March 5, 1963 K. E. JACOBSON 3,080,108

CENTRIFUGAL MACHINES HAVING A NOZZLE TYPE ROTOR STRUCTURE

Filed Jan. 12, 1961 2 Sheets-Sheet 1

FIG. 1

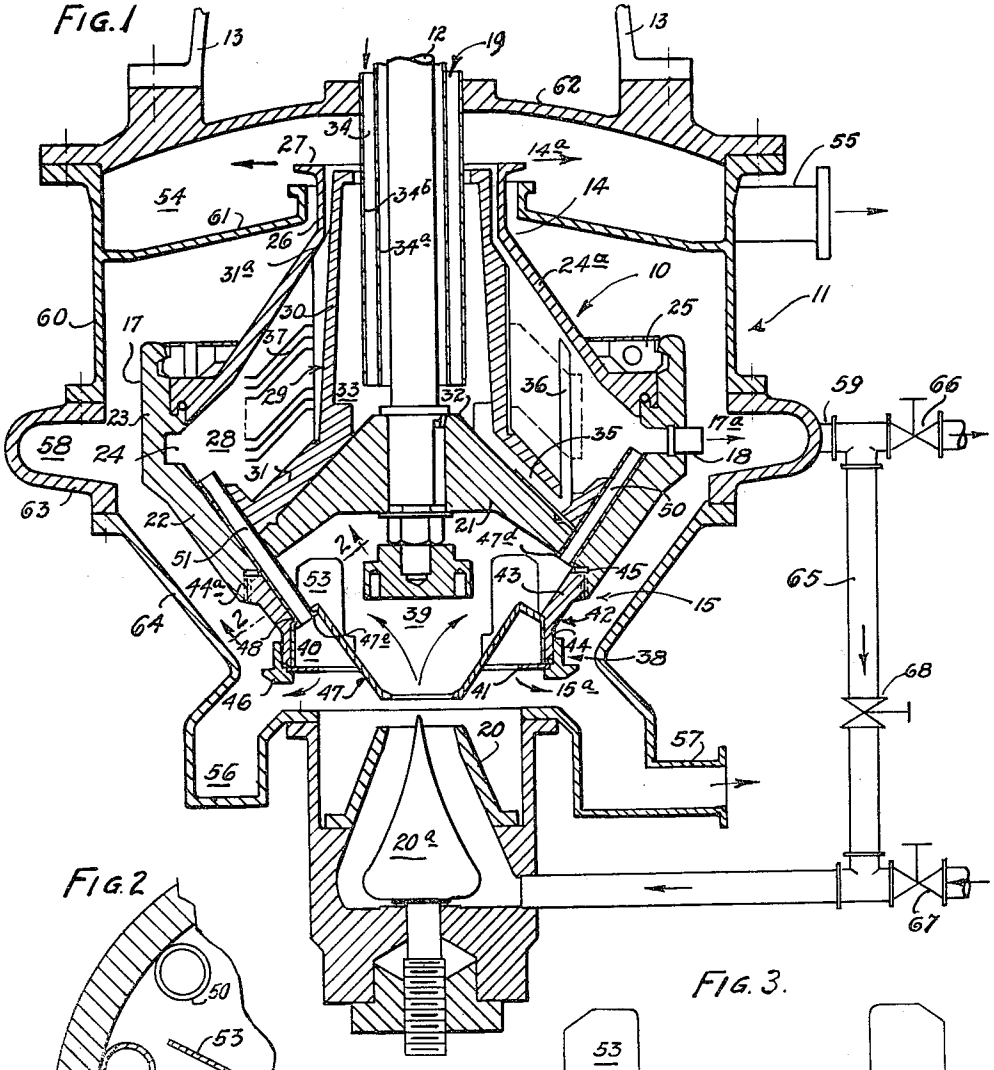


FIG. 2

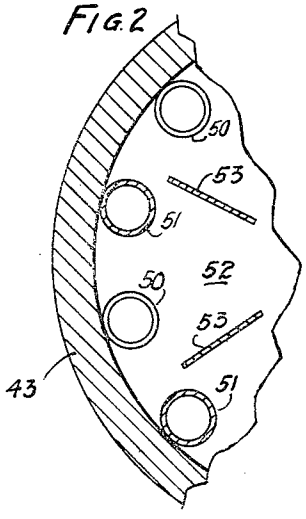
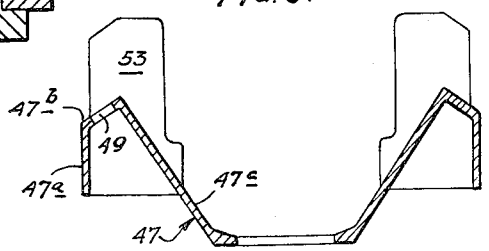


FIG. 3.



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FIG. 4

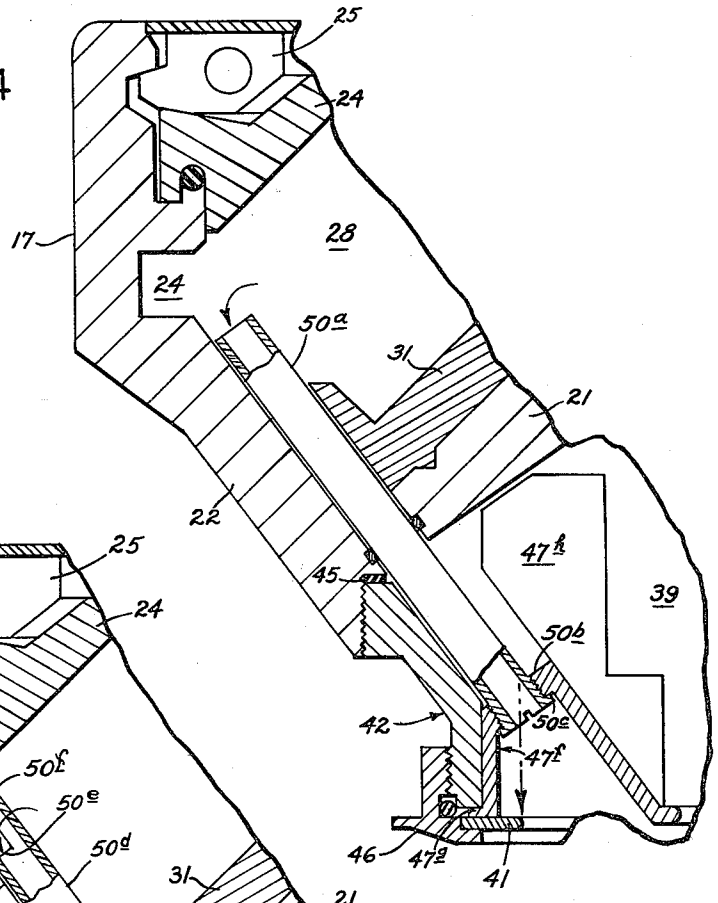
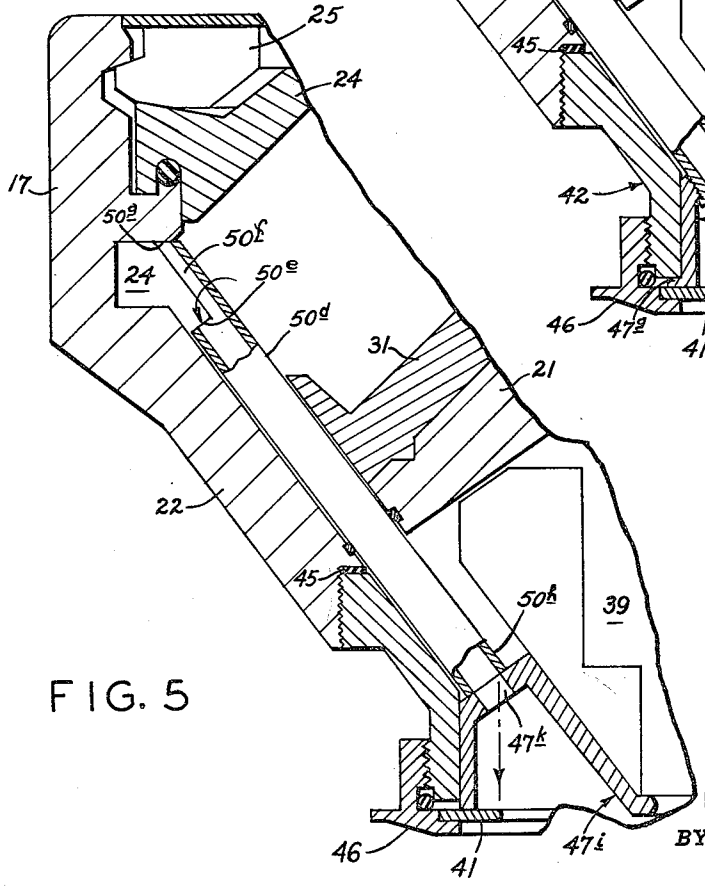


FIG. 5



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3,080,108

CENTRIFUGAL MACHINES HAVING A NOZZLE TYPE ROTOR STRUCTURE

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4 Claims. (Cl. 233—14)

This invention relates to improvements in centrifugal machines for separating a feed mixture or emulsion into a plurality of liquid fractions of different specific gravities, where an underflow fraction, for instance a solids bearing concentrate, is delivered by discharged nozzles along the outer periphery of the rotor or rotor bowl, while respective lighter liquid fractions discharge by way of respective circular overflows concentric with the rotor axis.

This invention may be embodied in what is termed a three-product machine, that is a machine from which two overflow liquid fractions of different specific gravities discharge at respective opposite constricted ends of the rotor body, and which includes means for returning third fraction underflow material from the nozzles into the separating chamber of the bowl with or without the addition of a wash water or control liquid, or for the introduction of wash water or control liquid alone.

A three-product machine of that general description is capable of producing the two overflow fractions at relatively great purity, namely uncontaminated one by the other, inasmuch as these two overflows are located at the opposed constricted ends of the rotor structure, with the nozzle underflow from the discharge nozzles located midway inbetween and adapted to intercept whatever stray overflow material may occur.

Such a machine may be advantageously employed for example in crude oil separation treatment whereby the separated oil and water discharge from the respective overflows, whereas water-solids mixture or solids carrying concentrate constitute the underflow delivered by the discharge nozzles.

A three-product machine adapted to embody this invention is more particularly illustrated in the copending patent application of Honeychurch, Ser. No. 34,303 (Series of 1960), filed June 6, 1960. That application discloses a centrifuge rotor wherein the rotor bowl has trunco-conically shaped end portions constituting an annular centrifugal separating chamber with the underflow discharge nozzles mounted upon the outer periphery thereof, and the respective overflows for the lighter fractions located at the opposed constricted end of this rotor structure. The one conical end portion of the bowl has an open end providing the primary overflow for the lightest fraction, while the opposite portion of this separating chamber is formed with a solid hub portion from which a rotor shaft extends through said open primary overflow end. A complementary annular construction is detachably connected to the rim of this hub portion, including integral annular partition means which in turn have full-fashioned integral radial pumping vanes. In this way, there is formed at the inner side of the partition means a centrally disposed influent chamber directly adjacent to said hub portion and thus adjacent to the separating chamber, for receiving underflow return or control liquid or the like engaged by the pumping vanes, whereas at the outer side of the partition means there is formed an annular discharge chamber having an annular dam member for centrifugally discharging the intermediate or secondary fraction overflow.

These mutually adjacent concentric influent and effluent chambers in the complementary construction communicate with the separating chamber in the bowl through respective sets of conduits which are in the form of the removable tube members. One set of divergent influent tube members is disposed around the rotor axis, leading from the central influent chamber directly through the hub portion into the region of the discharge nozzles for carrying the underflow return or the like, whereas a set of convergent effluent tube members leads from an intermediate zone of the separating chamber in the bowl through the hub portion thereof as well as through the influent chamber into the annular discharge chamber for discharging the intermediate or secondary fraction over said ring dam.

The invention more particularly relates to an improved mounting of the tubes in connection with the aforementioned complementary construction and other associated parts.

Incorporating the aforementioned detachable complementary annular construction into the rotor structure and placing it in accurate relationship with the respective sets of tube members represents a problem insofar as dynamic balance conditions require a compact threaded connection between the bowl and the complementary construction rather than the use of a bulky flange and bolt connection. This threaded connection in turn involves difficulties with respect to mounting the aforementioned set of convergent tube members which must penetrate through bores or holes in the respective thread-connected parts.

In solving the problem above set forth, the invention provides a novel structural organization wherein an outer ring member screwed directly into place with respect to the hub portion of the bowl, is combined and cooperates with an inner annular hollow partition member fitted into the outer ring member and turnably adjustable therein. This insert member is of special annular configuration defining by its annular hollow space the aforementioned effluent receiving chamber, and at the same time constituting with the adjacent hub portion of the bowl the central influent chamber for receiving the aforementioned underflow return or the like. This annular hollow insert member, according to the invention, is turnably adjustable about the rotor axis independently of the screwed-in outer ring member to achieve alignment for the convergent set of tube members and upon such adjustment this insert member is held fixed in place together with a detachable ring dam member by means of a common threaded end retainer ring.

According to a feature, the turnably adjustable insert member is unitary with specially shaped radial pumping vanes.

In one embodiment, this insert member is held by the end retainer ring tight in abutting relationship against the associated convergent tubes.

In another embodiment, the position of the convergent tube members longitudinally is secured by thread connection with the insert member.

Other features and advantages will hereinafter appear.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof will be best understood from the following description of specific embodiment when read in connection with the accompanying drawings, in which:

FIG. 1 is a vertical sectional view of a three-product centrifugal machine, illustrating one mode of mounting the convergent set of tubes by the use of the varied insert members of this invention.

FIG. 2 is a part sectional view taken on line 2—2 of

FIG. 1, illustrating the arrangement of the two sets of tubes relative to each other, as well as relative to the pumping vanes.

FIG. 3 is a detail vertical sectional view of insert member shown in place in FIG. 1.

FIG. 4 is an enlarged detail view of the invention illustrating a modified arrangement of the mounting of the tubes.

FIG. 5 is a detail view similar to FIG. 4, illustrating still another modified arrangement of the mounting of the tubes.

An example of a centrifuge machine embodying the invention as shown in FIGS. 1 to 4 comprises a rotor **10** operating in a stationary housing **11**. Mounted on top of the housing are means from which the rotor shaft **12** is suspended and mounted for rotation. The means of rotor support being well known are herein indicated only by the fragmentary showing of a top bracket structure **13** carried by the housing.

The rotor bowl embodying features of this invention comprises the so-called rotor bowl which is of generally double-conical configuration having constricted ends **14** and **15** for delivering respective separated liquid fractions as primary overflow **14***a* and a secondary overflow **15***a*. This configuration of the bowl, therefore, also comprises an intermediate portion **17** delivering a third fraction or concentrate also termed underflow **17***a* through well known discharge nozzles **18** mounted in this outer peripheral portion of the bowl. In the example of FIG. 1, feed mixture or emulsion with solids may enter the rotor at **19** through the primary overflow end thereof while control liquid or recirculating underflow may enter the rotor through the opposite end from an injection nozzle device **20** including return flow regulating means **20***a*.

More particularly, the construction of the rotor bowl in this embodiment comprises a hub portion **21** fixed to shaft **12** and shown to be integral with one trunco-conical end portion **22** of the bowl. The wide end of this end portion constitutes a cylindrical rim **23** preferably formed with an inner peripheral race or groove **24** communicating with the discharge nozzles **18** mounted in this rim. An opposite trunco-conical end portion **24***a* of the bowl has its wide end tightly, although detachably, connected to the wide end of the conical end portion **22**, being fitted into the rim **23** and secured thereto as by well-known securing means such as a spreader ring indicated at **25**. At its constricted end the conical end portion **24** of the rotor bowl terminates in a cylindrical portion **26** which in turn provides an overflow lip **27** for the aforementioned primary overflow **14***a*.

The hub portion **21** together with the two trunco-conical end portions of the bowl constitutes a centrifugal separating chamber **28** wherein there is mounted a feed inlet member or receiving well member **29** comprising a substantially cylindrical well portion **30** and a conical or flaring foot portion **31** seated upon the correspondingly conical face **32** of the hub portion **21** and held in place as at **31***a* by pressure contact with the conical end portion **24** of the bowl. The feedwell member **29** thus provides around the shaft a feed inlet passage **33** into which may extend an annular feed supply conduit **34** surrounding the shaft, formed by concentric tubes **34***a* and **34***b*. Feed mixture from this feedwell passes through divergent feed passages **35** into the separating chamber which may have perforated tubes **36** distributing the feed mixture cooperaitvely associated with a stack of separating discs **37**. The function of these discs together with the tubes **36** is well known in that they help separate and reject fine solids or other relative heavier component materials carried by the light liquid fraction as it passes through the interstices between the discs for discharge through the primary overflow **14***a*.

Detachably connected to the hub portion **21** is a compartmented complementary construction **38** constituting a part of the rotor bowl, which provides a centrally located influent chamber **39** for receiving control liquid or returning underflow material, and surrounding it is an annular discharge chamber **40** collecting and discharging the secondary liquid fraction as over a ring dam member **41**.

According to this invention, the complementary construction **38** in the rotor comprises a complementary ring member **42** consisting of a trunco-conical inner end portion **43** and a cylindrical outer end portion **44** extending from the constricted end of the portion **43**. The trunco-conical inner end portion has external thread whereby this ring member is screwed into an internally threaded rim portion **44***a* against a gasket **45**, the rim portion being formed at the junction of the hub portion **21** with the adjacent wall portion of the rotor bowl. The cylindrical portion **44** has thread engagement with an internally threaded retainer ring **46**. A novel hollow annular insert member **47** fits into the cylindrical outer end portion of the ring member **42** and is held in place therein by the retainer ring. This insert member **47** defines within itself the aforementioned annular discharge chamber **40**, and also defines together with the hub portion **21** and with the adjoining trunco-conical portion **43** of the complementary ring member and with the exposed part of the insert member **47** the centrally located influent chamber **39**.

The insert member **47** as illustrated in the embodiment of FIG. 1 is seated in the ring member **42** as against an abutment face **48**, so as to be turnably positionable in order that openings **49** in the insert member (see detail FIG. 3) may be brought into registry with respect to corresponding openings in the hub portion **21**, to provide for further mounting therein of tubular members or tubes presently to be described.

There is a set of divergent influent tubes **50** mounted in the hub portion **21** of the rotor bowl for carrying control liquid or wash liquid or recirculating underflow from the central influent chamber **39** to the region of the discharge nozzles in the separating chamber. There is further a set of convergent effluent tubes **51** aligned with the openings **49** in the insert member, which tubes extend through the influent chamber and on through the hub portion into the separating chamber of the bowl for carrying an intermediate liquid fraction from an intermediate zone in the separating chamber out into the annular effluent chamber **40** for discharge over the ring dam member **41**. As herein illustrated, both sets of tubes **50** and **51** carrying liquid in respective opposite directions are arranged around the rotor axis in alternation and substantially in the identical conical alignment as well as adjacent to the wall of the respective trunco-conical portion **22** of the rotor bowl.

Since the convergent effluent tubes **51** extend through the influent chamber **39**, they constitute between them recesses **52** (see detail FIG. 2) through which the control liquid or the like will reach and enter the divergent influent tubes **50**. Radial pumping vanes **53** in this embodiment are provided on the insert member **47** for urging control liquid or returning underflow from the influent chamber **39** through the divergent influent tubes **50** into the separating chamber of the bowl.

The insert member **47** cooperates with the ring dam member **41**, both being held in place in the ring member **42** by means of a common member, namely the retainer ring **46** in the structural arrangement of the invention.

The hollow annular insert member **47** itself (see FIG. 3) in this embodiment comprises an outer cylindrical wall portion **47***a*, an intermediate trunco-conical wall portion **47***b* extending from the inner end of the cylindrical portion and with its constricted end directed towards the hub portion of the bowl, and a frusto-conical end wall portion **47***c* extending from the constricted end of the intermediate portion so that its own constricted end is directed away from the hub portion of the bowl. In this way, the insert member **47** together with the ring dam

member 41 defines the aforementioned effluent chamber 40 as well as the central influent chamber 39, the ring dam member extending as far inwardly as is necessary relative to the effluent end of tubes 51 and also to an extent providing an overflow diameter suitably greater than the overflow diameter of the primary overflow 27. Accordingly, the central influent chamber 39 is definable more precisely as being formed by the hub portion 21, the frusto-conical portion 43 of ring member 42, the intermediate trunco-conical portion 47*b* of the insert member, and the frusto-conical end wall portion of the insert member.

Thus, with the insert member 47 being turnably adjustable relative to the hub portion 21, the assembly of the parts arranged according to this invention may be carried out conveniently as follows: before attaching the entire complementary construction 38 to the rotor bowl, the convergent effluent tubes 50 are inserted in the hub portion, their position in this instance being determined by a rim or stop bead 47*d* formed at the influent end of the tubes. Then, the ring member 42 is screwed and tightened into the threaded portion of the bowl, whereupon the insert member 47 may be positioned in this ring member ready for the convergent tubes 51 to be inserted to a position defined by their stop rim or bead 47*e*. The assembly is then completed by placing the ring dam member 41 against the insert member and attaching and fastening the retainer ring for holding both. Of course, it is also possible to first loosely assemble the insert member as well as the dam ring member and the retainer ring, and then inserting the tubes 51, followed by tightening the retainer ring.

The housing in the embodiment of FIG. 1 has separate discharge outlets for the three separated fractions and accordingly has a top receiving chamber 54 provided with an outlet 55 for the primary overflow, a bottom receiving chamber 56 provided with an outlet 57 for the secondary overflow, and an intermediate volute chamber 58 with outlet 59 for discharging underflow material from the nozzles. In the embodiment shown, the housing is subdivided into structural sections which comprise a cylindrical section 60 formed with an annular partition 61 and also with the outlet 55, a top cover portion 62 fastened to the upper end of the cylindrical section and carrying the aforementioned bracket structure 13 for supporting the rotor, a volute section 63 fastened to the lower end of the cylindrical section and formed with the outlet 59, and a conical bottom section 64 fastened to the lower end of the volute section and formed with the outlet 57. Moreover, this embodiment shows an external return conduit 65 for recirculating underflow from the nozzles back into the rotor through the injection device 20, 20*a*, with an underflow discharge control valve 66 operable to control the recirculation rate and thus the concentration of the underflow. Additional control liquid or wash water or the like may be introduced into the underflow return circuit as by means of a valve 67. The return conduit 65 has an additional valve 68 whereby recirculation therethrough may be interrupted while underflow discharge through valve 66 and the introduction of the control liquid through valve 67 may be operated individually. The separation of the intermediate fraction from the light fraction may be aided by separating discs 37 the function of which of itself is well known in the art.

According to the invention, the enlarged detail FIGURES 4 and 5 illustrate other ways of mounting the convergent flow transfer tubes, with means of securing them relative to the insert member and other associated parts of the rotor structure.

Thus, in FIG. 4, all parts are here designated by the same numerals as corresponding parts in FIG. 1, excepting the insert member and the associated tubes, identified by numerals 47*f* and 50*a*. In this embodiment, the securing means of the tubes comprise a thread connection 50*b* and a thread locking terminal rim or bead 50*c* formed at the effluent end of the tubes. This insert member 47*f* also differs from the one shown in FIG. 1 in that it is formed with a small outer flange or shoulder 47*g* confined between the ring member 42 and the overflow ring dam member 41, thereby securing the insert member shown to be provided with pumping vanes 47*h* preferably shaped with the contour herein illustrated. According to FIGURE 4, therefore, the outer cylindrical wall portion of the insert member provides a shoulder portion confined between the complementary ring member 42 and the ring dam member 41, when the retainer ring member 46 is tightened upon the external thread on ring member 42.

Considering the embodiment in detail FIG. 5, again the parts are numbered identical to those in FIG. 4, but with the exception of the insert member which is here designated 47*i* and differs from those in FIG. 1 and FIG. 4 in that it is provided with plain holes 47*k* which need not be substantially greater than the inside diameter of the associated tubes here designated 50*d*. The influent end 50*e* of these tubes has for example a partial extension 50*f* providing an abutment face cooperating with the companion abutment face 50*g* on the rotor bowl, while the effluent end 50*h* has pressure engagement with a respective abutment face on the insert member which in turn holds the tubes thus confined between the respective abutment faces when the retainer ring 46 is tightened up against the ring dam member 41 and thereby against the insert member 47*i*. In other words in this embodiment, the retainer ring member 46 when tightened upon the respective external thread of the complementary member 42 engages the ring dam member 41, thereby causing said insert member to be axially confined between said ring dam member and said divergent tubular members, and further causing said divergent tubular members themselves to be longitudinally confined between abutment faces on the insert member and abutment faces on the bowl respectively.

In the operation of the machine itself as illustrated in FIGS. 1 to 4, the feed mixture or emulsion enters the rotor through the stationary annular feed conduit 34 which extends into the feed inlet passage 33 within the rotor, whence the mixture passes on through downwardly divergent feed passages 35 into the separating chamber 28 of the rotor bowl. Rotation of the bowl will cause separation of the components of the mixture, into three fractions of different specific gravities, namely a sludge fraction discharging as underflow through the nozzles from the outer peripheral zone of the separating chamber, an intermediate liquid fraction passing from the separating chamber through convergent tubes 51 into the annular discharge chamber 40 and out at the bottom over ring dam 41 as secondary overflow, and finally a light liquid fraction discharging from the overflow lip 27 at the top. Meanwhile, control liquid or wash water or recirculating underflow from nozzle discharge or both may be injected at controlled rates continuously from the bottom into the influent chamber 39 where the pumping vanes 53 will insure that this suspension enters the divergent transfer tubes 50 for delivery in the region of the nozzles. Adjusting the rate of sludge draw-off at valve 66 will correspondingly influence the concentration of the underflow, in that a decrease in the rate of draw-off will increase the concentration. Wash liquid may be added to the sludge return, or wash liquid may be used alone. However, it will be understood that the nozzle flow requirements may be satisfied by recirculating nozzle discharge or by the addition of wash liquid from another source, to establish a suitable interface for maintaining light fraction separation. For example, crude oil may thus be separated into an oil fraction, a water fraction, and a concentrate which latter may consist of water containing solids such as sand and other particles.

From the foregoing, it will be seen that the invention provides in a centrifugal machine preferably of the three-

product type having underflow discharge nozzles, an improved rotor construction featuring a novel and highly practical structural assembly and relationship of parts, which assembly defines the central influent chamber for underflow return and the annular effluent chamber surrounding it for delivering the intermediate fraction derived through the divergent tubes. The separate insert member being turnably adjustable within that assembly provides the advantage of rendering the mounting of the convergent tubes independent of the degree of compressibility of the gasket **45** located between the ring member **42** and the rim portion **44***a* of the rotor bowl.

It will be understood that each of the elements described above pertaining to the invention, or two or more together may also find useful application in other centrifugal machines differing from the type described above.

While the invention has been illustrated and described as embodied in a three-product nozzle type centrifugal machine, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of this invention.

As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within metes and bounds of the claims, or equivalents of such metes and bounds are therefore intended to be embraced by the claims.

I claim:

1. In a centrifuge rotor having a separating chamber of double cone-shaped configuration defined by a rotor bowl provided with underflow discharge nozzles at the outer periphery thereof located between the constricted ends of the bowl, said bowl having a hub at one constricted end and having primary overflow means at the opposite constricted end, with a rotor shaft extending axially from said hub through the area defined by said primary overflow, said rotor also having means for discharging a secondary overflow fraction from the hub end portion of the bowl, as well as means for returning underflow material into the separating chamber at said hub end portion of the bowl, the arrangement which comprises an internally threaded rim portion located at the hub end portion of the rotor bowl; a complementary ring member comprising a frusto-conical end portion having the wide end thereof thread-connected to said threaded rim portion and also comprising a cylindrical end portion extending outwardly axially from the narrow end of said frusto-conical end portion and having an external thread; a hollow annular insert member surrounded by said complementary ring member, comprising a cylindrical outer wall portion providing a shoulder portion and fitted into said cylindrical end portion of the complementary ring member, an intermediate wall portion extending inwardly from the inner end of said cylindrical wall portion and having predetermined communication openings, and an inner wall portion extending from the inner end of said intermediate wall portion and directed away from said hub; a ring dam member surrounding said inner end wall portion of the insert member in concentrically spaced relationship therewith and located adjacent to the outer end of said outer wall portion of the insert member, and constituting with said hollow insert member an annular discharge chamber for secondary overflow from the separating chamber, said inner end wall portion together with said intermediate portion of the insert member and with said frusto-conical portion and with said hub providing a central influent chamber for receiving return underflow material; an internally threaded retainer ring member engaging respective external thread of the complementary ring member and effective when tightened upon said external thread to engage said ring dam member and to cause said shoulder portion of the insert member to be axially confined between said ring dam member and said complementary ring member; a set of convergent tubular members arranged around the rotor axis in registry with said respective communication openings, and detachably connected to said insert member and extending through said hub to provide communication between said annular discharge chamber and said separating chamber for discharging an intermediate fraction of secondary overflow material into said annular discharge chamber and out across said ring dam member; a set of divergent tubular members arranged around the rotor axis in alternation with said convergent tubular members and extending through said hub and providing communication between said central influent chamber and said separating chamber for the return of underflow material from said central influent chamber into the region of the nozzles in the separating chamber, and pumping vanes provided in said central influent chamber and effective to impel return underflow material into and through said divergent tubular members for delivery in said separating chamber.

2. The arrangement according to claim 1, wherein said pumping vanes are provided on said insert member.

3. In a centrifuge rotor having a separating chamber of double-cone shaped configuration defined by a rotor bowl equipped with underflow discharge nozzles at the outer periphery thereof located between the constricted ends of the bowl, said bowl having a primary overflow at one constricted end for discharging one overflow fraction, and having a hub at the opposite constricted end, with a rotor shaft extending from said hub through the area defined by said primary overflow, said rotor also having means for discharging secondary overflow material as an intermediate fraction, as well as means for returning underflow material from the nozzles into the separating chamber, the arrangement which comprises an internally threaded rim portion located at the hub end portion of the rotor bowl; a complementary ring member formed with a frusto-conical end portion having the wide end thereof thread-connected to said threaded rim portion and also comprising a cylindrical end portion extending outwardly axially from the narrow end of the frusto-conical portion and having an external thread; a hollow annular insert member surrounded by said complementary ring member, comprising a cylindrical outer wall portion fitted into said cylindrical end portion of the complementary ring member, an intermediate wall portion extending inwardly from the inner end of said outer cylindrical wall portion and having predetermined communication openings, and an inner end wall portion extending inwardly from the inner end of the intermediate wall portion and directed away from said hub; a ring dam member adjacent to the outer end of said cylindrical portion of the insert member while surrounding said inner end wall portion of the insert member in concentrically spaced relationship therewith, and constituting with said hollow insert member an annular discharge chamber for secondary overflow from the separating chamber, said inner end wall portion together with said intermediate portion of the insert member and with said frusto-conical portion and with said hub providing a central influent chamber for receiving return underflow material; means providing abutment faces on said rotor bowl and on said insert member respectively; a set of convergent tubular members extending through said hub and arranged around the rotor axis and having an influent end located in said separating chamber, and registering with said communication openings in the insert member for discharging secondary overflow material from the separating chamber into said annular discharge chamber and out across said ring dam member, said convergent tubular members being confined between respective abutment faces on the rotor bowl and on the insert member; a set of divergent tubular members arranged around the rotor axis in alternation with said convergent tubular members and extending through said hub and providing communication between said central

influent chamber and said separation chamber for the return of underflow material from said central influent chamber into the region of the nozzles in the separating chamber; an internally threaded retainer ring member engaging the respective external thread of the complementary ring member and effective when tightened upon said external thread to engage said ring dam member, thereby causing said insert member to be axially confined between said ring dam member and said divergent tubular members and further causing said divergent tubular members themselves to be longitudinally confined between said abutment faces on the insert member and on the bowl respectively; and pumping vanes provided in said central influent chamber and effective to impel underflow return material from said central chamber into and

through said divergent tubular members for delivery in said separating chamber.

4. The arrangement according to claim 3, wherein said pumping vanes are provided on said hollow annular insert member.

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