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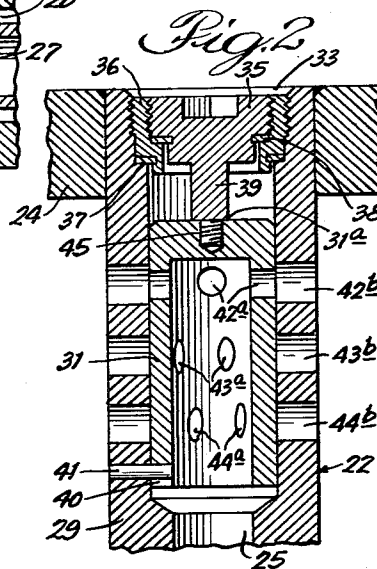
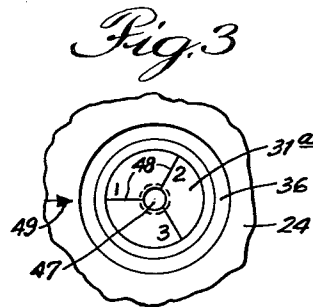
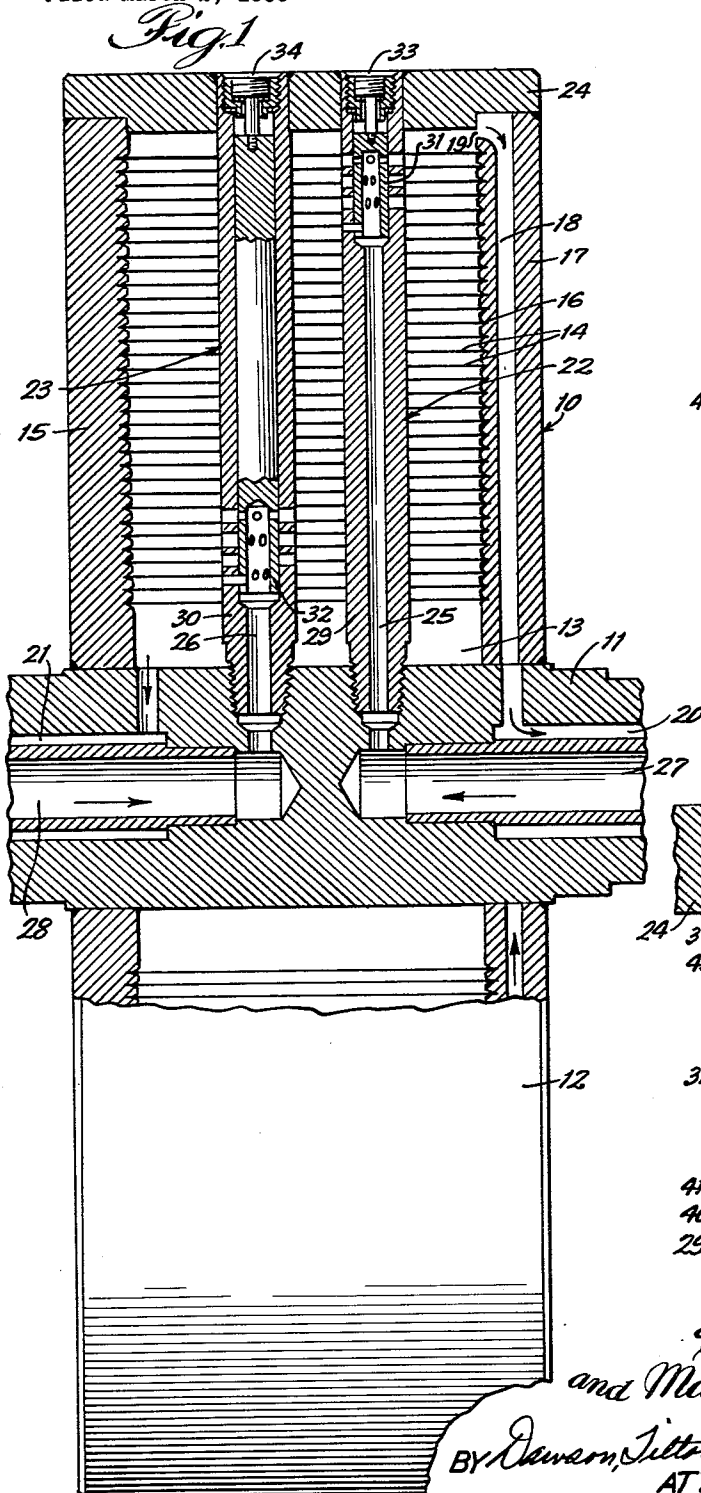
C. M. DOYLE ET AL

3,050,238

LIQUID FEED ARRANGEMENT FOR CENTRIFUGAL DEVICES

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2 Sheets-Sheet 1



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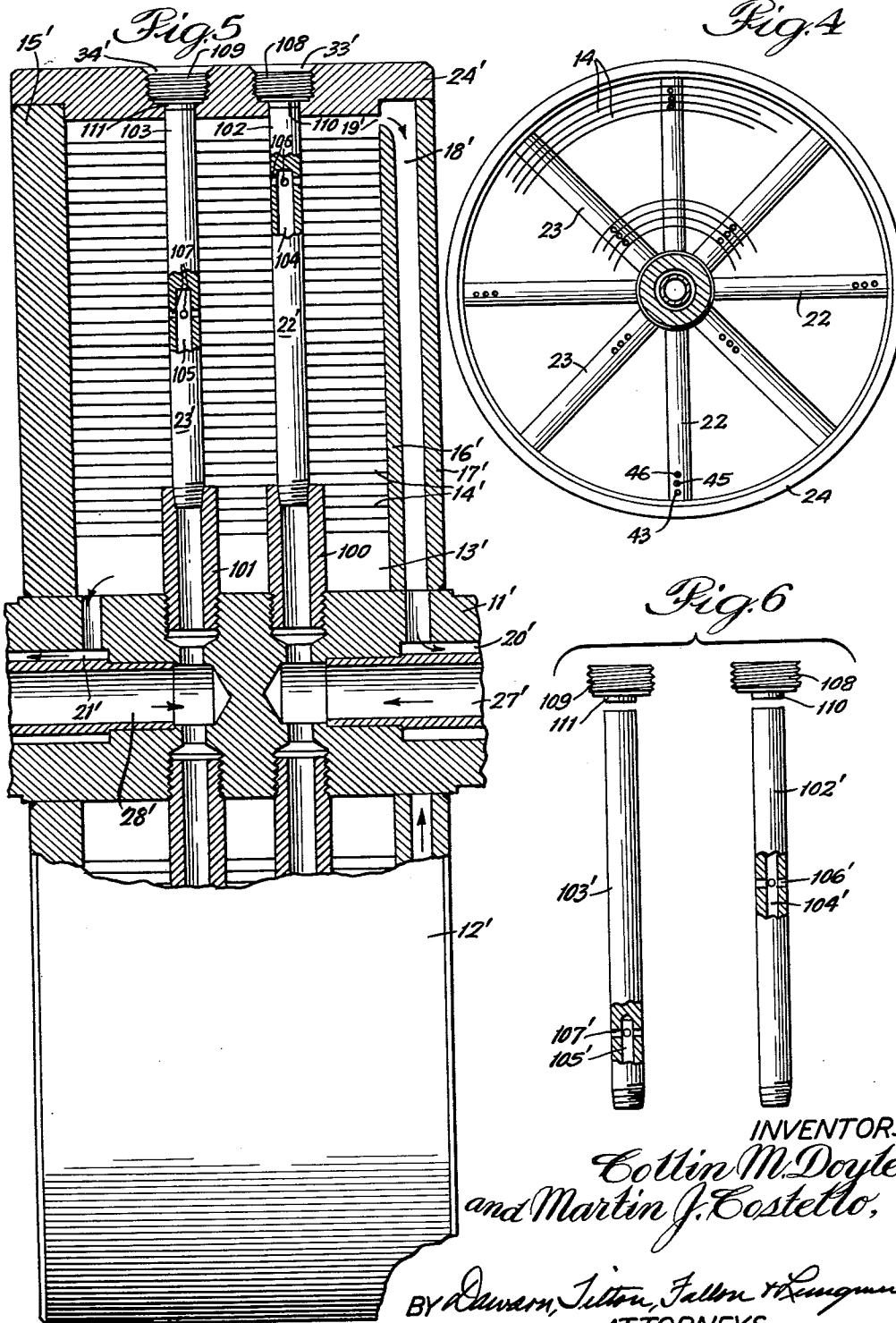
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LIQUID FEED ARRANGEMENT FOR CENTRIFUGAL DEVICES

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This invention relates to an improved liquid feed arrangement for centrifugal devices of the kind described in United States Patent Nos. 2,758,783 and 2,758,784. Such centrifugal devices can be employed for contacting and/or separating liquid phases of different densities.

The principal object of the present invention is to provide an improved liquid feed arrangement for centrifugal liquid-liquid contacting and separating devices which will permit greater flexibility in the operation of the device at varying rotational speeds, liquid flow volumes, and phase ratios. A more specific object is to provide means in a device of the character described for selectively adjusting the radial position of the inlets. Another object is to provide means for selectively varying the radial spacing between the light phase inlets and the heavy phase inlets. Still another object is to provide inlet means of novel construction which can be employed for introducing light and heavy phases into a centrifugal contacting device, the inlet means being accessible from outside the rotor of the device so that the inlet means can be adjusted and serviced without disassembling the rotor. Further objects and advantages will appear as the specification proceeds.

This invention as shown in illustrative embodiments in the accompanying drawings, in which—

FIGURE 1 is a front elevational view of a centrifugal contacting device embodying the present invention, the axial shaft and part of the rotor being shown in section to more clearly illustrate the novel inlet arrangement;

FIGURE 2, an enlarged fragmentary sectional view of one of the inlet tubes of FIGURE 1, the section being the same as that in FIGURE 1;

FIGURE 3 a detailed top view of the inlet tube of FIGURE 2 with the plug member removed to show the top of the adjustable sleeve therein;

FIGURE 4, an end view of the rotor of FIGURE 1 with the end plate removed to show the position of the inlet tubes, some of the concentric rings being broken away and some completely omitted to more clearly illustrate the tubes;

FIGURE 5, a view similar to FIGURE 1 showing a modified construction of the inlet and outlet tubes; and

FIGURE 6, a detail view of inlet and outlet tube components which can be used in the device of FIGURE 5 to vary the radial position of the heavy and light phase inlets.

FIGURE 1 illustrates the general construction of centrifugal devices wherein the present invention can be advantageously employed. The device includes a rotor designated generally by the number 10. This rotor is made up of a central shaft 11 and a hollow casing 12 which is mounted on shaft 11 and provides a radially-extending rotor chamber 13 therein. The device also includes a plurality of spaced-apart partition walls 14 within rotor chamber 13 and surrounding shaft 11. For certain purposes, the partition walls can be radially spaced, such as when the walls are in the form of a continuous spiral, or when concentric rings are employed to provide the walls. For other purposes the walls can be arranged to lie in planes which intersect the shaft axis. In the illustration given, as shown more clearly in FIGURE 4, the partition walls 14 comprise radially-spaced concentric

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rings or cylinders. It will be understood that the partition walls are constructed so as to permit respectively the outward and inward movement of the heavy and light phases. When concentric rings are used, the rings may be provided with openings therethrough. These openings may vary in construction and arrangement. For example, the openings may be in the form of all-around perforations of small diameter as described in prior Patent 2,758,784, or in the form of sectional perforations, also of small diameter, as described in prior Patent 2,758,783. A lesser number of relatively large openings may be used instead of the multiplicity of small perforations. The device of FIGURE 1 as indicated therein also includes means for removing the heavier phase from the outermost portion of rotor chamber 11 and means for removing the lighter phase from the innermost portion of the rotor chamber. In the illustration given, concentric rings 14 are supported between end plate 15 and a spill-over disk 16, which is spaced inwardly from end plate 17 to provide a heavy phase outflow passage 18 which communicates with the outermost portion of chamber 13 through a circumferentially-extending slot 19. Shaft 11 provides a heavy phase outflow passage 20 which communicates with the inner end of the outflow space 18 as shown in FIGURE 1. Shaft 11 also provides a light phase outflow passage 21 which communicates with the innermost portion of chamber 13 in the manner indicated in FIGURE 1. The construction of the liquid outlets can be varied. For example, the heavy phase can be removed through tubular outlets and the spill-over disk eliminated.

It will be understood that the constructional details of the rotor shaft, the rotor casing, the partition walls, as well as that of other elements described above, can be varied considerably while still permitting the improved liquid feed arrangement of the present invention to be advantageously employed. It is contemplated that liquid feed arrangements embodying the novel principles of the present invention will have wide utility in centrifugal devices for contacting and/or separating liquid phases of different densities. For purpose of illustration, the liquid feed arrangement of this invention is shown in two specific embodiments, one embodiment being illustrated by FIGURES 1 to 4 and the other by FIGURES 5 to 6.

In accordance with the present invention as illustrated by the embodiments of the drawings, there is provided a plurality of tubes extending between the rotor shaft and outer wall portions of the rotor casing. When the partition walls are radially-spaced, the tubes can extend through the walls. These tubes internally provide liquid flow passages extending outwardly to radially-spaced distances from the shaft. In conjunction therewith, the shaft provides passages for supplying the liquids to the tubes. Where the device is to be used as an extractor, some of the tubes will be light phase inlet tubes and will have the passages therein communicating with the light phase supplying shaft passage. Others of the tubes will be heavy phase inlet tubes and will have the passages therein communicating with the heavy phase supplying shaft passage. Both the light phase and heavy phase inlet tubes will provide outlet ports positioned outwardly of the shaft, the ports providing communication between the passages therein and the spaces between certain of the partition walls. The outlet ports in the light phase inlet tubes will be spaced outwardly further than the outlet ports in the heavy phase inlet tubes, but will be spaced inwardly from the outermost portion of the rotor chamber. Similarly, the outlet ports in the heavy phase inlet tubes will be spaced radially inwardly of the light phase inlet ports, but will be spaced outwardly of the innermost portion of the rotor chamber. In accordance with the present invention, means will be

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provided for varying the radial position of the light phase inlet ports, or the position of the heavy phase inlet ports, or the position of both types of ports, thereby permitting the depths of the heavy and light phase clarification zones to be varied as well as the radial extent of the zone of counter-current flow between the ports.

Looking first at the embodiment of FIGURES 1 to 4, there is shown a plurality of tubes 22 and 23 which extend along radial lines between shaft 11 and the outer wall 24 of casing 12. In the illustration given, as shown more clearly in FIGURE 4, there are four light phase inlet tubes 22 and four heavy phase inlet tubes 23. Since the rotor is designed to rotate at high speeds, it will be understood that the tubes should be arranged in a balanced, symmetrical manner, such as the arrangement indicated in FIGURE 4.

The tubes 22 and 23, as shown more clearly in FIGURE 1, respectively provide internal passages 25 and 26. Passages 25 of the light phase inlet tubes 22 communicate with the light phase inlet passage 27 of shaft 11, while the passages 26 of the heavy phase inlet tubes 23 communicate with the heavy phase supply passage 28 within the shaft.

In the illustration given, tubes 22 and 23 respectively include outer stationary sleeves 29 and 30, and inner-movable sleeves 31 and 32. As shown in FIGURE 1, the inner ends of stationary sleeves 29 and 30 are secured to shaft 11 by a threaded connection. The outer ends of the stationary sleeves extend through casing end wall 24, and are fixedly secured thereto by welding. The openings 33 and 34 in the casing end wall 24 (through which the stationary sleeves 29 and 30 respectively extend) provide access ports through which the movable sleeve members 31 and 32 can be adjustably positioned, as will now be described.

Looking first at FIGURE 2, which shows an enlarged view of the outer portion of the outlet tube 22 of FIGURE 1, it can be seen that the access port 33 is closed by a removable plug 35. In the illustration given, plug 35 is received within a bushing 36 and secured thereto by a threaded connection. Bushing 36 in turn is received within the upper end of stationary sleeve 29 and secured thereto by a threaded connection. Bushing 36 is sealed to sleeve 29 by a gasket 37, and plug 35 is sealed to bushing 36 by a gasket 38. Plug 35 provides a downward extension 39 which bears against the upper end of movable sleeve 31. The lower end of sleeve 31 is provided with slots 40 which cooperate with the inwardly projecting portion of pin 41 to lock the sleeve in position while the upper end thereof is engaged by plug extension 39. In the illustration given, there are three slots 40 within which pin 41 can be selectively received to establish three different rotational positions of the sleeve 31 about its vertical axis. It will be understood that the slots 40 are circumferentially spaced around the lower end of sleeve 31. Movable sleeve 31 provides a plurality of apertures at different radial distances from the shaft 11. Stationary sleeve 29 also provides a plurality of apertures at varying radial distances from the shaft 11, the apertures of the movable sleeve being selectively alignable with the apertures of the stationary sleeve. In the illustration given, as shown in FIGURE 2, the apertures 42a of movable sleeve 31 are aligned with the apertures 42b of stationary sleeve 29. The sleeve 31 provides other apertures 43a which are alignable with apertures 43b of sleeve 29, and still other apertures 44a which are alignable with apertures 44b of sleeve 29. The upper end 31a of sleeve 31 provides an internally threaded opening 45.

In the operation of the device, the light fluid is supplied through shaft passage 25 in the tubes 22. The liquid is discharged through the apertures of sleeve 31 which are in alignment with apertures in sleeve 29, thereby providing outlet ports for the introduction of the liquid between certain of the cylindrical partition walls 14.

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For example, as illustrated in FIGURES 1 and 2, the light phase would be discharged through the ports formed by the interconnection of apertures 42a and 42b thereby being introduced between the two outermost partition walls 14.

When it is desired to vary the radial position of the light phase inlet ports, this can readily be done in the following manner. The plug is unscrewed and removed, thereby exposing the upper end 31a of the movable sleeve. FIGURE 3 is a view looking into the outer end of one of the tubes 22 with the plug 35 removed. It will be seen that the outer end 31a of the movable sleeve is provided with indicator lines 48 numbered 1, 2 and 3. Casing wall 24 is provided with an indicator arrow 49. As shown in FIGURE 3, indicator line 1 is opposite the indicator arrow. This establishes the position of sleeve 31 wherein the apertures 42a are aligned with the apertures 42b, as shown in FIGURES 1 and 2. By inserting a threaded tool, such as a bolt, in recess 47 in the sleeve end 31a, the sleeve can be drawn outwardly far enough to release pin 41 from engagement with slot 40. The sleeve can then be rotated until one of the other indicator lines is opposite the indicator arrow. Since there is a slot 40 directly below and aligned with each of the indicator lines, sleeve 31 can then be moved downwardly to reseat the pin 41 within a different one of the slots 40. For example, if the indicator line 2 was brought opposite the indicator arrow, and sleeve 31 moved inwardly to the same position shown in FIGURE 2, this would bring the apertures 43a into alignment with the apertures 43b while disaligning the apertures 42a from the apertures 42b. The result of this would be that the inlet for the light phase would be moved closer to the shaft 11 and also closer to the inlets for the heavy phase. It will be understood that the plug 35 would be replaced before the operation of the device is resumed.

As shown in FIGURE 1, the heavy phase inlet tubes 23 are constructed similarly to the light phase inlet tubes 22. The only differences are that the stationary sleeve 30 has its apertures provided much closer to the shaft 11, and that the movable sleeve 32 is considerably longer than the movable sleeve 31. Since the construction and operation of the parts is otherwise the same, it is not believed that it will be necessary to repeat the discussion which has been given with respect to tubes 22 for the similarly constructed tubes 23. It will be understood, however, that with the arrangement described, the radial position of both the light phase inlet ports and the heavy phase inlet ports can be selectively varied.

FIGURE 5 illustrates another liquid feed arrangement somewhat similar to the liquid feed arrangement described above and which also comes within the scope of the present invention. The contactor elements in the device of FIGURE 5 which correspond with those of FIGURE 1 have been given the same numbers except that the numbers have been primed to indicate that the figure illustrates a modification. In the embodiment of FIGURE 5, the light phase inlet tubes 22' and the heavy phase inlet tubes 23' are formed respectively from fixed tube portions 100 and 101 and removable tube portions 102 and 103. Fixed tube portions 100 and 101 have threaded inner end portions which extend into shaft 11' and are arranged respectively to interconnect with the shaft passages 27' and 28'. If desired, tube portions 100 and 101 can be connected to the shaft by welding. The removable tube portions 22' and 23' have externally threaded inner ends which are received within the internally threaded outer ends respectively of tube portions 100 and 101. The tube portions 102 and 103 respectively provide internal passages 104 and 105 which are in communication with the fixed tube portions with which they connect. Near the outer ends of the passages 104 and 105, ports are provided for the discharge of the phases into the rotor chamber 13' between the cylindrical parti-

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tion walls 14'. In the illustration given, tube portions 102 provide a plurality of circumferentially spaced inlet ports 106, while the corresponding inlet ports of tube portions 103 are indicated by the number 107. Removable tube portions 102 and 103 are respectively held in place by threaded plugs 108 and 109 which are received within access ports 33' and 34'. In the illustration given, the plugs 108 are provided with an inward extension 110 of reduced diameter which bears against the outer end of tube portion 102, and the plugs 109 similarly provide reduced extensions 111 which bear against the outer ends of tube portions 103.

When it is desired to vary the radial position of the light or heavy phase inlet ports in the device of FIGURE 5, it is only necessary to unscrew the plugs 108 or 109, remove the tube members 102 or 103, and then replace the tube members with others which are identical except for the location of the outlet ports. For example, the tube members 102' and 103', as shown in FIGURE 6, can be substituted for the corresponding tube members 102 and 103 of FIGURE 5. It will be observed that the outlet ports 106' and 107' respectively of tube members 102' and 103' are substantially closer to the inner ends of the tube portions. Consequently, when these tube members are substituted in the device of FIGURE 5, both the light phase and heavy phase will be released considerably closer to shaft 11'. FIGURE 6 also indicates the relationship of the plugs 108 and 109 with their respective extensions 110 and 111 to the outer ends of the tube members 102' and 103'.

It should now be apparent from the foregoing description that the liquid feed arrangement of the present invention provides a means for selectively varying the radial distance between the light and heavy phase inlets. This provides control over an important operating condition. The primary area of countercurrent flow within which the light and heavy phases are repeatedly mixed and separated to provide a plurality of stages is within the area of the cylindrical bands between the heavy phase inlets and the light phase inlets. The rotor chamber area inwardly of the heavy phase inlets is primarily a clarification zone for the light phase, while the rotor chamber area outwardly of the light phase inlets is primarily a clarification zone for the heavy phase. Thus, the inlet arrangement of the present invention provides means for controlling the size of the mixing zone and the size of the two clarification zones. It is therefore possible to achieve an optimal operating capacity in a given contactor at widely varying ratios of the light and heavy phases. Usually, the larger volume phase requires a relatively larger size clarification zone, but there are many other factors involved, some of which can only be determined under actual operating conditions with a particular solvent system. It is therefore an important advantage of the present invention that it permits fine adjustments in the radial positions and relative positions of the heavy and light phase inlets.

While in the foregoing specification this invention has been described in relation to two specific embodiments thereof, it will be apparent to those skilled in the art that the invention is susceptible to other embodiments than those described herein, and that many of the details set forth in the foregoing specification can be varied considerably without departing from the basic principles of this invention.

We claim:

1. In a centrifugal device for contacting liquid phases of different densities wherein there is included a rotor having a central shaft and a hollow casing having an outer cylindrical wall mounted on said shaft to provide a radially-extending rotor chamber therein, said device also including a plurality of radially-spaced partition walls within said rotor chamber and surrounding said shaft, said partition walls having openings for the passage of said phases therethrough, said device further including

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means for removing the heavier phase from the outermost portion of said rotor chamber and means for removing the lighter phase from the innermost portion of said rotor chamber, an improved liquid feed arrangement comprising a plurality of tubes extending between said rotor shaft and said outer wall of said rotor casing, said tubes passing through said partition walls and internally providing liquid flow passages extending outwardly through radially-spaced distances from said shaft, said shaft providing separate passages for supplying respectively the light and heavy phases, some of said tubes being light phase inlet tubes and having the passages therein communicating with the said light phase supplying shaft passage, others of said tubes being heavy phase inlet tubes and having the passages therein communicating with the said heavy phase supplying shaft passage, said tubes providing inlet ports positioned outwardly of said shaft and providing communication between the passages therein and the spaces between certain of said partition walls, the inlet ports in said light phase inlet tubes being spaced outwardly further than the inlet ports in said heavy phase inlet tubes but spaced inwardly from the said outermost portion of said rotor chamber, the inlet ports in said heavy phase inlet tubes being spaced inwardly of said light phase inlet ports but outwardly of said innermost portion of said rotor chamber, and means for varying the radial spacing between said light phase inlet ports and said heavy phase inlet ports, said last-mentioned means being accessible from outside said casing.

2. The device of claim 1 wherein said means for varying the radial spacing between said light phase inlet ports and said heavy phase inlet ports includes means for selectively varying the radial position of both said light phase inlet ports and said heavy phase inlet ports.

3. In a centrifugal device for contacting the liquid phases of different densities wherein there is included a rotor having a central shaft and a hollow casing having an outer cylindrical wall mounted on said shaft to provide a radially-extending rotor chamber therein, said device also including a plurality of radially-spaced concentric cylinders surrounding said shaft, said cylinders having perforations therein for the passage of said phases therethrough, said device further including means for removing the heavier phase from the outermost portion of said rotor chamber and means for removing the lighter phase from the innermost portion of said rotor chamber, an improved liquid feed arrangement comprising a plurality of tubes extending between said rotor shaft and said outer wall of said rotor casing, said tubes passing through said partition walls and internally providing liquid flow passages extending outwardly through radially spaced distances from said shaft, said shaft providing separate passages for supplying respectively the light and heavy phases, some of said tubes being light phase inlet tubes and having the passages therein communicating with the said light phase supplying shaft passage, others of said tubes being heavy phase inlet tubes and having the passages therein communicating with the said heavy phase supplying shaft passage, said tubes providing inlet ports positioned outwardly of said shaft and providing communication between the passages therein and the spaces between certain of said partition walls, the inlet ports in said light phase inlet tubes being spaced outwardly further than the inlet ports in said heavy phase inlet tubes but spaced inwardly from the said outermost portion of said rotor chamber, the inlet ports in said heavy phase inlet tubes being spaced inwardly of said light phase inlet ports but outwardly of said innermost portion of said rotor chamber, and means for selectively varying the radial position of the inlet ports in at least one of said kinds of inlet tubes, said last-mentioned means being accessible from outside said casing.

4. In a centrifugal device wherein there is included a rotor having a central shaft and a hollow casing having

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an outer cylindrical wall mounted on said shaft to provide a radially-extending rotor chamber therein, said device also including a plurality of spaced-apart partition walls within said rotor chamber, said device further including means for removing a heavier liquid phase from the outer portion of said rotor chamber and means for removing a lighter liquid phase from the inner portion of said rotor chamber, a liquid feed arrangement comprising a plurality of passage-providing means extending between said rotor shaft and said outer wall of said rotor casing, said passage-providing means providing liquid flow passages extending outwardly to radially-spaced distances from said shaft, some of said passages being for the introduction of said heavier phase and some of said passages for the introduction of said lighter phase, said shaft providing passage means for supplying said lighter and said heavier phases respectively to said outwardly extending

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flow passages, each of said passage-providing means having inlet port means associated therewith positioned outwardly of said shaft and providing communication between the passages therein and the interior of said rotor chamber, and means for varying the radial position of said inlet port means, said last-mentioned varying means being accessible from outside said casing for varying the said radial positions of said inlet port means.

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Disclaimer

3,050,238.—*Collin M. Doyle*, Chicago, and *Martin J. Costello*, Burnham, Ill.
LIQUID FEED ARRANGEMENT FOR CENTRIFUGAL DE-
VICES. Patent dated Aug. 21, 1962. Disclaimer filed Oct. 7, 1965,
by the assignee, *Dresser Industries, Inc.*

Hereby enters this disclaimer to all claims of said patent for the entire
term of said patent.

[*Official Gazette April 5, 1966*]