Feb. 23, 1954 R. C. RIED 2,670,131

CENTRIFUGE WITH INTERSTAGE WASHING

Filed May 23, 1951

2 Sheets-Sheet 1

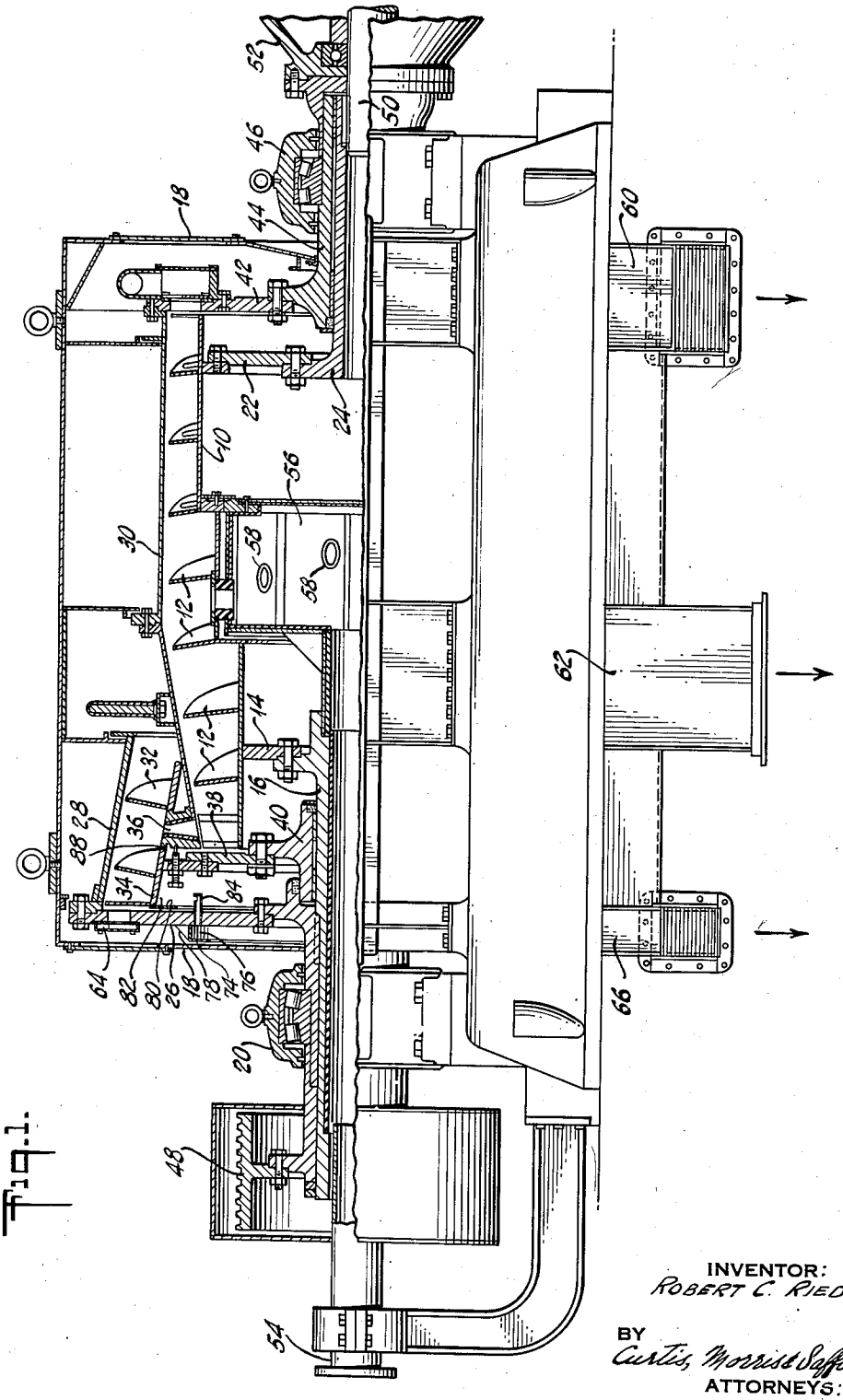


Fig. 1.

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Filed May 23, 1951 2 Sheets-Sheet 2

Fig. 2.

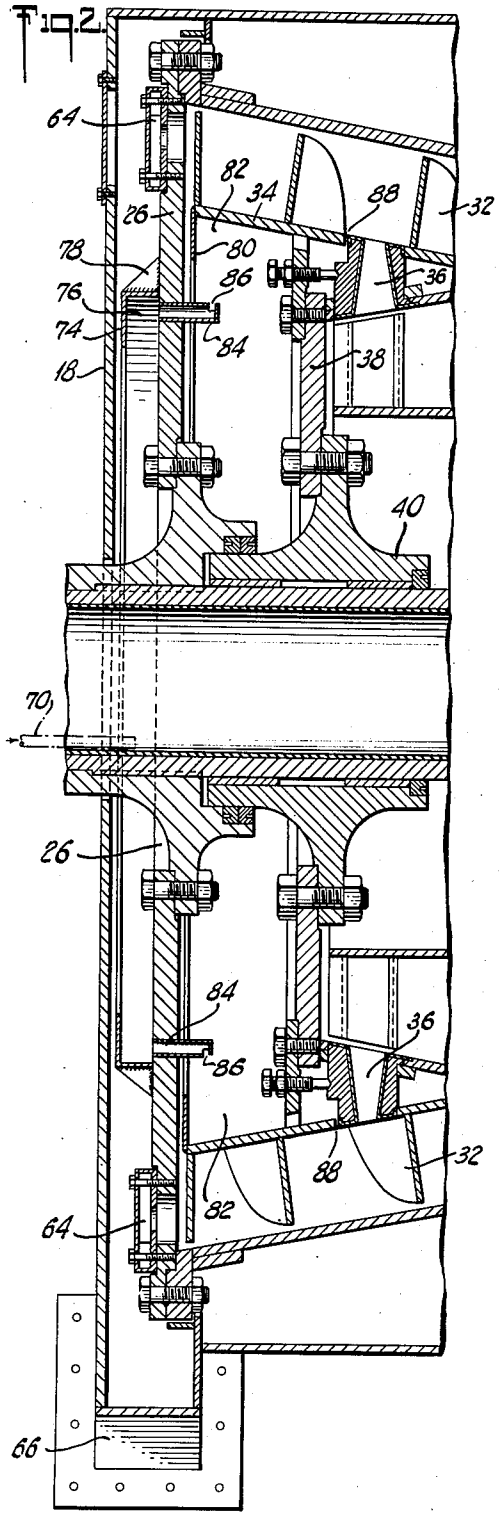


Fig. 3.

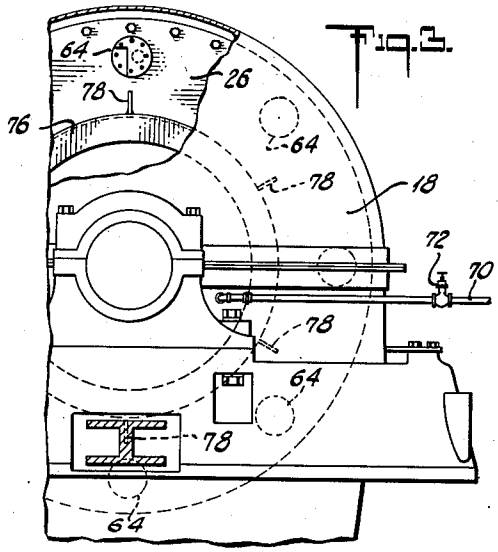


Fig. 4.

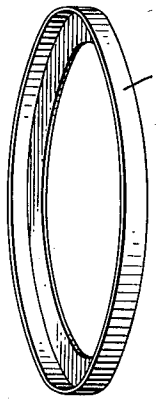


Fig. 5.

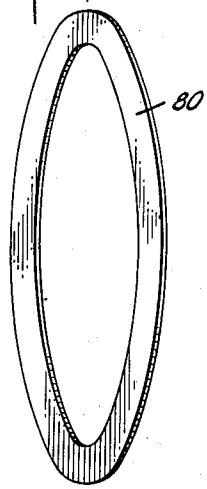
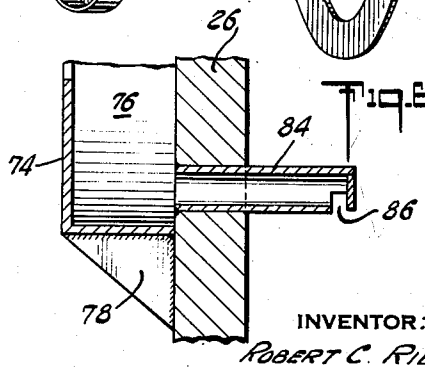


Fig. 6.



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CENTRIFUGE WITH INTERSTAGE WASHING

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Application May 23, 1951, Serial No. 227,908

3 Claims. (Cl. 233—14)

1

This invention relates to continuous centrifuges of the type adapted to be used in separating solids and liquids and more particularly to an improved inter-stage washing means for such centrifuges. Structures embodying the invention are particularly useful in two-stage centrifuges wherein separation is effected by the cooperative action of solid centrifuge bowls and screw conveyor scrolls rotatable with respect to the bowl, such as for example, the centrifuges disclosed in the copending applications of Robert C. Ried and Chester L. Knowles, Serial No. 84,638 filed March 31, 1949, now abandoned, and application Serial No. 84,516, filed by Otto R. Kuster and Robert C. Ried on March 31, 1949. Accordingly a preferred embodiment of present invention will be illustratively described as incorporated in this type of centrifuge, although as the description proceeds it will become apparent that the present structure may be used equally well with various other types of centrifuges.

Centrifuges such as those described in the above-identified copending applications may be used for example to effect separations of mixtures of water and relatively fine coal, e. g. minus ¼ inch particles, that are produced in coal-cleaning plants. In the operation of such a multi-stage centrifuge, it is often desirable to introduce a washing liquid between the stages at a point where it will mix with the partially separated solids during their inter-stage transfer. Such washing may be desirable, for example, to remove soluble salts contained in the surface moisture on the solid particles, or to remove entrapped slimy material, or to lower the viscosity of the solid material to permit more efficient de-liquification in the subsequent stage of the centrifuge. In order to achieve the most effective washing, it is necessary to introduce the washing liquid at approximately the point of discharge of solids from the preceding stage, thus providing the maximum time for intermingling of the solids and washing liquid and washing of the solids by the liquid before separation of liquid and solids occur in the next stage. Since in centrifuges of the type disclosed in the above-referred-to applications the co-axial rotors rotate at relatively high and somewhat different speeds, the introduction of washing liquid at the optimum point presents a difficult problem.

It is a principal object of the present invention to provide an improved means for introducing inter-stage washing liquid into a multi-stage continuous centrifuge. It is another object of the invention to provide inter-stage washing means

2

that avoids the use of a revolving joint, packing gland or like mechanical seal. It is still another object of the invention to provide means for introducing wash water into a multi-stage centrifuge at approximately the point of discharge of solids from a stage other than the last stage. It is a further object of the invention to provide inter-stage washing means without using a pipe or conduit that obstructs the flow of separated solids or liquids in either stage of the machine. It is a still further object of the invention to provide for introduction of inter-stage wash water in such a centrifuge without cutting of the conveying scroll with resultant reduction in conveyor capacity. Other objects of the invention will be in part obvious and in part pointed out hereafter.

The many objects and advantages of the present invention may best be understood and appreciated by reference to the accompanying drawings which illustrate a centrifuge incorporating a preferred embodiment of the present invention and wherein:

Fig. 1 is an elevation partly in vertical section showing the general construction of the centrifuge;

Fig. 2 is a vertical section through the left-hand end of the centrifuge rotors showing the construction of the liquid-retaining channels;

Fig. 3 is a partial left-end elevation broken away to show one of the liquid retaining rings;

Fig. 4 is a perspective view of the liquid-retaining ring of the low-speed rotor;

Fig. 5 is a perspective view of the liquid-retaining ring of the high-speed rotor; and

Fig. 6 is a detailed section showing one of the washing-liquid transfer conduits.

Referring to the drawings and particularly to Fig. 1, the centrifuge there shown is a two-stage solid bowl machine comprising a pair of co-axial rotors, one of which rotates at a somewhat higher speed than the other. The low-speed rotor comprises a stepped cylindrical core 10 having mounted on the outer surface thereof a screw conveyor scroll 12. The core 10, at its left-hand end is mounted through a head 14 on a hollow shaft 16 that extends laterally to the left through the casing 18 of the centrifuge and is supported in a self-aligning bearing 20 outside the casing. At its right-hand end the core 10 is mounted through head 22 on a hollow shaft 24 that extends through the right-hand end of casing 18. Secured to the hollow shaft 16 near the left-hand end of casing 18 and within the casing, there is an end plate or head 26 which carries at its pe-

riphery the tapered second-stage centrifuge bowl 28. The scroll 12 of the first stage of the centrifuge and the bowl 28 of the second stage of the centrifuge rotate as a unit.

The higher speed rotor comprises a first stage centrifuge bowl 30 that is mounted to cooperate with scroll 12 and a second stage-scroll 32 that is positioned to cooperate with the second stage centrifuge bowl 28. The scroll 32 is mounted on a tapered core 34 which at its small end embraces and is secured to the exterior of the tapered left-hand end of bowl 30. The centrifuge bowl 30 communicates at its tapered end with the bowl 28 through a circumferentially arranged series of ports or passages 36, only one of which is shown in Fig. 1. The high-speed rotor, including bowl 30 and scroll 32, is mounted at its left-hand end through a head 38 and bearing 40 on hollow shaft 16. At its right-hand end the high-speed rotor is mounted through head 42 and hollow shaft 44 in a self-aligning bearing 46, located outside the centrifuge casing 18.

To drive the rotors, the hollow shaft 16 is provided near its left end with a pulley 48 which may be driven by a multiple V-belt from a suitable power source (not shown). The low-speed rotor is driven directly through pulley 48 and the high-speed rotor indirectly therefrom. Referring to the right-hand portion of Fig. 1, the hollow shaft 24 is keyed to a shaft 50, and the hollow shaft 44 is secured to the housing 52 of a gear mechanism (not shown). The shaft 50 and housing 52 are interconnected by a gear mechanism described in detail in the above-referred-to application Serial No. 84,516 in such manner that the high-speed rotor is driven a few revolutions per minute faster than the low speed rotor.

The mixture of liquid and solids to be separated enters the machine at the left-hand end thereof through a pipe 54 that extends through the hollow shaft 16 to the feed chamber 56. It then passes through the hole 58 to the interior of bowl 30 which is rotating at a somewhat higher speed than scroll 12. The bowl 30 and scroll 12 cooperate to cause liquid to flow to the right-hand end of bowl 30 and be discharged through the first-stage liquid discharge passage 60. The partially separated solids flow to the left and pass through the ports 36 to the second-stage bowl 28 wherein a further separation takes place. In the second stage solids move toward the right and are discharged from the machine through solids discharge passage 62. Separated liquid flows to the left and passes through one of a series of liquid seal chambers 64 whereupon it is discharged from the machine through second-stage discharge passage 66. The seal chambers 64 may be of the type disclosed and claimed in my co-pending application Serial No. 227,909, filed on the same day as the present application.

Referring now to Figures 2 and 3, washing liquid is supplied to the machine from a suitable source (not shown) through a pipe 70 having a regulating valve 72 therein. The pipe 70, as shown in Fig. 2, extends through the casing 18 and terminates a short distance from the end plate 26 of the low-speed rotor. Mounted on the end-plate 26 there is a ring 74 (also shown in Fig. 4) which cooperates with end plate 26 to form an annular channel 76. The ring 74 is secured to end plate 26 by a series of triangular plates 78 that are welded to the ring and end plate respectively. When the centrifuge is in operation, washing liquid that flows through pipe 70 is thrown outwardly into the channel 76 and is retained therein by centrifugal force.

Secured to the larger end of scroll support 34 there is a second ring 80 (also shown in Fig. 5) which cooperates with the scroll support 34 to define a second channel 82 adapted to contain a body of the washing liquid when the centrifuge is in operation. Transfer of washing liquid from channel 76 to channel 82 is effected by means of the liquid-transfer conduits 84. Referring particularly to Fig. 6, the conduits 84 are secured in the end plate 26 and are provided with the notches 86 at their inner ends to permit passage of liquids therethrough. The discharge notches 86 as shown in Fig. 2 are positioned within the margin of the scroll support 34 and hence during operation of the centrifuge liquid flowing through the conduits 84 is thrown outwardly into channel 82.

The scroll support 34 is provided adjacent to each passage 36 with the ports or holes 88 which communicate with the washing liquid in channel 82 and serve to permit flow of the washing liquid to the separating space of the second stage of the centrifuge and to produce intermingling of the washing liquid with the solids flowing through the passages 36.

From the foregoing description it is apparent that the present invention provides a structures capable of achieving the several objects outlined above. The washing liquid is brought into contact with the inter-stage solids as they enter the separating space of the second stage of the centrifuge and therefore an adequate opportunity for mixing and washing is provided. The washing liquid flows from a stationary source to the rapidly moving ports 88 smoothly and uniformly and without the interposition of any revolving joint or mechanical seal. Moreover it is introduced under such conditions that it does not interfere with movement of either solids or liquid in either stage of the machine. Convenient regulation of the rate of supply of washing liquid is achived by means of the valve 72. It is evident that more than one pipe 70 may be provided if desired and a number of washing liquids supplied either simultaneously or sequentially.

It is of course to be understood that the foregoing description is illustrative and that numerous changes might be made in the specific structure described without departing from the scope of the invention as defined in the appended claims.

What is claimed as new is:

1. A two-stage centrifuge adapted to be used in separating a particulate solid material from a liquid comprising, in combination, a first rotor including a first-stage centrifuge bowl and a second-stage conveyor scroll, a second rotor coaxial with said first rotor and including a first-stage conveyor scroll adjacent to the inner surface of said first-stage bowl and a second-stage bowl embracing said second-stage scroll, said first stage bowl and scroll being located at least partially within said second stage scroll and bowl, driving means for driving said two rotors at different speeds, whereby each of said centrifuge bowls cooperates with its adjacent scroll to effect at least a partial separation of said solid material and liquid, the solids discharge end of said first rotor being provided with a plurality of passages for conducting said solid material to said second-stage bowl and the liquid discharge end of said second-stage bowl being provided with an end plate, a first annular ring mounted on said

end plate and cooperating therewith to define a first liquid-retaining channel, means for supplying a washing liquid to said channel, a second annular ring mounted at the solids discharge end of said first rotor and cooperating therewith to form a second liquid-retaining channel, a plurality of conduits communicating with said first channel and extending through said end plate to a point opposite said second channel, and a port adjacent to each of said passages and interconnecting said second channel and the second stage separating space of said centrifuge whereby washing liquid can be supplied to said solid material as it passes from the first to the second stage of said centrifuge.

2. A centrifuge according to claim 1 and wherein said rotors are encased in a housing, said washing liquid-supply means is a conduit extending through said housing to a point opposite said first channel and said conduit is provided externally of said housing with a regulating valve for regulating the quantity of washing liquid supplied to said solid material.

3. A two-stage centrifuge adapted to be used in separating a particulate solid material from a liquid comprising, in combination, a first rotor including a first-stage centrifuge bowl having a tapered solids discharge end, a second-stage conveyor scroll, a tapered support for said second-stage scroll embracing the tapered end of said first-stage bowl and a plurality of passages interconnecting the tapered end of said first bowl with said tapered support for conducting solid material from said first-stage bowl to said second-stage scroll; a second rotor co-axial with said first rotor and including a first-stage conveyor scroll adjacent to the inner surface of said first-stage bowl and a second-stage bowl embracing

said second-stage scroll; driving means for driving said two rotors at different speeds whereby each of said centrifuge bowls cooperates with its adjacent scroll to effect at least a partial separation of said solid material and liquid and causes separated solid material to flow through said passages, the liquid discharge end of said second-stage bowl being provided with an end plate; a first annular ring mounted on said end plate and cooperating therewith to define a liquid-retaining channel; means for supplying a washing liquid to said first channel; a second annular ring affixed to the larger end of said tapered scroll support and defining therewith a second liquid-retaining channel, a plurality of conduits communicating with said first channel and extending through said end plate to a point opposite said second channel for conducting liquid from said first channel to said second channel, said scroll support being provided adjacent to each of said passages with a plurality of ports communicating with said second channel, whereby washing liquid can be supplied to said solid material as it flows from the first to the second stage of said centrifuge.

ROBERT C. RIED.

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