizing the kinetic energy of the liquid in effecting its positive upward flow.

Another particular objective of the invention is to provide a rotor section which includes upper and lower members and a stator section which also includes upper and lower members having alined axial bores in which there is a tubular member whose bore defines the delivery passage and whose outside diameter is so related to the inside diameter of the alined bores, in a zone inclusive of the return ports, as to establish a clearance adequate for the return passageway.

It is preferred that, whether or not positive circulation is provided, there be an unsealed clearance between the chamber above the flange and the chamber below the flange although the delivery and return passageways may be positively isolated from each other. With such an unsealed clearance, any flow between the chambers is inconsequential when the delivered volume is not beyond the capacity of the coil. At the same time, excess liquid, as for example if the coil becomes clogged, bypasses the coil.

Another objective of the invention is to provide rotor and stator sections that are so sealed as to avoid any aerosol effect.

Yet another object of the invention is to provide that the devices can be readily assembled and disassembled to ensure ease and convenience in cleansing the parts or making seal replacements, for example.

In the accompanying drawings, there is shown an illustrative embodiment of a centrifuge in accordance with the invention from which these and other of its objectives, novel features, and advantages will be readily apparent.

In the drawings:

FIGURE 1 is a top plan view of a centrifuge basket in accordance with the invention,

FIGURE 2 is a vertical section through the centrifuge basket on a slightly increased scale,

FIGURE 3 is a vertical section through the contra-flow device on a substantially increased scale,

FIGURE 4 is a section taken approximately along the indicated lines 4—4 of FIGURE 2, and

FIGURE 5 is an exploded view showing in perspective the seal between the rotor and stator sections of the device.

As indicative of a centrifuge drive, there is shown a hub 10 in which the driving member 11 is journalled. The driving member is shown as having an upwardly and inwardly tapering portion 12 receiving the correspondingly tapered seat 13 in the axial, upwardly disposed hub 14 of the basket 15. The upper end of the spindle is threaded to receive the threaded socket 16 at the bottom of the lower housing member 17 of the generally indicated contra-flow device 18. The bottom end of the housing member 17 has a flange 19 for clamping engagement with the upper end of the hub 14 when the member 17 is threaded onto the spindle 11.

A cover 20 is attached to the periphery of the basket 15 as by screws 21 and has a depending flange 22 entrant of the mouth of the basket 15 and provided with a basket engaging annular seal 23. The cover 20 has an axial port defined by a depending, annular flange 24 provided with an annular seal 25 engaging the housing member 17 below its exteriorly threaded mouth 26.

The housing member 17 has spaced ports 27 and 28 and, the invention is illustrated with a coil 29 within the basket 15 having its inlet connected to the port 27, via a conduit 30, by means of fittings 30A and 30B and its outlet connected to the port 28, via a conduit 31, by means of fittings 31A and 31B. As coils may be used that vary in size and in the size of the tubing as well as in the material from which the tubing is formed, the fittings may be varied as a means of supplying balancing weight to the basket when readied for service.

The housing member 17 has a chamber 32 having an intermediate, annular shoulder 33 dividing the chamber into upper and lower portions. Adjacent but below the exteriorly threaded mouth 26 of the housing member 17, the chamber 32 has a shoulder 34 supporting a sleeve 35 and, above the shoulder 34, the chamber 32 is dimensioned to closely confine the sleeve 35 and preferably the sleeve 35 is provided with a seal 36 engaging that portion of the chamber 32. The inlet port 27 opens into the lower portion of the chamber 32 while the return port 28 opens through the upper face of the shoulder 33 into its upper portion.

A cover 37 has an interiorly threaded mouth 38 enabling it and the housing member 17 to be interconnected

and when thus connected, they establish the rotor section of the device **18**. The upper end of the interior of the cover **37** is dimensioned as at **39** to closely confine the sleeve **35** which is shown as having a cover-engaging seal **40**. The cover **37** also has a central port **41** upwardly through which the upper end of the generally indicated stator section **42** protrudes.

The stator section **42** comprises a lower conduit member **43** having its upper end **44** of reduced diameter and threaded as at **45**. An upper conduit member **46** has a downwardly opening mouth **47** which is threaded to enable it to be connected to the lower conduit member **43**. The conduit members **43** and **46** have axial bores **48** and **49**, respectively, the axial bore **48** extending from end-to-end of the member **43** and being in alinement with the bore **49** when the conduit members **43** and **46** are threaded together. Seated on the conduit member **46** is a separate cap portion **46A** which has a port **50** adapted to have the delivery conduit **51** attached thereto and counterbored as at **52** when it opens into the axial bore **49**. A seal **53** is provided between the upper end **44** of the conduit member **43** and the mouth of the upper conduit member **46** above its threads and the upper conduit member **46** has a seal **54** which engages the upper part of a tubular member **55** which has its upper extremity **56** dimensioned for entry into the counterbore **52**. Apart from production costs, the cap portion **46A** and the tubular member **55** are to be regarded as integral. The lower end of the tubular member **55** extends beyond the lower end of the lower housing member **17** and into the lower portion of the chamber **32**. The conduit member **43** has, adjacent the lower end of its bore **48**, a seal **57** engaging the tubular member **55** which is the delivery passageway.

Below the seal **54**, the upper conduit member **46** has a laterally disposed return port **58** adapted to have the return conduit **59** attached thereto. The conduit member **43** has a circular flange **60** adjacent its lower extremity and a laterally disposed return port **61** opens therethrough and is shown as including a plurality of scoop-like surfaces **62**, see FIGURE 4, disposed to intercept fluid in the chamber **32** above its shoulder **33**. The tubular member **55** is of reduced diameter in a zone **63** inclusive of the return ports **58** and **61**, thus to define therewith a return passageway.

It will be noted from FIGURE 3 that the sleeve **35** is provided with a retaining ring **64** between which and the upper end of the cover **37** there is clamped the outer race **65** of a generally indicated ball bearing unit **66**. The inner race **67** of that unit is clamped between the mouth of the upper conduit member **46** and a shoulder **68** with which the lower conduit member **43** is provided. By these or equivalent means, the stator section **42** is supported with the flange **60** pendant above the shoulder **33**. In this connection, it will be noted that the cap portion **46A** is provided with flattened faces **69**, see FIGURE 1, engaged by the side portions of a loop **70** at the end of an arm **71** supported by an upright **72** at one side of the basket **15** by a bracket **73** clamped to the hub **10**. By these or other means the stator section **42** of the device is held against rotation.

A seal of the shaft seal type between the rotor and stator sections is generally indicated at **74**. A satisfactory type of such a seal comprises a ring **75** seated against the retaining ring **64** and having an annular seal **76** in engagement with the sleeve **35**. The ring **75** is provided with spaced depending lips **77** for entry between the ends of annular rib sections **78** of the holder **79** with which rib sections the lips **77** then engage on partial rotation thus to interconnect the ring **75** and the holder **76** with a spring element **80** between them. Preferably the holder **79** has a sleeve portion **79A** fitting within the ring **75** and provided with a seal **81** for sealing engagement therewith. The holder **75** is provided with a ring **82**, typically a carbon ring, for engagement with the upper face of the

flange **60** with their mutually engaged surfaces lapped to an extent ensuring the effectiveness of the seal.

From the foregoing, it will be apparent that both the rotor and stator sections are sealed against leakage while leakage between them is effectively prevented by the seal **74**. At the same time, the sections are adapted to be readily disassembled and serviced as required and as readily re-assembled.

In operation, the effective sealing of the several parts of each section and the seal between the sections ensures against an aerosol effect while the use of the intercepting surfaces **62** ensures a positive return flow of the liquid. With or without the surfaces **62** and their flow assisting function, the fact that the space between the upper and lower portions of the chamber **32** is unsealed has the substantial advantage that, so long as the flow through the delivery system is within reasonable limits, inter-passageway flow is either non-existent or inconsequential but should the flow to the coil exceed those limits, then the excess is by-passed to avoid tube ruptures, excessive heads on the tube contents, or like objectionable consequences.

I claim:

1. In a continuous flow centrifuge of the type having a basket into which and from which liquid is to be circulated via concentric passageways axially of the basket when connected to exterior delivery and return conduits, respectively, a device axially of said basket and comprising rotor and stator sections, said rotor section being connected to said basket to rotate therewith and having a chamber and including a lower housing member and a cover threaded thereon, the lower end of said member being within said basket when the rotor section is connected thereto, said chamber having an annular shoulder above its bottom, a delivery port opening into the chamber below said shoulder, and a return port opening into said chamber above said shoulder, and a ball bearing unit within the chamber but above said shoulder rotatably connecting said sections, the outer race of said unit being clamped between said housing member and said cover, and said stator section including a conduit member having an axial bore opening through its lower end and provided with a circular flange between said shoulder and said unit, the upper end of said conduit member being above said rotor section, and a tubular member in said axial bore opening into said chamber below said shoulder, the upper end of said conduit member having a delivery port opening into said tubular member for connection to said delivery conduit, said tubular member and said chamber below said shoulder being the fluid delivery passageway, said conduit member having return ports in communication with said axial bore, one opening into said chamber above said shoulder and the other being above said rotor section for connection to said return conduit, said axial bore and said tubular member being dimensioned, in a zone inclusive of said return ports, to provide a conduit defining clearance, said zone and said chamber above the shoulder being the fluid return passageway.

2. In a continuous flow centrifuge of the type having a basket into which and from which liquid is to be circulated via concentric passageways axially of the basket when connected to exterior delivery and return conduits, respectively, a device axially of said basket and comprising rotor and stator sections, said rotor section being connected to said basket to rotate therewith and having a chamber and including a lower housing member and a cover threaded thereon, the lower end of said member being within said basket when the rotor section is connected thereto, said chamber having an annular shoulder above its bottom, a delivery port opening into the chamber below said shoulder, and a return port opening into said chamber above said shoulder, and a ball bearing unit within the chamber but above said shoulder rotatably connecting said sections, the outer race of said

unit being clamped between said housing member and said cover, and said stator section including a conduit member having an axial bore opening through its lower end and provided with a circular flange between said shoulder and said unit and a sealing unit below said bearing unit and including an annular member in siding engagement with the upper surface of said flange, the upper end of said conduit member being above said rotor section, and a tubular member in said axial bore opening into said chamber below said shoulder, the upper end of said conduit member having a delivery port opening into said tubular member for connection to said delivery conduit, said tubular member and said chamber below said shoulder being the fluid delivery passageway, said conduit member having return ports in communication with said axial bore, one opening into said chamber above said shoulder and the other being above said rotor section for connection to said return conduit, said axial bore and said tubular member being dimensioned, in a zone inclusive of said return ports, to provide a conduit defining clearance, said zone and said chamber above the shoulder being the fluid return passageway.

3. In a continuous flow centrifuge of the type having a basket into which and from which liquid is to be circulated via concentric passageways axially of the basket when connected to exterior delivery and return conduits, respectively, a device axially of said basket and comprising rotor and stator sections, said rotor section being connected to said basket to rotate therewith and having a chamber and including a lower housing member and a cover threaded thereon, the lower end of said member being within said basket when the rotor section is connected thereto, said chamber having an annular shoulder above its bottom, a delivery port opening into the chamber below said shoulder, and a return port opening into said chamber above said shoulder, and a ball bearing unit within the chamber but above said shoulder rotatably connecting said sections, the outer race of said unit being clamped between said housing member and said cover, and said stator section including a conduit member having an axial bore opening through its lower end and provided with a circular flange between said shoulder and said unit, the upper end of said conduit member being above said rotor section, and a tubular member in said axial bore opening into said chamber below said shoulder, the upper end of said conduit member having a delivery port opening into said tubular member for connection to said delivery conduit, said tubular member and said chamber below said shoulder being the fluid delivery passageway, said conduit member having return ports in communication with said axial bore, one opening downwardly througth said flange and including a series of circumferentially spaced surfaces in the lower face thereof, each in the form of a pump scoop, and the other being above said rotor section for connection to said return conduit, said axial bore and said tubular member being dimensioned, in a zone inclusive of said return ports, to provide a conduit defining clearance, said zone and said chamber above the shoulder being the fluid return passageway.

4. In a continuous flow centrifuge of the type having a basket into which and from which liquid is to be circulated via concentric passageways axially of the basket when connected to exterior delivery and return conduits, respectively, a device axially of said basket and comprising rotor and stator sections, said rotor section being connected to said basket to rotate therewith and having a chamber and including a lower housing member and a cover threaded thereon, the lower end of said member being within said basket when the rotor section is connected thereto, said chamber having an annular shoulder above its bottom, a delivery port opening into the chamber below said shoulder, and a return port opening into said chamber above said shoulder, and a ball bearing unit within the chamber but above said shoulder rotatably

connecting said sections, the outer race of said unit being clamped between said housing member and said cover, and said stator section including a conduit member having an axial bore opening through its lower end and provided with a circular flange between said shoulder and said unit, the upper end of said conduit member being above said rotor section, and a tubular member in said axial bore opening into said chamber below said shoulder, said conduit member including upper and lower sections threaded together, each conduit section including a shoulder, the inner race of said bearing unit being clamped between said shoulders, the upper end of said conduit member having a delivery port opening into said tubular member for connection to said delivery conduit, said tubular member and said chamber below said shoulder being the fluid delivery passageway, said conduit member having return ports in communication with said axial bore, one opening into said chamber above said shoulder and the other being above said rotor section for connection to said return conduit, said axial bore and said tubular member being dimensioned, in a zone inclusive of said return ports, to provide a conduit defining clearance, said zone and said chamber above the shoulder being the fluid return passageway.

5. In a continuous flow centrifuge of the type having basket into which and from which liquid is to be circulated via concentric passageways axially of the basket when connected to exterior delivery and return conduits, respectively, a device axially of said basket and comprising rotor and stator sections, said rotor section being connected to said basket to rotate therewith and having a chamber and including a lower housing member and a cover threaded thereon, the lower end of said member being within said basket when the rotor section is connected thereto, said housing member having an annular shoulder above its bottom and a second annular shoulder between the first named shoulder and its cover receiving end, a sleeve on said second shoulder and extending upwardly over the joint defined by the ends of the housing member and cover, and including an inwardly disposed retaining ring between its ends, said housing member also having a delivery port opening into the chamber below the first named shoulder and a return port opening into said chamber above said first named shoulder, and a ball bearing unit within the chamber rotatably connecting said sections, the outer race of said unit being clamped between said cover and said retaining ring, and said stator section including a conduit member having an axial bore opening through its lower end and provided with a circular flange between said shoulder and said unit, the upper end of said conduit member being above said rotor section, and a tubular member in said axial bore opening into said chamber below said shoulder, the upper end of said conduit member having a delivery port opening into said tubular member for connection to said delivery conduit, said tubular member and said chamber below said shoulder being the fluid delivery passageway, said conduit member having return ports in communication with said axial bore, one opening into said chamber above said shoulder, and the other being above said rotor section for connection to said return conduit, said axial bore and said tubular member being dimensioned, in a zone inclusive of said return ports, to provide a conduit defining clearance, said zone and said chamber above the shoulder being the fluid return passageway.

6. In a continuous flow centrifuge of the type having a basket into which and from which liquid is to be circulated via concentric passageways axially of the basket when connected to exterior delivery and return conduits, respectively, a device axially of said basket and comprising rotor and stator sections, said rotor section being connected to said basket to rotate therewith and having a chamber and including a lower housing member and a cover, said cover and housing member including overlapping cylindrical ends threaded together, the lower end of

said member being within said basket when the rotor section is connected thereto, said housing member having an annular shoulder above its bottom and a second annular shoulder between the first named shoulder and its cover receiving end, a sleeve on said second shoulder and extending upwardly over the joint defined by the ends of the housing member and cover, and including an inwardly disposed retaining ring between its ends, said housing member also having a delivery port opening into the chamber below the first named shoulder and a return port opening into said chamber above said first named shoulder, and a ball bearing unit within the chamber rotatably connecting said sections, the outer race of said unit being clamped between said cover and said retaining ring, and said stator section including a conduit member having an axial bore opening through its lower end and provided with a circular flange between said shoulder and said unit, and a sealing unit below said bearing unit and including an annular member in sealing engagement with the upper surface of said flange, the upper end of said conduit member being above said rotor section, and a tubular member in said axial bore opening into said chamber below said shoulder, the upper end of said conduit member having a delivery port opening into said tubular member for connection to said delivery conduit, said tubular member and said chamber below said shoulder

being the fluid delivery passageway, said conduit member having return ports in communication with said axial bore, one opening into said chamber above said shoulder and the other being above said rotor section for connection to said return conduit, said axial bore and said tubular member being dimensioned, in a zone inclusive of said return ports, to provide a conduit defining clearance, said zone and said chamber above the shoulder being the fluid return passageway.

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