United States Patent [19]

Kartinen et al.

[11] **3,791,575**

[45] **Feb. 12, 1974**

[54] **CENTRIFUGAL SEPARATOR DISCHARGE CONTROL SYSTEM**

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[22] Filed: **Aug. 30, 1971**

[21] Appl. No.: **175,886**

[52] **U.S. Cl.** ..... **233/19 A**, 233/33, 210/103, 210/90, 210/109, 210/115

[51] **Int. Cl.** **B04b 11/02**

[58] **Field of Search** 233/3, 19 R, 19 A, 20 R, 20 A, 233/27, 28, 31, 32, 33, 34; 210/137, 108, 109, 110, 78, 90, 115

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[57] **ABSTRACT**

Disclosed is a discharge control system for a centrifugal separator.

34 Claims, 6 Drawing Figures

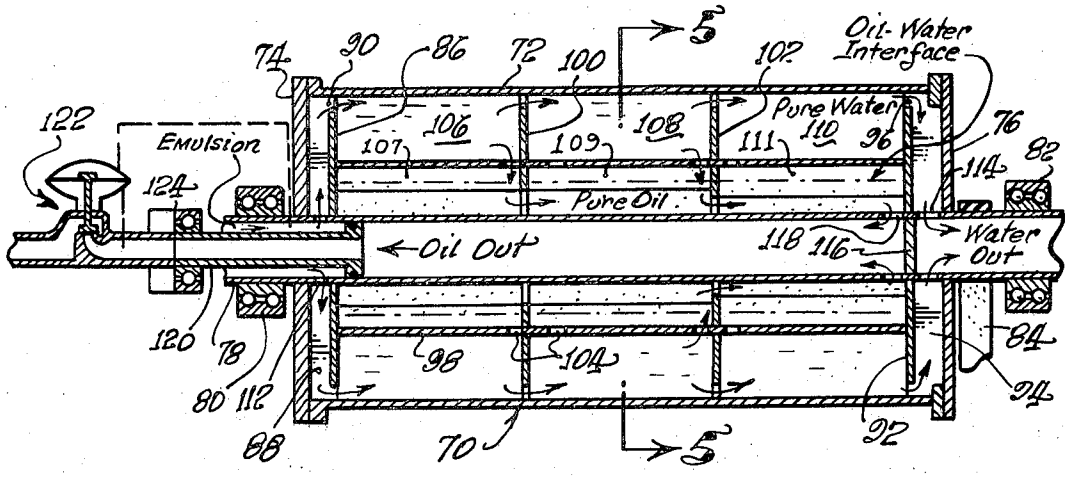


FIG. 3.

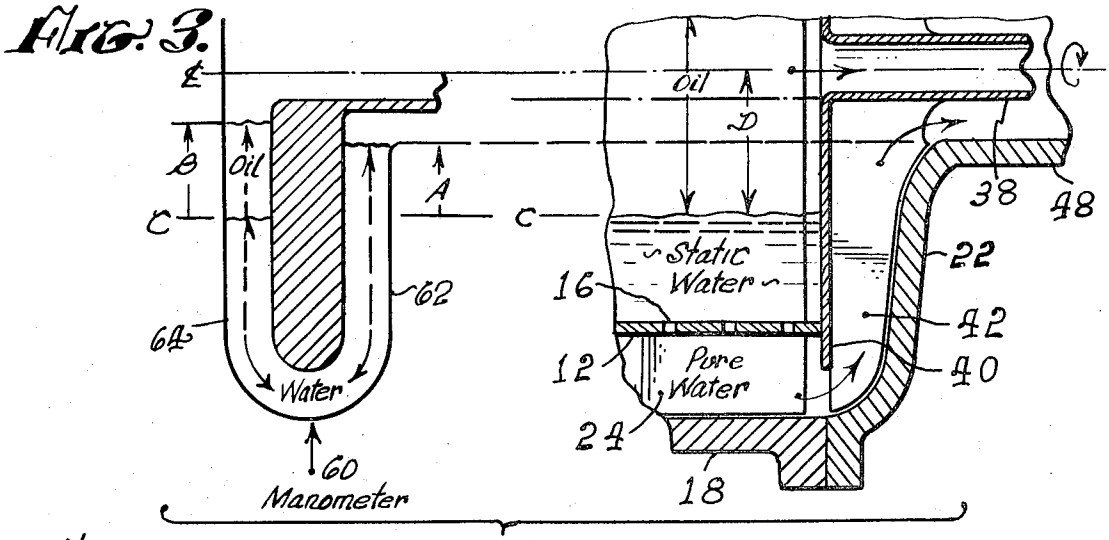
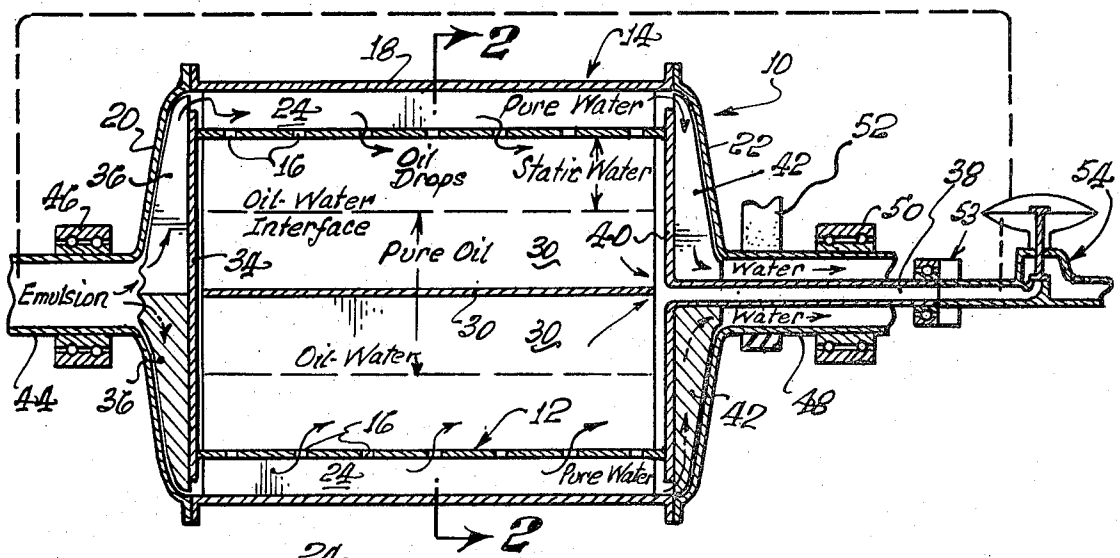


FIG. 1.



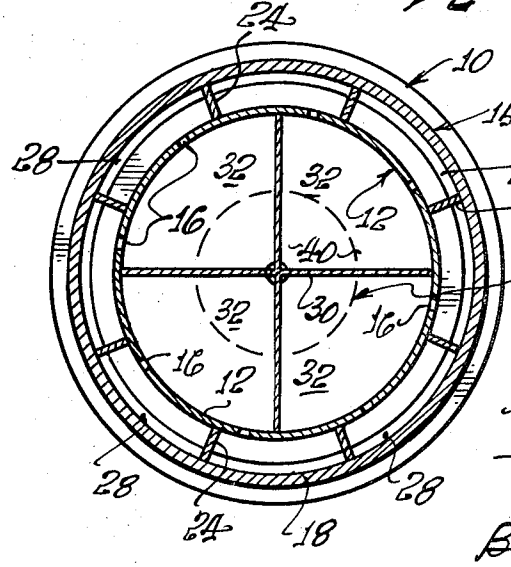
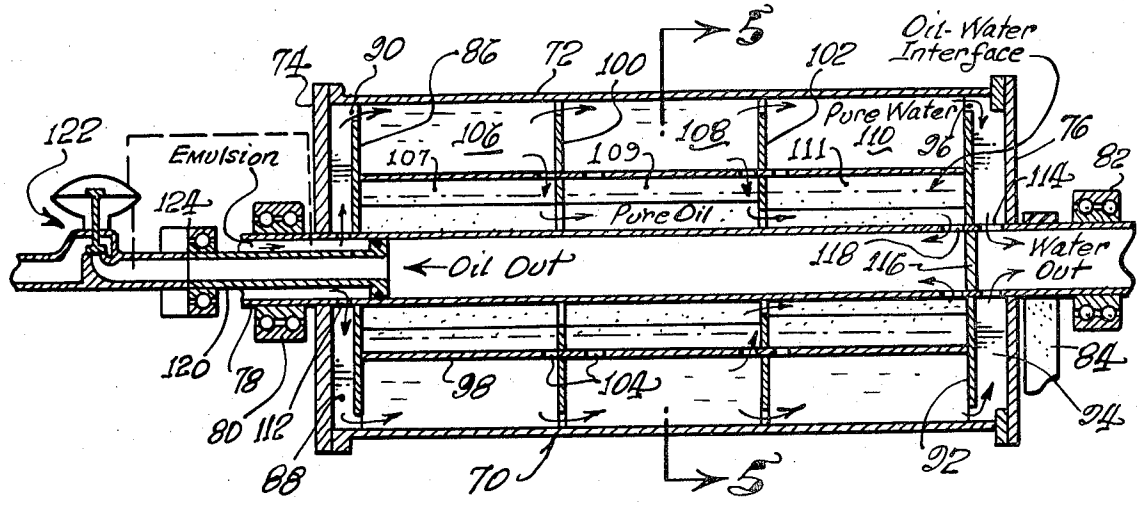


FIG. 2.

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FIG. 4.



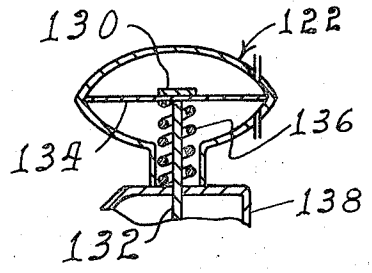
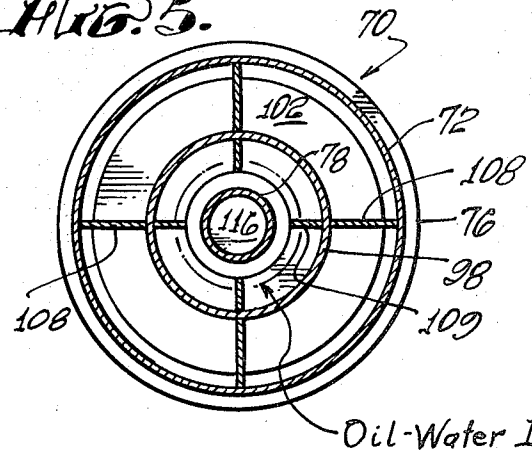


FIG. 6.

FIG. 5.



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CENTRIFUGAL SEPARATOR DISCHARGE CONTROL SYSTEM

BACKGROUND OF THE INVENTION

There are many applications in which it is necessary to separate a mixture or emulsion of two immiscible fluids. Examples include the separation of oil and water produced in land-based or off-shore oil drilling rigs, oil refineries, oil tanker ballast tanks and many other similar applications. A centrifugal separator or centrifuge is ideally suited to separate two fluids of different densities in a rapid and efficient manner. For economical reasons this separation should be accomplished on a continuous and automatic basis. In prior art separators the flow control of the fluids discharging from the centrifuge presented a significant problem in that widely varying inlet flow rates and fluid properties upset conventional control systems.

SUMMARY OF THE INVENTION

The invention is directed to a discharge flow control system for a centrifugal separator in which the separator configuration significantly enhances control and simplifies the system. The flow control system includes a diaphragm operated valve in the outlet line carrying the lighter density fluid from the centrifugal separator. The valve is operated by the discharge pressure of the separated, lighter density fluid which is compared to the inlet mixture or emulsion pressure across the control diaphragm. The discharge flow control system is useful with a variety of centrifugal separator configurations, including separators having energy transfer and/or conversion surfaces such as an inlet impeller, radially extending septa, and an outlet turbine.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diametral cross-sectional view of a centrifugal separator having the discharge control system of the present invention.

FIG. 2 is a cross-sectional view of the centrifugal separator of FIG. 1 taken along line 2—2.

FIG. 3 is a schematic representation comparing the centrifugal discharge control system of FIG. 1 to a static manometer.

FIG. 4 is a diametral cross-sectional view of an alternate centrifugal separator having the discharge control system of the present invention.

FIG. 5 is a cross-sectional view of the centrifugal separator of FIG. 4 taken along line 5—5.

FIG. 6 is a partial, enlarged sectional view of an alternate diaphragm controlled valve.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As illustrated in FIGS. 1 and 2, the centrifugal separator 10 basically comprises a perforate cylindrical inner drum 12 concentrically positioned within an imperforate cylindrical outer drum 14. The inner drum 12 includes a plurality of openings 16 randomly or spirally situated throughout the drum. The outer drum 14 includes a cylindrical central section 18 with inlet and outlet end sections 20 and 22 respectively. The perforate inner drum 12 is spaced within the central section 18 of the outer drum 14 by means of a plurality of radially extending septa 24 which divide the annular space between the perforate inner drum 12 and the central section 18 of the outer drum into a plurality of annular sectors 28. Additionally, a plurality of radial septa 30 extend from the rotational axial centerline of the centrifugal separator to the inner surface of the perforate inner drum 12 to likewise divide the interior of the perforate inner drum into a plurality of sectors 32. Both the septa 24 and 30 extend substantially the entire axial length of the perforate inner drum 12.

The inlet end of the perforate inner drum 12 is closed by a solid circular plate or disc 34 upon which are mounted a plurality of radially extending blades or vanes 36 to define an inlet impeller. The plate 34 extends outward slightly beyond the diameter of the perforate inner drum 12. Except for a lighter fluid outlet 38, the outlet end of the perforate inner drum is closed by a solid disc weir 40 upon which is mounted a plurality of vanes or blades 42 to define an outlet turbine. This weir 40 likewise extends a short distance outward from the diameter of the perforate inner drum 12. While there may be small clearances between the septa 24 and the outer drum 14, between the impeller vanes 36 and the inlet end section 20 and between the turbine vanes 42 and the outlet end section 22, the entire assembly is rotated as an integral assembly or unit.

The centrifugal separator inlet 44, which delivers the mixture or emulsion to the inlet section 20 of the outer drum 14, is rotatably mounted upon bearings 46. The heavier fluid outlet 48, which receives the heavier fluid from the outlet end 22 of the outer drum 14, is likewise rotatably mounted by bearings 50. Either the inlet 44 or outlet 48 may be rotatably driven by any conventional means such as the belt 52 connected to a power source or motor (not shown). A stationary diaphragm controlled valve 54 is connected to the lighter fluid discharge outlet 38 through a bearing and seal housing 53.

In operation, the inlet 44 of the centrifugal separator receives an emulsion or mixture of two fluids such as oil and water. This oil/water mixture or emulsion is forcibly directed outward into the annular space between the inner drum 12 and the outer drum 14 by means of the inlet impeller formed by the vanes or blades 36 on plate 34. In the annulus, the oil/water mixture is subjected to extremely high gravitational forces generated by the rapid rotation of the centrifuge which forcibly disengages or separates the oil from the water due to the difference in the specific gravities of the two fluids. The water, being heavier than the oil, flows outwardly while the oil passes inwardly through the openings 16 in the perforate inner drum 12 to form a solid cylinder of pure oil in the center of the perforate inner drum 12. The septa 24 and 30 keep the fluids rotating at the same rotational speed as the integral unit. The water in the annulus between the perforate inner drum 12 and the imperforate outer drum 14 passes over the weir 40 and is directed by the (outlet turbine) vanes or blades 42 out through the heavier fluid outlet 48. The separated or pure oil is directed through the lighter fluid outlet 38 centrally located in the weir 40.

The oil discharge rate from the centrifugal separator is controlled by the diaphragm control valve 54 in the lighter fluid outlet 38. One side of the diaphragm, tending to open the valve 54, is subject to the pressure in the lighter fluid outlet 38. The other side of the diaphragm, tending to close the valve 54, is subject to the pressure in the centrifugal separator inlet 44. The valve 54 will remain closed until there is sufficient accumulation of oil within the perforate inner drum 12 to create a pressure greater than the inlet pressure in inlet 44.

FIG. 3, which compares the centrifugal separator discharge control system with a static manometer, is provided to facilitate a more complete understanding of the operation of the system. The manometer **60** includes a water leg **62** and an oil leg **64** shown in a statically balanced situation. A reference line C is provided at the oil/water interface in the oil leg **64.** The height of the water column above this referenced line C is a dimension A which is less than the height of the oil column B above the same reference line C. This difference is a result of the fact that the density of oil is less than the density of water and thus the longer column of oil B produces the same pressure at reference line C as the shorter column of water A. The linear difference between A and B is a short column of oil which extends above the water level in the water manometer leg **62.** This difference can be considered as a pressure measured in inches of oil for the manometer system at the local value of the earth's gravitation.

In order for the analogy to hold true to the centrifugal separator, the manometer **60** must be rotated about the centerline which corresponds to the centrifuge centerline. By rotating either system an artificial gravity is produced whose mangitude is dependent on angular velocity and radial distance and can reach several thousand g's. Accordingly, the pressure produced by the short cylinder of oil having a height B–A is increased by this angular rotation. Since the manometer, however, is a static system it cannot be used to completely explain the operation of the centrifugal separator. It does illustrate, however, that a column of oil will stand above a column of water in either a static or rotating system.

Referring to the centrifugal separator, the radius D is the parameter which must be controlled to prevent it from increasing to the point where oil would spill over the weir and contaminate the clean water. In the manometer situation, if the oil height B were allowed to increase toward the centerline, A would also increase and both oil and water would begin spilling over the edges shown, thus destroying the existence of the static manometer. In all cases, however, the oil leg would still be longer than the water leg.

In the centrifugal separator, the fluids continuously flow through the system. If the oil discharge would suddenly be blocked, an accumulation of oil would occur thus increasing the radius D. This would increase the pressure at the blockage to a maximum until the oil would spill over the weir. It is this pressure change which is sensed by the side of the diaphragm control valve **54** tending to open the valve. The radius D can thus be effectively controlled by intermittently opening and closing the valve **54.** Below a given radius D, the valve **54** will remain closed because the pressure at inlet **44** is greater than the oil pressure at **38.** As the radius D increases due to oil accumulation, the oil pressure at **38** will become greater than the inlet pressure at **44** and valve **54** will open until sufficient oil has been removed to decrease radius D back to its minimum controlled value. If the emulsion entering the centrifugal separator is substantially clean water, very little oil will accumulate in the center of the perforate inner drum and the valve **54** will remain closed for extended periods of time. Once, however, an oil cylinder of sufficient radius has accumulated in the perforate inner drum, the valve **54** will open to reduce the oil radius back to the preselected value. Since the entire center of the separator is filled with oil, the capacitance of the system is quite large and its response rate small compared to that of the control valve. This oil reservoir capacity will damp fluctuations in the inlet emulsion concentration thus eliminating the need for a high response control valve.

The inlet impeller including vanes **36** and the outlet turbine with vanes **42** together with septa **30** and **24** act as energy transfer and/or conversion surfaces to balance the pressures in the unit. Thus a balanced pressure condition is established in the unit and the pressure drop through the unit is minimized. When an incremental fluid volume moves through the separator, it must change its radial position in a rotating environment. To do so, it must have its rotational kinetic energy level appropriately adjusted and the vanes and septa provide the necessary energy transfer points to establish this adjustment and enable the utilization of the diaphragm control valve.

While the centrifugal separator of FIGS. **1** and **2** is rotatably supported in a hub type arrangement and both the ligher fluid (oil) outlet and heavier fluid (water) outlet discharge from the same end, alternate arrangements are possible. In addition, the internal configuration of the centrifugal separator including the inlet impeller, outlet turbine, inner drum, radial septa, and weirs can likewise be varied considerably while maintaining a balanced pressure condition and minimum pressure drop through the separator.

FIGS. **4** and **5** illustrate an alternate embodiment of the centrifugal separator **70** which includes an imperforate cylindrical outer drum **72** closed at both ends by end closures **74** and **76** respectively. A central hollow shaft **78** extends the entire length of the outer drum **72** and also extends outward through the end closures **74** and **76** to be rotatably supported by bearings **80** and **82.** Conventional driving means such as the belt **84** may be employed to drive the shaft **78.**

Situated in the inlet end of the outer drum **72** is a circular plate **86** having a plurality of radial blades or vanes **88** extending to the end closure **74** to form an inlet impeller. An opening **90** is provided between the plate **86** and the interior of the outer drum **72.** Likewise a circular plate **92** having blades or vanes **94** extending to the end closure **76** is positioned at the opposite end of the outer drum **72** to form an outlet turbine which also includes an opening **96** between the plate **92** and the interior of the outer drum **72.** An inner drum **98** intermediate the hollow shaft **78** and outer drum **72** extends between the plates **86** and **92.** Additional circular plates or weirs **100** and **102** may be situated within the centrifugal separator intermediate the plates **86** and **92** to essentially divide the separator into several stages. These intermediate weirs **100** and **102** do not extend all the way to the outer drum **72** nor all the way to the hollow shaft **78.** The intermediate weir **102** furthest from the inlet end of the separator **70** may extend closer to the hollow shaft **78** than the intermediate weir **100** which is closest to the inlet end.

The inner or intermediate drum **98** is essentially imperforate except for a plurality of openings or slots **104** on either side of the intermediate weirs **100** and **102** and also near the plate **92.** A plurality of septa **106, 108** and **110** radially extend between the inner drum **98** and outer drum **72.** A plurality of corresponding septa **107, 109** and **111** extend radially inward from the inner drum **98** to the end of the interdmediate weirs **100** and

102 or alternately to the hollow shaft 78. Radial septa 106 and 107 axially extend between plate 86 and weir 100, radial septa 108 and 109 axially extend between weirs 100 and 102 while radial septa 110 and 111 axially extend between weir 102 and plate 92.

The hollow shaft 78 is provided with a plurality of openings or slots 112 between the end closure 74 and plate 86 and a similar plurality of openings 114 between plate 92 and end closure 76. A solid cylindrical plug 116 is provided in the hollow shaft 78 at the plate 92. Additional openings 118 are provided in the hollow shaft 78 at the inlet side of this plug 116. A lighter fluid discharge tube 120 concentrically extends into the inlet end of the hollow shaft 78 to beyond the plate 86. A stationary diaphragm control valve 122 is connected to the lighter fluid discharge tube 120 through a bearing and seal housing 124.

In operation, the centrifugal separator 70 receives the oil-water mixture or emulsion through the inlet end of the hollow shaft 78. The emulsion proceeds to the annular space between the plate 86 and end closure 74 through the openings 112 where it is forcibly directed outward by the vanes 88 around the plate 86 through the opening 90. The oil and water proceeds through the separator in the annular opening between the outer drum 72 and inner drum 98 to the weir 100. The water which is heavier, tends to proceed through the openings between the weir 100 and outer drum 72, while the lighter oil tends to proceed through openings 104 in the inner drum 98. This separation process is repeated at the weir 102 and plate 96 such that an oil-water interface is established between the hollow shaft 78 and inner drum 98. The separated or pure oil is discharged through opening 118 into the interior of the hollow shaft 78 to be discharged through the outlet tube 120. The oil-free water proceeds through the opening 96 to be discharged through opening 114 into the outlet end of the hollow shaft 78.

One side of the diaphragm in the valve 122 is subjected to the pressure in the lighter fluid outlet 120, while the other side is subjected to the emulsion inlet pressure in the hollow shaft 78. Operation of the valve is essentially identical to that previously described with respect to the embodiment of FIGS. 1 and 2.

As described above, the discharge control system effectively and efficiently controls the discharge of the fluids separated in a continuously operated centrifuge. The operating level of the oil in the centrifuge is maintained at an acceptable value compatible with efficient separation. This oil level, in the form of pressure, operates the control valve to discharge the separated oil. As long as a pressure balanced condition is maintained in the separator and the pressure drop through the separator is minimized, the discharge control system can effectively handle widely varying inlet flow rates and inlet fluid properties.

If for any reason the centrifugal separator is not or cannot be pressure balanced and/or a high inlet pressure is required to overcome an excessive pressure drop through the separator, the stationary diaphragm control valve 122 can be biased as illustrated in FIG. 6. The top flange 130 of the valve stem 132 is affixed to the top side of the diaphragm 134. A biasing member such as coil spring 136 may be positioned around the stem 132 between the top of the valve body 138 and the underside of the diaphragm 134.

The spring 136 will bias the valve towards its open position and thus assist the lighter density fluid outlet pressure in overcoming the inlet emulsion pressure to permit the discharge of the lighter density fluid from the separator.

While specific embodiments of the invention have been illustrated and described, it is to be understood that these embodiments are to be provided by way of example only and the invention is not to be construed as being limited thereto but only by the proper scope of the following claims.

What we claim is:

1. A discharge control system for a centrifugal separator adapted to separate a lighter density fluid from an inlet fluid mixture and including a discharge for the lighter density fluid therefrom, comprising:
   - means to sense the discharge pressure of the centrifugally separated lighter density fluid;
   - means to sense the centrifugal separator inlet fluid mixture pressure; and
   - valve means operably disposed in the lighter density fluid discharge, said valve means being responsive to said discharge pressure sensing means and said inlet fluid mixture pressure sensing means to control the discharge of lighter density fluid from said centrifugal separator.

2. In a centrifugal separator having an inlet to receive a mixture of two immiscible fluids of differing densities, a first outlet for the discharge of the separated heavier density fluid, and a second outlet for the discharge of the separated lighter density fluid, a discharge control system comprising:
   - means to balance the fluid pressures in the centrifugal separator;
   - first fluid pressure sensing means disposed in the second outlet;
   - second fluid pressure sensing means disposed in the centrifugal separator inlet; and
   - valve means operably disposed in the second outlet and responsive to said first and second fluid pressure sensing means to control the discharge of the separated lighter density fluid.

3. The discharge control system of claim 2 wherein said pressure balancing means comprise energy transfer means disposed in the centrifugal separator.

4. The discharge control system of claim 3 wherein said energy transfer means include inlet impeller means.

5. The discharge control system of claim 4 wherein said energy transfer means additionally include outlet turbine means.

6. The discharge control system of claim 5 wherein said energy transfer means additionally include radially extending septa means.

7. The discharge control system of claim 3 wherein said energy transfer means include outlet turbine means.

8. The discharge control system of claim 7 wherein said energy transfer means additionally include radially extending septa means.

9. The discharge control system of claim 3 wherein said energy transfer means include radially extending septa means.

10. The discharge control system of claim 9 wherein said energy transfer means additionally include inlet impeller means.

11. A centrifugal separator comprising:

an imperforate cylindrical outer drum;
means to rotatably support said imperforate cylindrical outer drum;
inlet impeller means disposed within said imperforate cylindrical outer drum at one end thereof;
outlet turbine means disposed within said imperforate cylindrical outer drum at the other end thereof;
a perforate cylindrical inner drum disposed within said imperforate cylindrical outer drum between said inlet impeller means and said outlet turbine means;
a plurality of septa radially extending inwardly from said imperforate cylindrical outer drum and said perforate cylindrical inner drum;
said imperforate cylindrical outer drum including inlet means to deliver a mixture or emulsion of two immiscible fluids of differing densities to said inlet impeller means, first outlet means to receive separated heavier density fluid from said outlet turbine, and second outlet means to receive separated lighter density fluid from said imperforate cylindrical outer drum;
first fluid pressure sensing means disposed in said second outlet means;
second fluid pressure sensing means disposed in said inlet means; and
valve means operably disposed in said second outlet means and responsive to said first and second fluid pressure sensing means to control the discharge of the separated lighter density fluid through said second outlet means to maintain a central column of separated lighter density fluid within prescribed radial limits in the perforate cylindrical inner drum.

12. The centrifugal separator of claim **11** wherein said second outlet means is concentrically disposed within said first outlet means.

13. The centrifugal separator of claim **11** wherein said second outlet means is concentrically disposed within said inlet means.

14. A discharge control system for a centrifugal separator adapted to separate a lighter density fluid from an inlet fluid mixture and including a discharge for the lighter density fluid therefrom, comprising:
means to sense the pressure of an accumulated central column of separated lighter density fluid;
means to sense the centrifugal separator inlet fluid mixture pressure; and
valve means operably disposed in the lighter density fluid discharge, said valve means being responsive to said lighter density fluid column pressure sensing means and said inlet fluid mixture pressure sensing means to control the discharge of lighter density fluid from said centrifugal separator and thereby controlling the breadth of the lighter density fluid column.

15. A centrifugal separator comprising:
an imperforate cylindrical outer drum;
means to rotatably support said imperforate cylindrical outer drum;
a perforate cylindrical inner drum disposed within said imperforate cylindrical outer drum to rotate therewith;
said imperforate cylindrical outer drum including inlet means to deliver a mixture or emulsion of two immiscible fluids of differing densities to said separator, first outlet means to receive separated heavier density fluid from said separator, and second outlet means to receive separated lighter density fluid from said separator;
means operably associated with said imperforate outer drum and said perforate inner drum to balance the fluid pressures in the centrifugal separator;
first fluid pressure sensing means disposed in said second outlet means;
second fluid pressure sensing means disposed in said inlet means; and
valve means operably disposed in said second outlet means and responsive to said first and second fluid pressure sensing means to control the discharge of the separated lighter density fluid through said second outlet means to maintain a central column of separated lighter density fluid within prescribed radial limits in the perforate cylindrical inner drum.

16. The centrifugal separator of claim **15** wherein said pressure balancing means comprise energy transfer means disposed in the centrifugal separator.

17. The centrifugal separator of claim **16** wherein said energy transfer means include inlet impeller means disposed between one end of the inner drum and the corresponding end of the outer drum.

18. The centrifugal separator of claim **17** wherein said energy transfer means additionally include outlet turbine means disposed between the other end of the inner drum and the corresponding end of the outer drum.

19. The centrifugal separator of claim **18** wherein said energy transfer means additionally incude septa means extending radially between the outer drum and the inner drum and extending radially inward from the inner drum.

20. The centrifugal separator of claim **16** wherein said energy transfer means include outlet turbine means disposed between one end of the inner drum and the corresponding end of the outer drum.

21. The centrifugal separator of claim **20** wherein said energy transfer means additionally include septa means extending radially between the outer drum and the inner drum and extending radially inward from the inner drum.

22. The centrifugal separator of claim **16** wherein said energy transfer means include septa means extending radially between the outer drum and the inner drum and extending radially inward from the inner drum.

23. The centrifugal separator of claim **22** wherein said energy transfer means additionally include inlet impeller means disposed between one end of the inner drum and the corresponding end of the outer drum.

24. A method of controlling the discharge from a centrifugal separator adapted to separate and discharge a lighter density fluid from an inlet fluid mixture, comprising:
sensing the fluid pressure in the lighter density fluid outlet of the separator;
sensing the fluid pressure in the inlet of the separator; and
opening a valve in the lighter density fluid outlet when the fluid pressure sensed in the lighter density fluid outlet exceeds a preselected value above the fluid pressure sensed in the separator inlet.

25. A method of controlling the discharge from a centrifugal separator adapted to separate and discharge

a lighter density fluid from an inlet fluid mixture, comprising:

sensing the fluid pressure in the lighter density fluid outlet of the separator;

sensing the fluid pressure in the inlet of the separator; and

comparing the lighter fluid outlet pressure with the inlet fluid pressure to discharge lighter density fluid from the separator when the fluid pressure sensed in the lighter density fluid outlet exceeds a preselected value above the fluid pressure sensed in the separator inlet.

26. A method of controlling the discharge from a centrifugal separator adapted to separate and discharge a lighter density fluid from an inlet fluid mixture, comprising:

sensing the fluid pressure of an accumulated central column of separated lighter density fluid;

sensing the fluid pressure in the inlet of the separator; and

discharging the accumulated lighter density fluid when the fluid pressure from the central column of lighter density fluid exceeds a preselected value above the fluid pressure sensed in the separator inlet to control the breadth of the lighter density fluid column.

27. A discharge control system for a centrifugal separator adapted to separate and discharge a lighter density fluid from an inlet fluid mixture, comprising:

means to sense the discharge pressure of the centrifugally separated lighter density fluid;

means to sense the centrifugal separator inlet fluid pressure; and

valve means operably disposed in the lighter density fluid discharge to discharge separated lighter density fluid from said separator when the sensed discharge pressure of the ligher fluid exceeds a preselected value above the sensed inlet fluid pressure.

28. A discharge control system for a centrifugal separator adapted to separate and discharge a lighter density fluid from an inlet fluid mixture, comprising:

means to sense the discharge pressure of the centrifugally separated lighter density fluid;

means to sense the centrifugal separator inlet fluid pressure; and

valve means operably disposed in the lighter density fluid discharge to discharge separated lighter density fluid from the separator when the sensed discharge pressure of the lighter density fluid exceeds a preselected value above the sensed inlet fluid pressure;

the valve means including a diaphragm controlled valve, the sensed discharge pressure on one side of the diaphragm tending to open the valve and the sensed inlet fluid pressure on the opposite side of the diaphragm tending to close the valve.

29. The discharge control system of claim **28** wherein said valve means includes means to bias the diaphragm controlled valve towards the open position.

30. The discharge control system of claim **29** wherein said biasing means comprises a coil spring.

31. A method of controlling the discharge from a centrifugal separator adapted to separate and discharge a lighter density fluid from an inlet fluid mixture, comprising:

balancing the fluid pressures in said centrifugal separator;

sensing the fluid pressure in the lighter density fluid outlet of the separator;

sensing the fluid pressure in the inlet of the separator; and

opening a valve in the lighter density fluid outlet when the fluid pressure sensed in the lighter density fluid outlet exceeds a preselected value above the fluid pressure sensed in the separator inlet.

32. A method of controlling the discharge from a centrifugal separator adapted to separate and discharge a lighter density fluid from an inlet fluid mixture, comprising:

balancing the fluid pressures in said centrifugal separator;

sensing the fluid pressure in the lighter density fluid outlet of the separator;

sensing the fluid pressure in the inlet of the separator; and

comparing the lighter fluid outlet pressure with the inlet fluid pressure to discharge lighter density fluid from the separator when the fluid pressure sensed in the lighter density fluid outlet exceeds a preselected value above the fluid pressure sensed in the separator inlet.

33. A method of controlling the discharge from a centrifugal separator adapted to separate and discharge a lighter density fluid from an inlet fluid mixture, comprising:

balancing the fluid pressures in said centrifugal separator;

sensing the fluid pressure of an accumulated central column of separated lighter density fluid;

sensing the fluid pressure in the inlet of the separator; and

discharging the accumulated lighter density fluid when the fluid pressure from the central column of lighter density fluid exceeds a preselected value above the fluid pressure sensed in the separator inlet to control the breadth of the lighter density fluid column.

34. A discharge control system for a centrifugal separator adapted to separate and discharge a lighter density fluid from an inlet fluid mixture, comprising:

means to sense the discharge pressure of the centrifugally separated lighter density fluid;

means to sense the centrifugal separator inlet fluid pressure; and

valve means operably disposed in the lighter density fluid discharge, said valve means being responsive to said discharge pressure sensing means and said inlet fluid pressure sensing means to control the discharge of lighter density fluid from said centrifugal separator, said valve means including a diaphragm controlled valve, the sensed discharge pressure on one said of the diaphragm tending to open the valve and the sensed inlet fluid pressure on the opposite side of the diaphragm tending to close the valve.

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