Sept. 7, 1937. F. M. TOMLINSON 2,092,484

CENTRIFUGAL SEPARATOR

Filed July 11, 1932 2 Sheets-Sheet 1

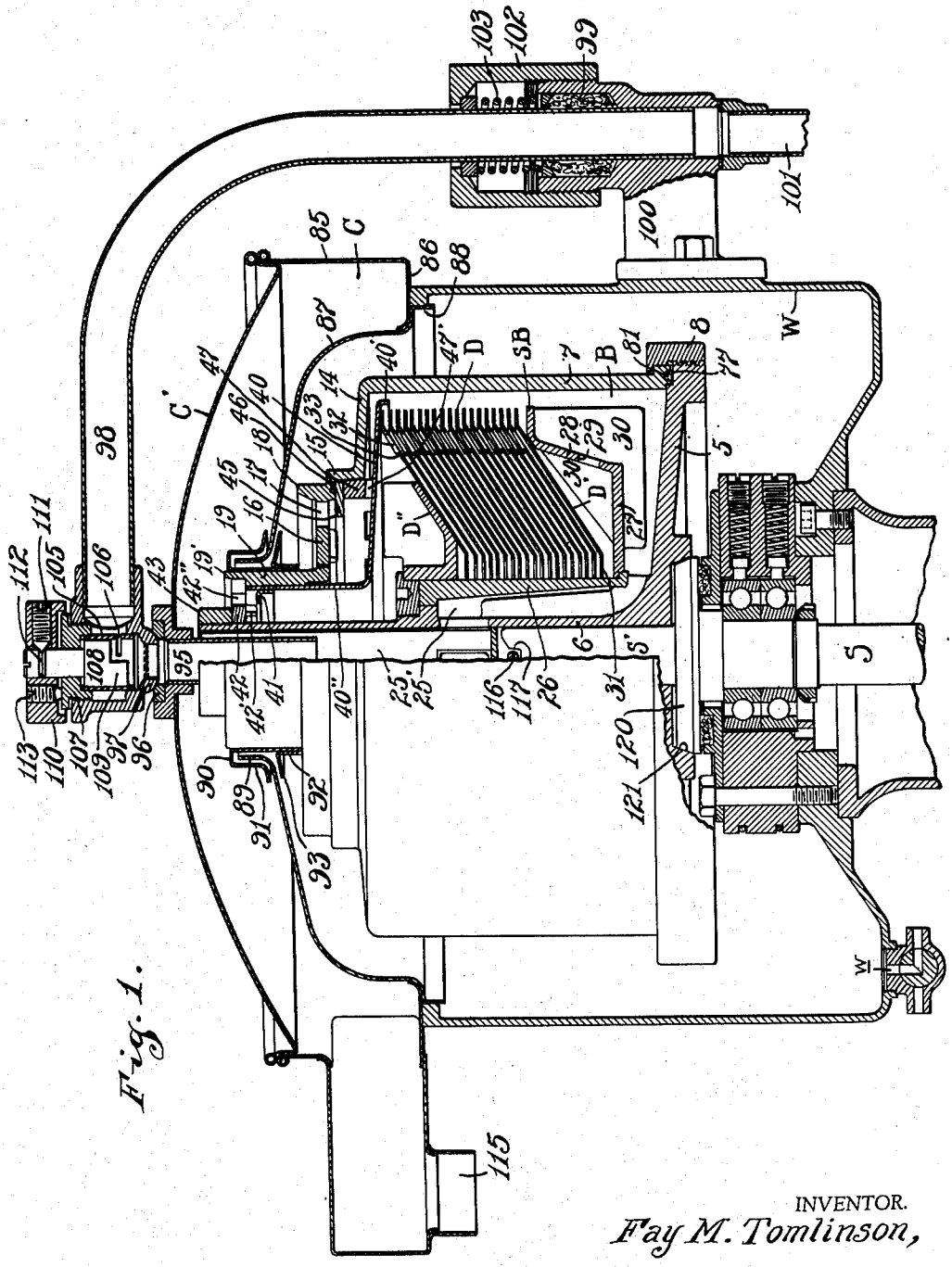

Fig. 1.

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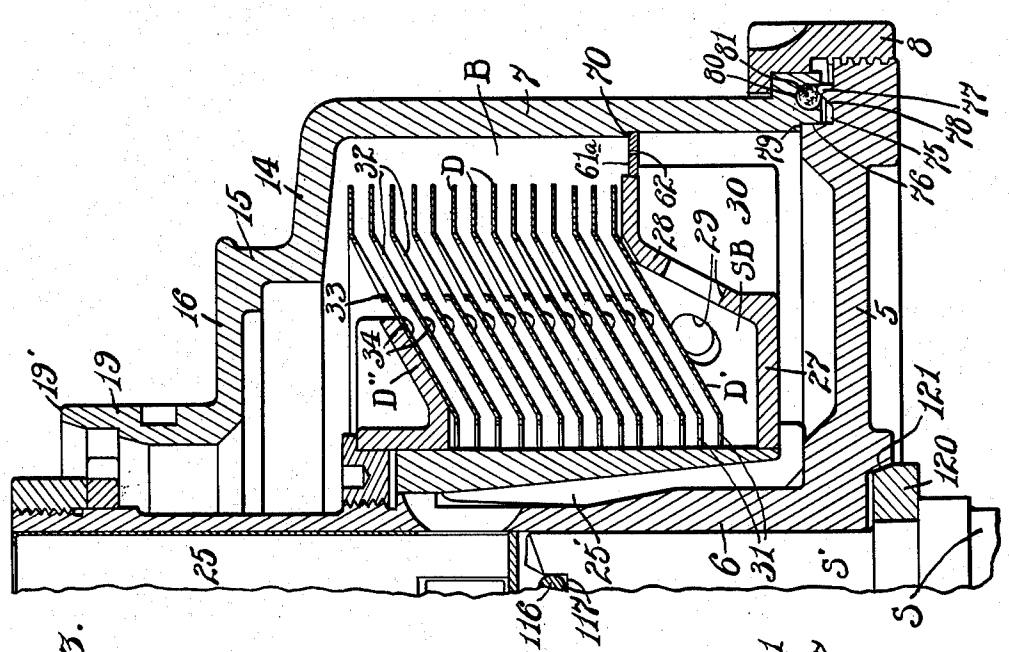

Fig. 3.

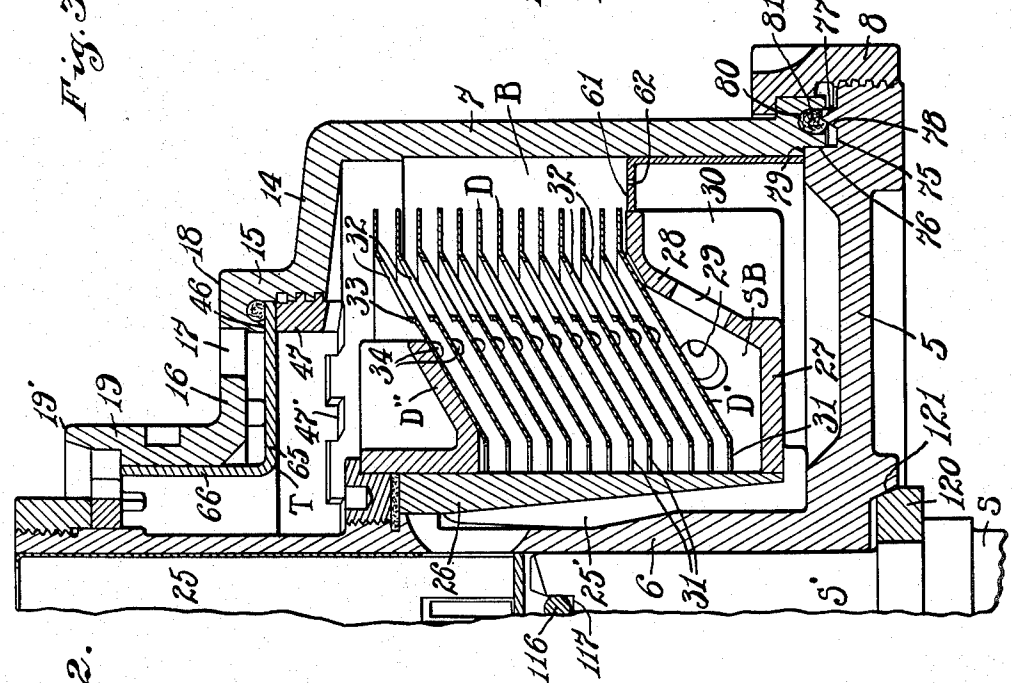

Fig. 2.

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CENTRIFUGAL SEPARATOR

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Application July 11, 1932, Serial No. 621,777

5 Claims. (Cl. 233—29)

My invention relates to certain improvements in details of construction of a centrifugal separator comprising a rotary bowl and a plurality of nested stratification disks so arranged that separating flow therebetween is only outwardly through higher pressure regions.

In order to adapt such an apparatus for acting upon a wide range of liquids and liquid mixtures, modifications, substitutions and rearrangements of parts are desirable and necessary and one object of my present invention is to provide readily changeable parts by means of which the structure may act efficiently to accurately separate different constituent mixtures of two liquids of different specific gravities, and at the same time to clarify said two liquids by retention of solids having specific gravities greater than those of the two constituent liquids.

A further object of my invention is to provide readily placeable means whereby the fundamental elements of the structure may be caused to efficiently function merely as a clarifier.

A further object of my invention is to provide improvements in details of construction of the receiving pans whereby convenience of manipulation is obtained.

The accompanying drawings illustrate my invention.

Fig. 1 is an elevation in half axial section of an embodiment of my invention when the parts are arranged for simultaneous clarification and two-liquid separation.

Fig. 2 is a similar view of a bowl and contained parts, where the parts are arranged for simple clarification; and

Fig. 3 a similar view of a bowl to be used merely as a clarifier.

The apparatus consists, primarily, of a rotary bowl B within which are nested a plurality of axially-separated stratification disks D, subtended by a guard disk D' and supertended by a guard flange D''.

Bowl B comprises, primarily, the bottom plate 5 which is conveniently integral with the hollow stem 6, and the annular side wall 7 removably attached to the periphery of bottom plate 5 by nut 8.

The side wall 7 comprises a main vertical lower portion, an inwardly extending annular flange 14, a short annular vertical wall 15 rising from the inner edge of flange 14, an inwardly extending annular flange 16 perforated at 17 and surmounted by an annular discharge lip 18 for the heavier liquid, and an annular discharge neck 19, the upper edge 19' of which forms a discharge lip for the lighter liquid.

An inlet passage 25 leads downwardly through the upper part of stem 6 to the upper ends of downwardly extending inlet passages 25' which lead to the bottom of the bowl. These passages 25' are formed in part by a sleeve 26. Arranged above the delivery ends of passages 25' and extending outwardly substantially parallel with the bottom plate 5, is the bottom 27 of a supplemental bowl SB which also comprises the upwardly and outwardly inclined annular wall 28 perforated at 29 and formed at its upper edge as a seat for the guard disk D. Bowl SB carries a plurality of radial vanes 30 (inside and outside) to reduce circumferential slippage of liquid relative thereto.

Guard disk D' has an eye 31 of less diameter than bottom 27 and greater diameter than the adjacent part of stem 6 and its outer edge is spaced inwardly from wall 7 as shown. This disk is most conveniently outwardly and upwardly dished, as shown, and is preferably imperforate. In any event it should be of such character as to insure a substantial flow of liquid inwardly between it and bottom 27 and thence upwardly through its eye 31.

Nested within and above disk D' are a number of identical annular stratification disks D each of which has an eye 31 and a plurality of intermediate perforations 32 each of which is preferably guarded, on the upper face of the disk, by a guard lip 33, the height of which is less than the distance to the under surface of the immediately superposed disk. The disks carry isolated spacer blocks 34 (Fig. 2) which serve to maintain proper spacing of the disks.

The disks are held in a unit within and above the supplemental bowl SB by the guard flange D'' which blocks outflow through eye 31 of the uppermost disk D and directs flow between the two top disks to the perforations 32 of the top disk and to the peripheral space between the two top disks.

Overlying the top disk and contacting the upper surface of its outer edge is a collecting bell 40 the outer edge 40' of which is spaced from wall 7. Bell 40 has a neck 40'' which extends up into and fits neck 19.

Within neck 40'', near its upper end, is an annular ring dam 41 which fits neck 40'' and is held against upward displacement by the depending lugs 42' of a ring 42 held in place by nut 43 threaded on stem 6. The outer edge of ring 42 is serrated, as indicated at 42'' to afford out-

flow passages from the interior of neck 40'' to the upper end of neck 19.

The bowl B and its contained parts is supported and rotated at desired high speed by a shaft S driven by any suitable means (not shown), and the bowl B is subtended by a basin W having a discharge passage *w* through its bottom.

The parts thus far described, while differing in some details, in general form the subject matter of my copending application Serial Number 438,961, and are not herein generally claimed.

In order that the device may be successfully used to separate any two liquids having a difference of specific gravities within the range of the device, and in order that minute adjustments may be readily made, it is necessary to provide radially differential dams between the interior of the bowl and the two discharge lips 18 and 19'. The ring dam 41 is therefore readily removable and replaceable by any one of a number having different internal diameters differing but slightly from their adjacent fellows. I also provide a similar group of ring dams 45, any one of which may be seated on the shoulder 46 at the root of wall 15 by the ring nut 47. This ring nut 47 is serrated on its lower edge, as shown at 47' so as to support the main plate of bell 40 against the pressure created beneath the bell.

At times it is desirable to use a device of this kind solely as a clarifier to abstract undesirable solids (or comparatively small volumes of a heavier liquid or sludge) from a simple liquid, (or a mixture of several liquids of different specific gravities separation of which is not desired).

In order that this end may be attained a ring dam 61 (Fig. 2) is inserted to block the annular space between wall 7 and the upper edge of bowl SB. The ring dam 61 may be imperforate or, as shown, may be lightly perforated, as indicated at 62.

When ring dam 61 is used the ring dams 41 and 45 and bell 40 are removed and in place of dam 45 I insert a thimble T (Fig. 2) comprising a horizontal flange 65 and a neck 66. The outer edge of flange 65 is clamped against shoulder 46 by nut 47 and neck 66 fits neck 19, thus blocking any outflow to and through perforations 17 and over lip 18.

If only clarification is ever desired the modification shown in Fig. 3 (where similar parts are similarly designated), is used.

In this construction flange 16 is not perforated and there is no need for dams 41 and 45 or for bell 40 or thimble T. Here, instead of the dam 61 shown in Fig. 2, I provide a plain ring dam 61*a* (slightly perforated at 62 if desired) which is held in place between a downwardly-presented shoulder 70 on wall 7 and the extended tips of vanes 30.

Devices of the character which have been described are often used for treating lubricating oils and other similar fluids which rapidly deteriorate rubber packings and in prior devices frequent necessary replacements of rubber packing rings, at junctions of bowl parts, has been and is a considerable item of expense of maintenance.

I have overcome this difficulty in the following manner:

The upper surface of the bottom plate 5 of bowl B at its outer rim is provided with a narrow annular depressed surface 75 flanked at the inner periphery by the outwardly-presented shoulder 76 and provided with an intermediate upwardly-extending wedge rib 77 having an outwardly-flaring inner surface 78. Wall 7, at its inner corner is provided with a rabbet 79 which receives and closely fits shoulder 76. The lower edge of wall 7 is provided with an annular groove 80 which is nearly circular in cross-section to provide a throat somewhat narrower than the cross-sectional diameter of the groove and compressed into this groove is a rubber packing strip 81 of corresponding cross-section. The parts are so proportioned, as shown, that the upper edge of rib 77 may enter the throat of groove 80 and the inclined face 78 engage strip 81 to compress strip 81 inwardly and upwardly as wall 7 is drawn down to operative position by nut 8. Strip 81 is thus most firmly compressed in the only region which oil under any considerable pressure may possibly reach it and, as rubber is non-absorbent of oil when it is under substantial compression, the strip 81 is thoroughly protected against deterioration.

When wall 7 is separated from bottom 5 to permit discharge of accumulated solids and sludge, the outflow but lightly touches the packing strip and can be easily and promptly wiped away before the bowl parts are reassembled. I have found in actual practice that, with the above described construction, the life of the packing 81 is increased very many times over packings of the same material heretofore used in centrifuges.

Basin W and the separator bowl therein, are covered by a sheet-metal collecting pan C, comprising an annular outer wall 85 subtended by an inwardly-extending flange 86 adapted to rest upon the mouth of basin W and secured to the exterior of an inverted bell-like annulus 87 the outer depending edge 88 of which fits within the mouth of basin W. The annulus 87 arches over the bowl B and has a central eye defined by an upwardly-extending flange 89 through which neck 19 protrudes. Sleeved frictionally upon, and rotating with, neck 19 is a guard sleeve 90 provided with a depending lip 91 which overlaps flange 89.

Frictionally sleeved upon sleeve 90 is a second guard sleeve 92 having a flange 93 which underlies the eye of annulus 87. By this arrangement communication between basin W and pan C is prevented.

The outflow over lip 19' is directed into the annular chamber of cover C by a supplemental cover C' which fits within wall 85. Cover C' is centrally perforated and carries a depending tube 95, which projects down into the inlet passage 25 of stem 6, and at the upper end of this perforation is a packing gland 96 upon which may be seated downwardly-presented a supply nipple 97.

Nipple 97 is carried by a goose-neck pipe 98, the depending vertical receiving end of which is axially and rotatably sleeved in the packing gland 99 carried by a bracket 100 secured to basin W and to which is connected supply pipe 101. The upper end of bracket 100 is threaded to receive the sleeve nut 102 between which and gland 99 is interposed a compression spring 103.

Within nipple 97 is a sleeve 105 circumferentially slotted at 106 to afford passage from pipe 98 to the mouth of nipple 97. The upper end of sleeve 105 is secured to nut 107. Journaled within sleeve 105 is a valve 108 having a segmental portion 109 which may be moved to more or less block slot 106. Journaled on the stem of valve 108 is a gauge head 110 which may be angularly adjusted upon and secured to the stem by means of screw 111 which takes into circumferential groove 112.

Head 110 and an adjacent portion of the nipple body are provided with coordinated graduations

(not shown) and head 110 may be held in adjusted position by screw 113 the inner end of which may be moved into frictional engagement with nut 107. Relative angular adjustments of head 110 and valve 108 permit accurate coordination of valve 108 with slot 106 and of head 110 for position indication so that inflow of fluid to the bowl 13 may be accurately adjusted.

Collecting pan C is provided with a discharge orifice 115 for lighter liquid and this will be the primary discharge when the device is used solely for clarification.

Compression of gland 99 will serve to hold nipple 97 in vertical position so as to hold supplemental cover C' and collecting pan C in operative position. By slightly loosening nut 102 nipple 97 may be shifted slightly upwardly and swung to one side, whereupon the light parts C and C' may be easily handled for removal and replacement. The nipple 97 will always be downwardly presented so that, if the supply pump (not shown) should be inadvertently started when the nipple is moved from operative position (as is not at all unusual) the discharge will be downwardly and the operator will not be sprayed with disagreeable fluid.

In order to facilitate removal of bowl B from shaft S without sacrificing proper balance of the bowl in high speed operation, the upper end S' of shaft S fits the lower end of the bore of stem 6 with an easy sliding fit and positive driving connection is established between shaft S and bowl by the transverse pin 116 which extends across the bore of stem 6 and is placed approximately at the operative center of the bowl B and lies loosely in the transverse slot 117 formed across the upper end of shaft S.

Shaft S is provided with a relatively large-diameter conical collar 120 over which is nested the conical pocket 121 formed in the lower face of the bottom 5 of bowl B.

By this arrangement the bowl is readily removable and replaceable, is positively driven, and permits minor relative aberations between the bowl and shaft.

Referring now to Fig. 1. Fluid passing through nipple 97 and bowl B being rotated at high speed, the fluid passes down through passages 25 and 25' and outwardly between bottoms 5 and 27 into high-pressure regions of the bowl. An annular layer of heavier liquid is thus established in the bowl to a line submerging the outer edges of disks D and D' and heavier solids will accumulate in the outer lower corner of the bowl.

The lighter liquid, and such heavier particles and heavier liquid as may still be entrained in the lighter liquid, will then be forced inwardly beneath disk D' and through the eye 31 thereof and thence upwardly and outwardly through the several eyes 31 of disks D and between the disks. The heavier liquid and particles, still entrained in the larger volume of lighter liquid, pass with the lighter liquid into higher-pressure regions of the bowl and into the heavy-liquid space of the bowl while the lighter liquid passes upwardly through perforations 32 of disks D, thence inwardly beneath bell 40, upwardly through neck 40'' pass dam 41 and out over lip 19' into pan C.

The degree of separation of the two liquids may depend upon the pressure difference between the bowl regions at the eyes of the two dams 41 and 45 and the pressures at these regions are dependent upon bowl speed and the radii of these two eyes. Consequently, by selecting and placing the dams 41 and 45 with eyes of proper diameters, relative to bowl speed, accurate demarcation of any two liquids, within a wide range of variation, can be obtained. Proper dam-eye diameters can be accurately determined by methods of mathematical calculation well known to engineers ordinarily skilled in this art.

The valve 108 will be set so as to permit a rate of inflow of mixture such that substantially equal films of heavy and light liquids will flow over the two dams 45 and 41 respectively.

When accumulation of heavy particles and sludge nears the outer edge of the supplemental bowl SB, the cover, comprising parts C and C', is removed, nut 8 is retracted from bottom 5 and the wall part of bowl B withdrawn, whereupon the contents of the bowl flows through the waste passages. Rotation of the bowl bottom, and parts remaining therewith, will serve to cleanse the disks. The disks may be readily withdrawn and arranged with different spacings if desired, larger spacing being desirable for more viscous liquids than for less viscous liquids.

As previously pointed out, the placing of the packing gasket 81 in the under edge of wall 7 thoroughly protects it from submergence at all times except when it is under compression.

Referring now to Figs. 2 and 3:—Ring dam 61 or 61*a* blocks or obstructs free passage from the high pressure region in the lower part of bowl B to the similar high pressure region of the bowl in the zone occupied by the disks. Considerable volumes of heavy particles and sludge may therefore accumulate in the lower high pressure region before cleansing becomes necessary. In the meantime, finer heavy particles and sludge may accumulate in the high pressure region in the disk zone until shortly before the passages between the outer edges of the disks become blocked thereby.

I claim as my invention:

1. A centrifuge bowl having two discharge necks of different radii, and a removable annular obstructor comprising a tubular portion sleevable within the smaller neck and a flange mounted in said bowl in position to block outflow from the interior of the bowl to the larger-radius neck and to direct all normal outflow from the interior of the bowl to the smaller-diameter neck.

2. A centrifugal bowl comprising a main body, a plurality of superposed stratifier disks mounted therein, each of said disks having a diameter substantially less than the adjacent interior of the bowl, an axial eye affording passage from below to above said disk, and an intermediate perforation affording passage from below to above said disk, means below the lower-most disk to divert flow from lower regions of the bowl respectively to the highest pressure region and to the eyes of the disks, means to direct inflow to the interior of the bowl below said last-mentioned means, means to block flow through the upper disk except through its intermediate perforation, an annular dam substantially obstructing direct axial flow in the high pressure region of the bowl from the zone below the disks to the disk zone, said bowl having an inlet passage leading to the high pressure region of the bowl below the disk zone.

3. A centrifugal bowl comprising a main body, a plurality of superposed stratifier disks mounted therein, each of said disks having a diameter substantially less than the adjacent interior of the bowl, an axial eye affording passage from below to above said disk, and an intermediate

perforation affording passage from below to above said disk, means below the lower-most disk to divert flow from lower regions of the bowl respectively to the highest pressure region and to the eyes of the disks, means to direct inflow to the interior of the bowl below said last-mentioned means, means to block flow through the upper disk except through its intermediate perforation, a removable annular dam substantially obstructing direct axial flow in the high pressure region of the bowl from the zone below the disks to the disk zone, said bowl having an inlet passage leading to the high pressure region of the bowl below the disk zone.

4. In a centrifugal bowl, a bottom plate, a cylindrical wall surmounting the outer periphery of said plate, an inwardly projecting annular upper wall supplementing the upper end of the cylindrical wall and axially separable relative to the bottom plate, and perforated to form a heavy-liquid outlet, an upwardly extending neck supplementing the inner periphery of said upper wall, an annular dam removably interposed between said outlet and the large-diameter lower region of the bowl, a removable annular separator bell arranged below and spaced from the said upper wall with its outer rim extended toward the outer regions of the bowl beyond the inner rim of the dam but not to the cylindrical wall and coordinated with the neck to block outflow therethrough from outer regions of the bowl, an axial tubular stem lying within said neck and communicating with the interior of the bowl below the separator bell, an upwardly removable inwardly-projecting annular dam arranged in said neck and around said stem and a nut threaded on said stem and retaining said last-mentioned dam against upward displacement.

5. A centrifuge comprising a bowl, a stationary housing therefor, an annular collecting pan supported by the housing and having a central neck sleeved around the upper end of the bowl between the heavy-liquid and light-liquid discharge outlets of the bowl, a guard sleeve structure carried by the upper end of the bowl and forming an annular pocket enveloping the inner periphery of the collecting pan, a cover separably associated with the collecting pan and provided with a feed inlet removably associable with the inlet of the bowl, a primary feed pipe having its discharge end anchored upon the housing, a supplemental feed pipe associated with the discharge end of the primary feed pipe and having a discharge end separably associable with the feed inlet of the cover, said supplemental supply pipe being slidably associable with the primary feed pipe by a liquid-tight connection, and a flow-controlling valve carried by said supplemental supply pipe.

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