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CENTRIFUGAL SEPARATOR

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11 Claims. (Cl. 233-20)

The present invention relates to centrifugal separators designed to separate sludge from liquids, the term "sludge" being considered as designating not only impurities, but any material including a large proportion of solids of higher specific gravity than the liquids in which they are suspended.

It relates more particularly to centrifugal separators of the type in which the rotor includes two parts which are designed to undergo a relative axial movement at periodic intervals to afford provision for discharge of sludge between the two parts when separated. Such a separator is described in the patent to Nyrop, No. 1,735,692. In the preferred construction described in that patent, a piston is rigidly secured to one of the rotor parts and this piston reciprocates within the other rotor part intermittently to effect the desired relative movement between the parts. The rotor parts are normally retained in closed position under the influence of a pressure which may be imposed by springs and are moved intermittently to open position by the admission of operating liquid to the under side of the piston, this operating fluid acting under the influence of centrifugal force to effect the desired movement of the piston.

The present invention involves improvements over the Nyrop patent with respect to sealing connections, and with respect to the provision of means for guiding the rotor parts during their relative reciprocation.

A primary object of the invention has been to provide a sealing arrangement between the piston and cylinder of a centrifugal separator of the type described above which will efficiently fulfill the functions of preventing the passage of sludge into the space through which hydraulic operating liquid normally passes incident to the operation of the machine and to prevent the passage of hydraulic operating liquid into the part of the rotor occupied by materials subjected to separation therein.

A further object of the invention has been to afford improved guiding means between the rotor parts which are strong and positive in their operation and which are adequately protected from contamination by sludge discharged from the rotor.

Other objects and advantages of the invention will be evident from a reading of the following detailed description in the light of the attached drawing, in which

Fig. 1 is a central axial sectional view through a centrifugal separator rotor illustrating the principles of the invention.

Fig. 2 is a detail sectional view of the parts within the line 2 of Figure 1, illustrating the rotor closure connections.

Fig. 3 is a view similar to Fig. 2 illustrating the closure connections in open position and

Fig. 4 is a detail sectional view of parts of the inner rotor member before assembly with other parts of the rotor.

Referring to the drawing by reference characters the rotor comprises a rotatable lower section 10 and an upper section 12 which is rotatable with the lower section but movable axially with respect thereto to effect opening and closing of the rotor. A driven shaft 14 is secured to a boss 16 of the lower rotor section 10.

The interior of the rotor tapers outwardly from both ends toward the middle and has its maximum diameter at the zone of junction between its opposed sections 10 and 12, and sludge which accumulates between these sections is discharged through the opening between them when the rotor sections are moved to open position as illustrated in Fig. 3.

An inner rotor member 18 is rigidly secured to the upper section 12 by means of a nut 20 which operates to clamp the rotor member 12 to the base of the inner rotor member 18 through a disc inset consisting of stratifying discs 36 and radial wings 38. Movement of rotor members 12 and 18 in an axial direction relatively to section 10 is accomplished by hydrostatic pressure developed under the inner rotor member 18 by the admission of liquid from a nozzle 22 through a channel 24 into a space 26 under member 18. Openings 76 are provided in the rotor wall to permit escape of actuating liquid.

The rotor sections are normally held in closed position by means of a plurality of springs 28 which surround bolts 30 projecting downwardly from the inner rotor member 18 through openings in the base of the section 10. Each spring bears at its upper end against the bottom of section 10 and at its lower end against a nut 32 secured to the bolt which the spring surrounds.

Material to be treated may be admitted during the rotation of the rotor through a distributing feed tube 34 through which it is discharged into the base of the member 18. Rotation of the rotor forces solid matter to be concentrated into the outer portion of the rotor while stratified light and heavy effluents are discharged through outlets 40 and 42 respectively.

The rotor section 10 is provided with a replaceable liner 44 which is secured in position by an annular clamp 46 which is bolted to section 10

and bears against a shoulder of the liner. Since the liner and clamp are rigidly secured to the lower rotor section they may properly be regarded as a part thereof.

5 In the operation of the machine as described above a suspension of solids in one or more liquids is fed to the rotating rotor through the feed tube 34 while the rotor sections are held in their closed position with the liner 44 abutting
10 a gasket 45 which is secured to the upper section 12 of the rotor. During the continued feed to the rotor of material to be treated, a liquid effluent is discharged through the discharge outlet 42,
15 and a liquid effluent will also be discharged through the discharge outlet 40 in case the material fed to the rotor includes two liquids of different specific gravity. At the same time, the heavier solid material will accumulate toward the outermost radial portion of the rotor adjacent
20 to the joint between the liner 44 and the gasket 45.

When a quantity of solid material has accumulated in this zone which is sufficiently large to make it desirable that it be discharged, the feed
25 of material through the tube 34 is discontinued and a hydraulic actuating fluid such as water is introduced through the nozzle 22. This actuating fluid passes through the opening 24 and into the space 26 beneath the inner rotor member 18
30 and forces this member upwardly under the influence of centrifugal force exerted upon the liquid in the space 26 incident to rotation of the rotor. This centrifugal force acts against the springs 28 to force the member 18 and section
35 12 upwardly with respect to the section 10. This upward movement causes the joint between the liner 44 and the gasket 45 to be broken and permits discharge of the sludge accumulated adjacent to the larger portion of the circumference of
40 the rotor to take place. Liquid admitted through nozzle 22 is discharged from the rotor through the opening 76 in the cylindrical portion of the lower rotor section 10.

When the discharge of sludge from the rotor
45 has been completed, the feed of hydraulic actuating fluid through the nozzle 22 is discontinued and the liquid head within the space 26 therefore recedes toward the outer circumference of that space by reason of the discharge through the
50 openings 76. When the liquid head in the space 26 has become so small as to fail to counteract the downward force exerted by the springs 28, these springs force the member 18 and section 12 back into sealing relationship with respect to
55 the section 10 and its attached liner 44. The cycle of operations is then repeated.

While centrifugal separators embodying the above principles of operation have met with a fair degree of commercial success, certain problems have been encountered in the operation
60 thereof. Thus, it is essential to the successful operation of a machine of this character that adequate provision be made to avoid passage of sludge from the rotor into the space occupied by
65 the hydraulic actuating fluid and to avoid passage of hydraulic actuating fluid into the separating portion of the rotor. Similarly, it is essential that the relatively moveable rotor sections be guided in their relative movements in such a manner
70 as to insure proper registry of the sealing members with each other. In connection with such guide means, it is also essential that provision be made for avoiding damage to the parts of such means or impairment of their function
75 by the attack of sludge upon the guiding means.

The present invention was primarily conceived as a solution of these problems.

A clamping ring 48 is secured to the base of the member 18 and provided with an annular upwardly extending flange 50 which occupies a recessed portion of the vertically extending wall
5 52 of the member 18. The clamp is secured in position by a series of screws 54. The outer side of the wall 18 is inwardly recessed at 56 to afford an abutment designed to position the sealing
10 member constituting the most important feature of the present invention. This sealing member may include a central spacing ring 58 and a pair of supporting rings 60, these being made of relatively rigid material, such as brass or steel, for
15 example. A sealing ring 62 is secured to each of the supporting rings 60. Gaskets 64 are provided between the respective rings of the sealing assembly. A sealing ring 66 is fitted into a groove on the outer side of the vertically extending portion
20 52 of the member 18 adjacent the upper end thereof. This sealing ring operates to prevent passage of any substantial quantity of sludge downwardly through the space between the members 18 and the liner 44.

25 The sealing members 62 operate to prevent the passage into the space occupied by the hydraulic actuating liquid of any small amount of material, which may pass downwardly beyond the ring 66. Similarly, any hydraulic actuating liquid which
30 may reach the zone of the rotor occupied by the sealing members 62 will be prevented by the sealing members 62 and 66 from reaching the zone of the rotor occupied by the material under treatment. The most important feature of the invention consists in the nature of the rings 62 and the method of operation thereof. These rings are
35 constructed of a metal which is not merely flexible but is also sufficiently plastic to permit it to flow into irregularities between its sealing surface and the adjacent surfaces of the liner 44. By reason of this fact, these members effect their sealing function regardless of whether or not the co-acting sealing surface of the liner 44 is initially
40 machined to a high degree of accuracy and also regardless of whether or not this surface may subsequently wear irregularly in such a manner that it would not adequately perform the sealing function if a sealing ring were employed which is merely flexible and not sufficiently plastic to
45 assume, under the influence of centrifugal force, the shape of the surface with which it co-acts. The sealing member 66 is also preferably constructed of plastic material capable of taking a permanent set under the influence of centrifugal
50 force. By employing material of this character in the construction of the members 62 and 66, the question of exactly fitting these members to the size and shape of their co-acting sealing surfaces becomes unimportant, for the operation
55 of centrifugal force upon the members incident to the operation of the machine acts to project the outer surfaces of these sealing members outwardly and cause them to take the exact shape of the surfaces with which they co-act.

Fig. 4 illustrates the shape and arrangement of the parts 62 and 66 after initial assembly with respect to the vertically extending portion 52 of the member 18. Fig. 1 illustrates the positions
70 which these parts take after being assembled with the remaining parts of the rotor and being subjected to centrifugal force. It will be seen from Fig. 1 that the centrifugal force acting upon the unsupported portions of the members 62 pro-
75

jects them outwardly into sealing engagement with the co-acting sealing surfaces of the liner 44.

The desired degree of plasticity and tendency to assume permanently the shape which they assume under the influence of centrifugal force, which constitutes the most important feature of the invention with respect to the members 62 and 66, can be attained by constructing these members of lead, tin or zinc or other metals or alloys having a sufficient degree of plasticity to cause them to assume the shape of the member within which they rotate. This will be evident from comparing Fig. 4 of the drawing with Fig. 1. The choice of materials to be used in constructing the members 62 and 66 will depend somewhat upon the stress applied to these members incident to rotation of the rotor but the fundamental consideration in making a choice of material is the consideration of employing a material which is sufficiently plastic to operate in the manner discussed above in connection with the particular stress and particular centrifugal force for which the centrifugal separator is designed. In work done by the present applicant involving a centrifugal separator employing a ring 62 having an outer diameter of 12.210" and rotating at a speed of 6200 R. P. M. to effect a separating force at the outer circumference of the separating chamber of the rotor which is approximately equal to 6560 times the force of gravity, lead sealing members have been found to be most successful. Separators employed in the practice of the principles of the invention may vary in the magnitude of the centrifugal force applied at the outer circumference of their separating chambers between a force of 1500 times the force of gravity and 7500 times the force of gravity or within even wider limits, and the stress upon a unit mass of the ring 62 caused by the action of centrifugal force upon itself may also vary within wide limits. In any case, in the practice of the invention a material is chosen for the construction of the sealing rings 62 which has the necessary degree of plasticity under the stress applied to its outermost surface, by reason of the action of centrifugal force upon the entire ring, to cause the outer surface to flow into irregularities in the liner 44. The thickness of the rings 62 must be sufficiently great to give these rings enough mass to exert the necessary amount of sealing pressure against the co-acting surface of liner 44 but it must not be so great as to prevent or unduly retard the relative reciprocation of the rotor sections under the influence of the springs 28 and the hydraulic actuating liquid respectively.

I am aware that centrifugal separators of the general type of the present invention have heretofore been designed and that flexible metallic sealing members have been employed in such separators. I believe, however, that the present invention represents the first instance of the employment of very plastic metals in this connection.

An important feature of the invention consists in the arrangement of guiding means for insuring registry of the liner 44 with the desired portion of the gasket 45. These guide means consist of a ring 68 which is secured by bolts to the lower surface of the rotor section 12 and spaced from that rotor section by the interposition of guide thimbles 70 between the ring 68 and the overhanging flange 72 of the section 12. Guide pins 74 are secured to the ring 46 and project upwardly into openings in the ring 68

and into the thimbles 70. It will thus be seen that the rotor parts are guided and accurately registered during their relative axial movement by the positioning of the guide pins 74 within the thimbles 70. Thimbles 70 perform an important function in addition to the fact that they afford an elongated guide for pins 74 in that they prevent erosion of the guide pins 74 by impact of sludge thereagainst. These thimbles also prevent the ingress of sludge into the guide pin openings and thus prevent cloggage of these openings and impairment of the guiding function.

Modifications will be obvious to those skilled in the art and I do not wish, therefore, to be limited except by the scope of the subjoined claims.

I claim:

1. In a centrifugal separator, the combination comprising a rotor composed of two normally abutting sections effecting closure of a separating chamber of the rotor but axially movable into non-abutting relationship to permit discharge of sludge between them, means for effecting relative axial movement between said rotor sections, pins secured to one of said rotor sections adjacent its zone of abutment with the second rotor section, and thimbles secured to the second rotor section and aligned with said pins, said thimbles extending between said rotor sections across said sludge discharge opening and serving to guide said pins in the reciprocating movements of the rotor parts.

2. In a centrifugal separator, the combination comprising a rotor composed of two normally abutting sections effecting closure of a separating chamber of the rotor but axially movable into non-abutting relationship to permit discharge of sludge between them, means for effecting relative axial movement between said rotor sections, pins secured to one of said rotor sections adjacent its zone of abutment with the second rotor section, an annular ring secured to said second rotor section adjacent said zone of abutment and spaced from said second rotor section, said annular ring lying in guiding contact with a portion of said first rotor section and being substantially circumferentially co-extensive with the adjacent portions of the rotor section, and thimbles aligned with said pins and extending between said rotor sections and interconnecting said ring with said second rotor section, said thimbles serving to guide said pins in the reciprocating movements of the rotor parts.

3. In a centrifugal separator, the combination comprising a rotor composed of two normally abutting sections effecting closure of a separating chamber of the rotor but axially movable into non-abutting relationship to permit discharge of sludge between them, means for effecting relative axial movement between said rotor sections, an annular ring secured to one of said rotor sections adjacent its zone of abutment with the second rotor section, pins placed about said ring and secured thereto, a second annular ring secured to and spaced from said second rotor section and lying in guiding contact with a portion of said first rotor section, said annular rings being substantially circumferentially co-extensive with the adjacent portions of the rotor section, and thimbles extending between said rotor sections from guide openings in said second annular ring into said second rotor section, said thimbles being aligned with said pins and serving to guide said pins in the reciprocating movements of the rotor parts.

4. In a centrifugal separator, the combination comprising a rotor composed of two normally abutting sections effecting closure of a separating chamber of the rotor but axially movable into
5 non-abutting relationship to permit discharge of sludge between them, means for effecting relative axial movement between said rotor sections, an annular ring secured to one of said rotor sections adjacent its zone of abutment with
10 the second rotor section, pins placed about said ring and secured thereto, a second annular ring secured to and spaced from said second rotor section and lying in guiding contact with a portion of said first rotor section, said annular rings
15 being substantially circumferentially co-extensive with the adjacent portions of the rotor sections, thimbles extending between said rotor sections from guide openings in said second annular ring into said second rotor section, said thimbles being
20 aligned with said pins and being arranged in abutting relationship to portions of said second ring and said second rotor section in order to space said second ring from said second rotor section, said thimbles serving to guide said pins
25 in the reciprocating movements of the rotor parts.

5. In a centrifugal separator, the combination comprising a rotor composed of two normally abutting sections effecting closure of a separating chamber of the rotor but axially movable
30 into non-abutting relationship to permit discharge of sludge between them, means for effecting relative axial movement between said rotor sections, an annular ring secured to one of said rotor sections adjacent the zone of abutment of said sections but spaced from the rotor
35 section to which it is secured, said annular ring being substantially coextensive with the adjacent portions of the rotor sections, said rotor section to which said ring is not secured being provided with a portion having a guiding surface
40 abutting the inner surface of said ring and to be guided thereby during the opening and closing movements of the sections of the rotor.

6. A centrifugal separator comprising a rotor,
45 and including a relatively reciprocable cylinder and piston designed to move axially relatively to each other, and means for sealing the space between said cylinder and piston against the passage of liquid therethrough, said sealing
50 means comprising a metallic ring mounted to rotate with the piston and having an axially extending portion of a sufficient degree of plasticity to cause it to flow plastically against irregularities in the surface of the cylinder wall under
55 the influence of centrifugal force between 1500 and 7500 times the force of gravity and thereby effect the desired sealing function.

7. A centrifugal separator comprising a rotor, and including a relatively reciprocable cylinder and piston designed to move axially relatively to
60 each other, and means for sealing the space between said cylinder and piston against the passage of liquid therethrough, said sealing means comprising a lead ring mounted on said piston for rotation therewith in a position in
65 which the lead ring is adapted to flow plastically against irregularities in the surface of the cylinder wall under the influence of centrifugal force

between 1500 and 7500 times the force of gravity caused by rotation of said piston and thereby effect the desired sealing function.

8. A centrifugal separator comprising a rotor, and including a relatively reciprocable cylinder
5 and piston designed to move axially relatively to each other, and means for sealing the space between said cylinder and piston against the passage of liquid therethrough, said sealing means comprising a zinc ring mounted on said
10 piston for rotation therewith in a position in which the zinc ring is adapted to flow plastically against irregularities in the surface of the cylinder wall under the influence of centrifugal force between 1500 and 7500 times the force of gravity
15 caused by rotation of said piston and thereby effect the desired sealing function.

9. A centrifugal separator comprising a rotor, and including a relatively reciprocable cylinder and piston designed to move axially relatively to
20 each other, and means for sealing the space between said cylinder and piston against the passage of liquid therethrough, said sealing means comprising a tin ring mounted on said piston for rotation therewith in a position in which the tin
25 ring is adapted to flow plastically against irregularities in the surface of the cylinder wall under the influence of centrifugal force between 1500 and 7500 times the force of gravity caused by rotation of said piston and thereby effect the
30 desired sealing function.

10. A centrifugal separator comprising a rotor, and including a relatively reciprocable cylinder and piston designed to move axially relatively to
35 each other, and means for sealing the space between said cylinder and piston against the passage of liquid therethrough, said sealing means comprising a metallic ring annularly secured to the piston and having a second annular portion unsecured and capable of movement
40 under the influence of centrifugal force, said second annular portion having an axially extending portion of a sufficient degree of plasticity to cause it to be plastically deformed against irregularities in the surface of the cylinder wall under centrifugal force between 1500 and 7500
45 times the force of gravity and thereby effect the desired sealing function.

11. A centrifugal separator comprising a rotor and including a relatively reciprocable cylinder and piston designed to move axially relatively
50 to each other, and means for sealing the space between said cylinder and piston against the passage of liquid therethrough, said sealing means comprising a pair of metallic rings provided with radially extending flanges which are
55 secured to the piston and with axially extending free annular portions extending in opposite directions from the zone of securement to the piston, the axially extending portions of said rings having a sufficient degree of elasticity to cause
60 them to be plastically deformed against irregularities in the surface of the cylinder wall under centrifugal force between 1500 and 7500 times the force of gravity and thereby effect the desired sealing function.

WILMER H. BATH.

CERTIFICATE OF CORRECTION.

Patent No. 2,209,554.

July 30, 1940.

WILMER H. BATH.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 42, for the word "opening" read --openings--; and second column, line 24-25, for "membes" read --member--; page 3, second column, line 23, claim 1, for "betwen" read --between--; line 23-24, same claim, for "efrecting" read --effecting--; page 4, first column, line 17, claim 4, before "thimbles" insert --and--; line 20, same claim, for "aranged" read --arranged--; same page, second column, line 18, claim 9, for "ceintrifugal" read --centrifugal--; line 60, claim 11, for "lasticity" read --plasticity--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of October, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.