

March 12, 1963

G. R. COULSON
CENTRIFUGE CONTROL

3,081,027

Filed Jan. 8, 1959

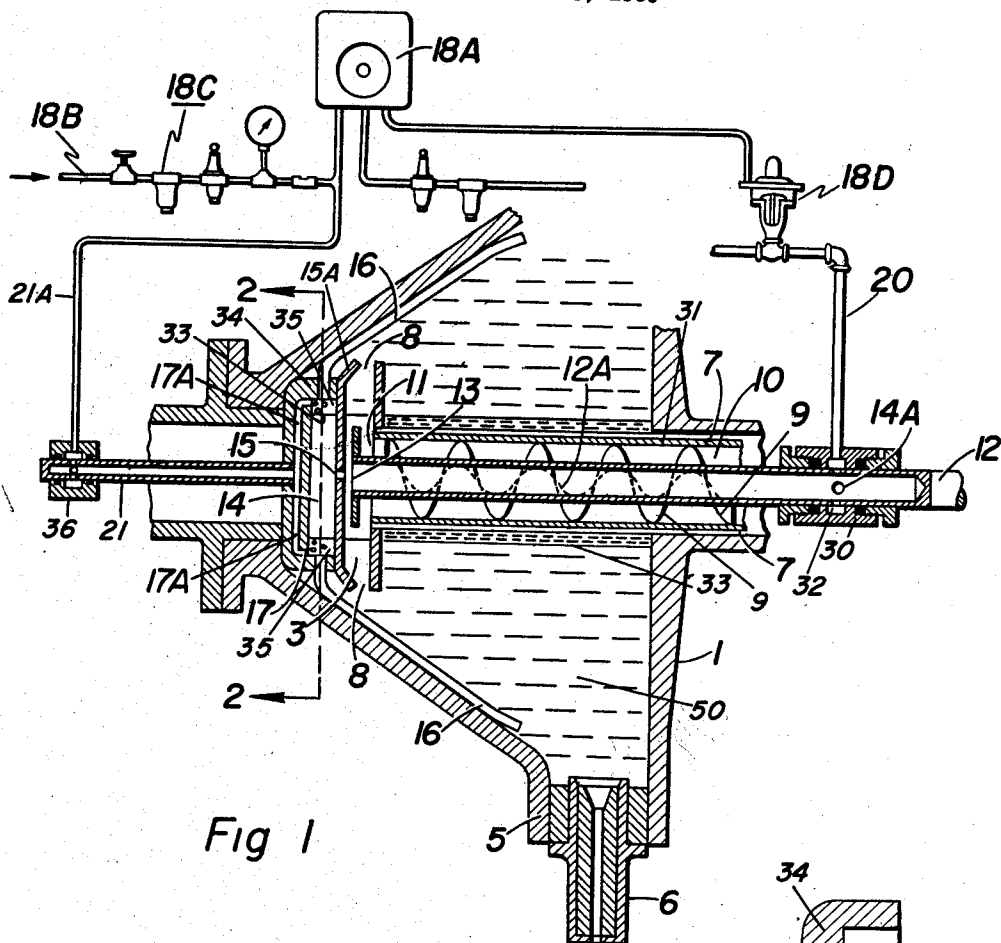


Fig 1

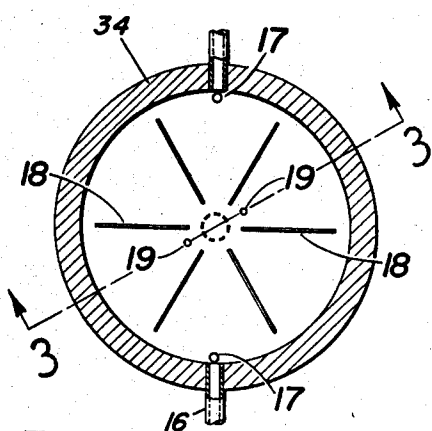


Fig 2

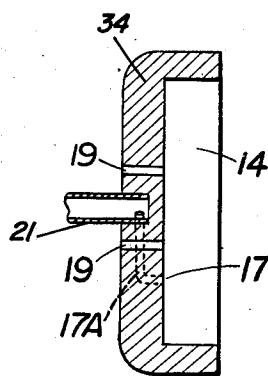


Fig 3

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3,081,027

CENTRIFUGE CONTROL

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Filed Jan. 8, 1959, Ser. No. 785,623

7 Claims. (Cl. 233-4)

This invention relates to centrifuges, and more particularly to an improved control means for a continuous centrifugal separation.

There are many applications in which a centrifugal separation is required as a continuous process, i.e. where in the raw material is continuously charged into the centrifuge, and the separated constituents are individually withdrawn.

In my United States Patent No. 2,825,677, I have described one such process, i.e. the separation of oil from bituminous sands, in the presence of a large excess of water. According to the manner of this invention, raw oil-bearing sand, such as that found naturally along the Athabasca River in Alberta, Canada, is first diluted through the addition of an oil solvent and introduced into a centrifuge with a large excess of aqueous medium. This mixture, when subjected to centrifugal force, results in a three-way separation of oil, aqueous medium, and water saturated sand, which constituents assume three distinct strata in the centrifuge according to their densities.

For this process to operate economically, it is essential that it be operated continuously, rather than as a "batch" process, and it is to a specialized problem arising out of this and similar continuous centrifugal separations that this invention is directed.

The desideratum of operating efficiency of this oil sand separation method, is that the sand be continuously withdrawn (with an inevitable amount of water) from the outer periphery of the centrifuge bowl, and the separated oil continuously withdrawn from the inner periphery. The accomplishment of this desideratum requires a close control of the level of sand, aqueous medium and freed oil maintained in the centrifuge under operating conditions.

It is therefore necessary to regulate carefully the amount of water added to the centrifuge, for too much water will result in the recovery of oil with a large proportion of admixed water, while too little water will result in the recovery of little or no oil.

According to the manner of this invention, an automatic control of the amount of water fed to the centrifuge, is accomplished through the use of a special centrifuge construction, and the recognition of a centrifugal law.

A better understanding of the precise nature of the invention may be had with reference to the attached drawings in which

FIGURE 1 is a partial vertical cross-section of a centrifuge constructed according to this invention;

FIGURE 2 is a section taken along line 2-2 of FIGURE 1; and

FIGURE 3 is a section taken along line 3-3 of FIGURE 2.

In the drawings, the centrifuge, indicated generally as at 1 is provided with an initial chamber 3 into which are separately charged a diluted raw oil sand and an aqueous medium. The means for so charging chamber 3 is well known in the prior art as shown by U.S. Patent No. 994,497 to Berrigan of June 6, 1911 for example and its specific form constitutes no part of the present invention. This means comprises a rotatable tube 12 driven by any suitable means (not shown) and rotatably supported in a bearing 30, tube 12 having a screw 9 fixed

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to the outer surface thereof and a channel 12A therein; and a non-rotating cylinder 31, which, with tube 12, defines an annular channel 10 in which tube 12 and screw 9 rotate. The sand is loaded into channel 10 by any suitable conventional means such as a hopper, which, for the sake of simplicity, has not been shown, the sand being conveyed to the annular inlet 11 into chamber 3 by the rotation of tube 12 and screw 9. The aqueous medium is delivered to the inlet 13 into chamber 3 through a pipe 20 which communicates with an annular channel 32 in bearing 30, passages 14A in tube 12 communicating with channel 12A and annular channel 32, and channel 12A.

The charge of raw diluted sand and water passes from the initial chamber 3 via outlet 8 into the main centrifuge bowl 50 where, upon separation, the three constituents occupy separate strata consisting of an outer layer of water and saturated sand (withdrawn continuously through sand outlets 6), an intermediate or "barrier" layer of aqueous medium, and an inner layer of freed oil (withdrawn continuously through outlets 7). The interface between the intermediate layer of aqueous medium and the oil layer is shown at 33. It is to be understood, of course, that this intermediate layer also will be drawn off continuously through outlets 6.

The water flow through pipe 20 is controlled by means of a valve 18D which is actuated in a manner to be described in detail hereafter.

According to the manner of this invention, the centrifuge is provided with a separate chamber 14. Chamber 14 is defined by a plate 15A which is secured to a backing member 34 in the form of a bowl. Chamber 14 is mounted concentric in the centrifuge and communicates by inlet 15 in plate 15A, with the source of supply of the aqueous medium, whereby a portion of the flow of aqueous medium discharged through inlet 13 into chamber 3 is diverted from the initial chamber 3 and into the separate chamber 14. A plurality of outlet pipes 16 extend through member 34 into chamber 14 and also into the water layer in the main centrifuge bowl. The outlet pipes 16 preferably terminate towards the outer boundary of the water layer in the main centrifuge, to prevent backflow of light constituents into the separate chamber.

The separate chamber must be concentric with the main centrifuge, integral therewith and must extend beyond outlets 7 so that the level of the aqueous medium diverted into the separate chamber 14 will be the same as the level of the aqueous medium in the main centrifuge bowl. As shown in FIGURE 1, in the operation of the centrifuge, the aqueous medium 35 is thrown to the outside of chamber 14 and is at the same level 33 as the aqueous layer in the main separating chamber 50 of the centrifuge.

A plurality of air inlets 17 are disposed in member 34 towards the outer periphery of the separate chamber 14 and are supplied with air under pressure in a manner to be described hereafter.

The separate chamber may be provided with a plurality of vanes 18 adapted to rotate the liquid in the separate chamber at the same rate as the liquid in the centrifuge bowl, thus ensuring that the liquid level 33 in the separate chamber will be the same as that in the main bowl.

At least one exhaust port 19 is provided towards the inner portion of the chamber 14, and communicates with the atmosphere, whereby the inner portion of chamber 14 not containing water 35 may be maintained at atmospheric pressure for reasons which will become apparent hereafter.

Passages 17A are provided in backing member 34 and communicate with inlets 17 and a pipe 21 fixed in mem-

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ber 34, as best seen in FIGURES 1 and 3. Pipe 21 is rotatably supported in bearing 36 which has an annular channel therein, as in the case of bearing 30. This annular channel communicates with the interior of pipe 21 through passages in the wall of pipe 21, as in the case of passages 14A in pipe 12. The annular channel in bearing 36 is supplied with air through pipe 21A.

It is basic hydraulic theory that the pressure of air required to overcome a water head is directly proportional to the head.

The hydraulic theory forms the basis for pneumatic flow controllers manufactured by the Foxboro Company in the United States and by others. These controllers are adapted to control the level of a liquid in an open and stationary tank. The systems include a tube located below the lowest level to be controlled to which tube compressed air is supplied at varying pressures. The air pressure just required to overcome the water head i.e. that pressure in the line at which an air bubble will just be formed in the tank, is sensed and used to regulate the flow of liquid to the tank. If the level of liquid in the tank drops, the air pressure required to overcome the head will decrease and such pneumatic flow controllers actuate a valve to increase water flow to the container; similarly, when the water level rises, the pressure required increases and the control acts to decrease the flow. These pneumatic flow controllers are well known and since they do not of themselves form part of this invention they are not described in detail here. The invention in this application is directed towards the adaptation of these standard open tank flow controllers to the centrifuge art.

Referring again to the structure of the centrifuge constructed so as to embody features of this invention, a pneumatic flow controller of the class described comprises a compressed air line 18b, pressure and orifice plates in this line indicated generally as at 18c adapted to supply compressed air at varying pressure through pipes 21A and 21, through the passages 17a, and out of the inlets 17 into the aqueous medium 35 in the separate chamber already described. The pressure of air required to cause a bubble to form as shown in the drawings, is sensed by the pneumatic flow controller 18a which actuates valve 18d to increase or decrease the water flow through pipes 20 as required. The pneumatic control dribbles air continuously through the ports 17 at varying pressures and this determines the head of the fluid by establishing the degree of air pressure just required to overcome the head.

The operation of the centrifuge is as follows:

Centrifuge 1 is rotated by conventional means, which, for the sake of simplicity, have been omitted. As chamber 14, defined by member 34 and plate 15A, is integral with the centrifuge, it also rotates, as does pipe 21 in bearing 36. Diluted oil, sand and water are separately charged into the centrifuge via initial chamber 3 in the manner previously described, a portion of the water passing through inlet 15 into the separate chamber 14, where, since the separate chamber is concentrically mounted in the centrifuge, it assumes a level 33 the same as the water level 33 in the main bowl 50.

Compressed air is supplied at varying pressures by the flow controller into the outer periphery of this separate chamber and into aqueous medium 35 via pipes 21A, 21, passages 17A and air inlets 17, and the measure of the pressure just required to overcome the head of the level and pass bubbles into aqueous medium 35 is used to regulate the water flow through valve 18D. As the water level in the separate chamber drops, the flow controller acts, in response to the diminished pressure required to overcome the head, to open the valve 18D and admit more aqueous medium. Conversely as the water level rises, the valve 18D is activated to decrease the flow of aqueous medium.

The flow controller may be set to any pressure and

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thus to maintain any desired water level 33 in the main centrifuge bowl. The water level will desirably be maintained slightly below the outlets 7, so that the freed oil, which rises to the surface of the aqueous medium, may be continuously withdrawn through outlet 7 without undue contamination with the aqueous medium.

It should be noted that the adaptation of the standard pneumatic flow controller to this centrifuge art aids the sensitivity of the controller. If the inside diameter of the water layer should vary by one-quarter of an inch the pressure at two inches depth would vary almost three pounds per square inch (assuming two thousand r.p.m. at ten inches diameter) thus providing a greater sensitivity of control that the same apparatus would provide when applied, as it is designed to be applied, to a standing open tank.

The invention has been described in detail with reference to a particular continuous centrifugal separation process. It will be obvious, however, that the invention is not limited in its application to this process. The invention would be applicable to and useful in any continuous centrifugal separation wherein it is sought to effect a separation between two constituents in the presence of a liquid of intermediate specific gravity, wherein the amount of the intermediate liquid is sought to be maintained at a predetermined level.

It is to be understood, moreover, that the invention is not limited to precise constructional details shown, and that such embodiments of the invention as come within the scope and purview of the appended claims, are to be considered as part of the invention.

What I claim as my invention is:

1. Continuous process centrifuge apparatus and control system comprising a centrifuge mounted for rotation about a longitudinal axis and having a main separating chamber, first liquid carrying means in fluid-flow relationship with said centrifuge and adapted to introduce a liquid therein, a flow control valve in said first liquid carrying means adapted to regulate the flow of liquid in said first liquid carrying means, a housing defining a separate chamber, said housing being carried by said centrifuge and rotatable therewith, said housing and separate chamber being mounted concentrically in said centrifuge on said longitudinal axis, an inlet passage in said housing communicating in fluid-flow relationship with said separate chamber and said main separating chamber and thereby being adapted to receive a portion of the liquid flowing into said centrifuge through said first liquid carrying means, at least one second liquid carrying means connecting said separate chamber and said main separating chamber in fluid-flow relationship, a source of compressed air, at least one first air carrying means communicating with said source of compressed air and said separate chamber adjacent the periphery thereof and remote from said longitudinal axis, at least one second air carrying means communicating with the central portion of said separate chamber adjacent said longitudinal axis and the atmosphere, two outlets communicating with said main separating chamber for passage of separated material from said centrifuge, one of said outlets being closer to said longitudinal axis than the other, said source of compressed air and said first air carrying means being adapted to pass air bubbles through liquid in said separate chamber adjacent the periphery thereof, material carrying means communicating with the interior of the centrifuge for introducing a material to be separated into said centrifuge and actuating means for actuating said flow control valve in response to variations in the air pressure required to overcome the liquid head in said separate chamber, whereby a constant liquid level may be maintained in said main separating chamber of said centrifuge.

2. The invention according to claim 1 wherein said separate chamber is circular in cross-section perpendicular to said longitudinal axis.

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3. The invention according to claim 2 wherein said first liquid carrying means are mounted about said longitudinal axis.

4. The invention according to claim 2 wherein said first liquid carrying means is coaxially mounted in said material carrying means, said liquid carrying means and material carrying means being mounted about said longitudinal axis.

5. Continuous process centrifuge apparatus and control system adapted to continuously separate two constituents in the presence of a liquid of intermediate specific gravity comprising a centrifuge mounted for rotation about a longitudinal axis and having a main separating chamber, first liquid carrying means including an inlet in fluid-flow relationship with said centrifuge for introducing a liquid therein, constituent carrying means communicating with the interior of said centrifuge for introducing said constituents into said centrifuge, a flow control valve in said first liquid carrying means adapted to regulate the flow of liquid in said first liquid carrying means, a housing defining a separate chamber, said housing being carried by said centrifuge and rotated therewith, said housing and separate chamber being mounted concentrically in said centrifuge on said longitudinal axis, an inlet passage in said housing communicating in fluid-flow relationship with said separate chamber and said main separating chamber adjacent said inlet of said first liquid carrying means and thereby being adapted to receive a portion of the liquid flowing into said centrifuge through said inlet of said first liquid carrying means, at least one second liquid carrying means connecting said separate chamber and said main separating chamber in fluid-flow relationship, a source of compressed air, at least one first air carrying means communicating with said source of compressed air and said separate chamber adjacent the periphery thereof and remote from said longitudinal

axis, at least one second air carrying means communicating with the central portion of said separate chamber adjacent said longitudinal axis and the atmosphere, two outlets communicating with said main separating chamber for passage of separated material from said centrifuge, one of said outlets being closer to said longitudinal axis than the other, said source of compressed air and said first air carrying means being adapted to pass air bubbles through liquid in said separate chamber adjacent the periphery thereof, and actuating means for actuating said flow control valve in response to variations in the air pressure required to overcome the liquid head in said separate chamber, whereby a constant liquid level may be maintained in said main separating chamber of said centrifuge.

6. The invention according to claim 5 wherein said separate chamber is circular in cross-section perpendicular to said longitudinal axis.

7. The invention according to claim 6 wherein said first liquid carrying means includes a first pipe, and said constituent carrying means includes a second pipe, said first pipe being coaxially mounted in said second pipe, said pipes being positioned about said longitudinal axis of said centrifuge and extending into said centrifuge.

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