Jan. 21, 1958 H. C. FITZSIMMONS 2,820,589

CENTRIFUGAL SEPARATOR

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FIG. 1.

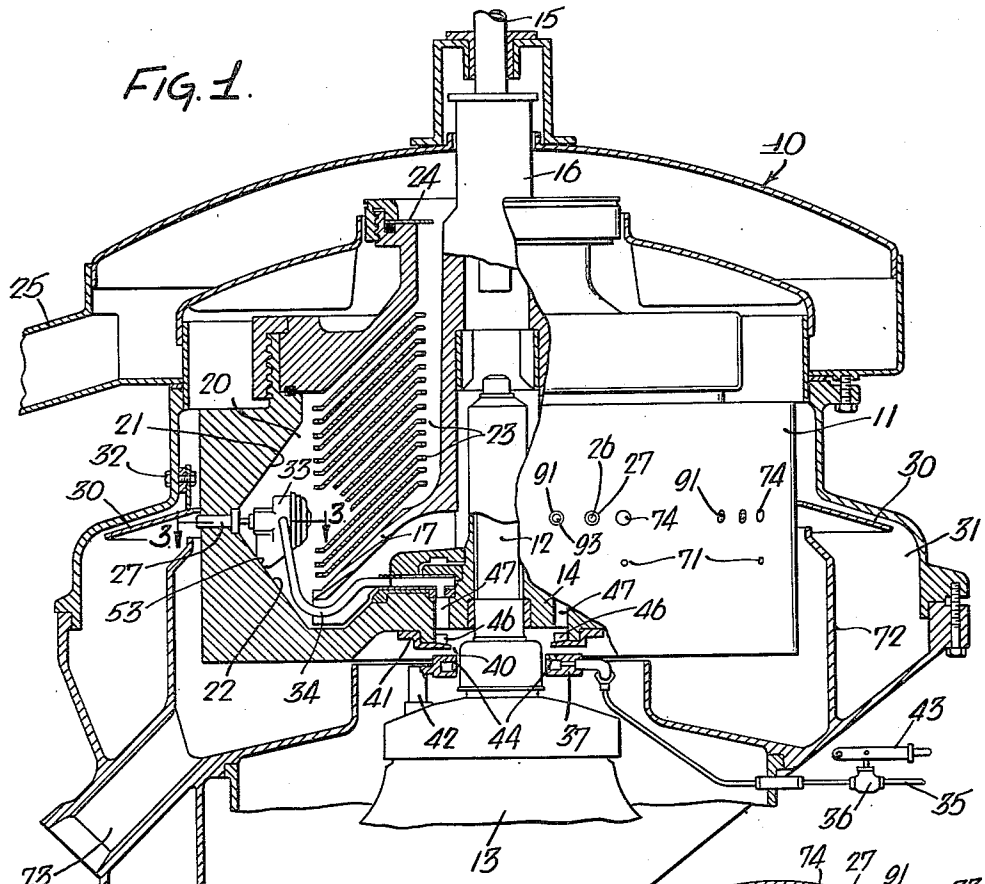
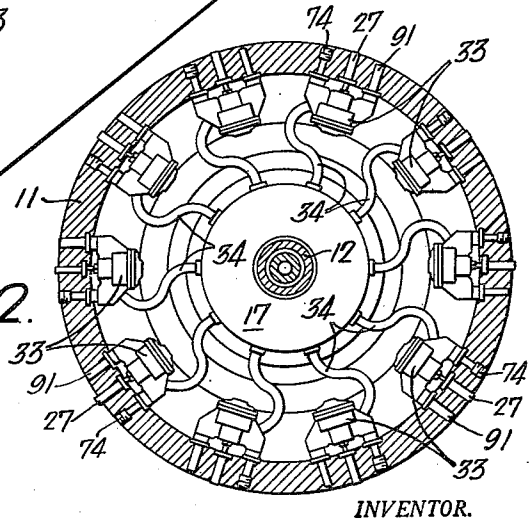


FIG. 2.



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FIG. 3.

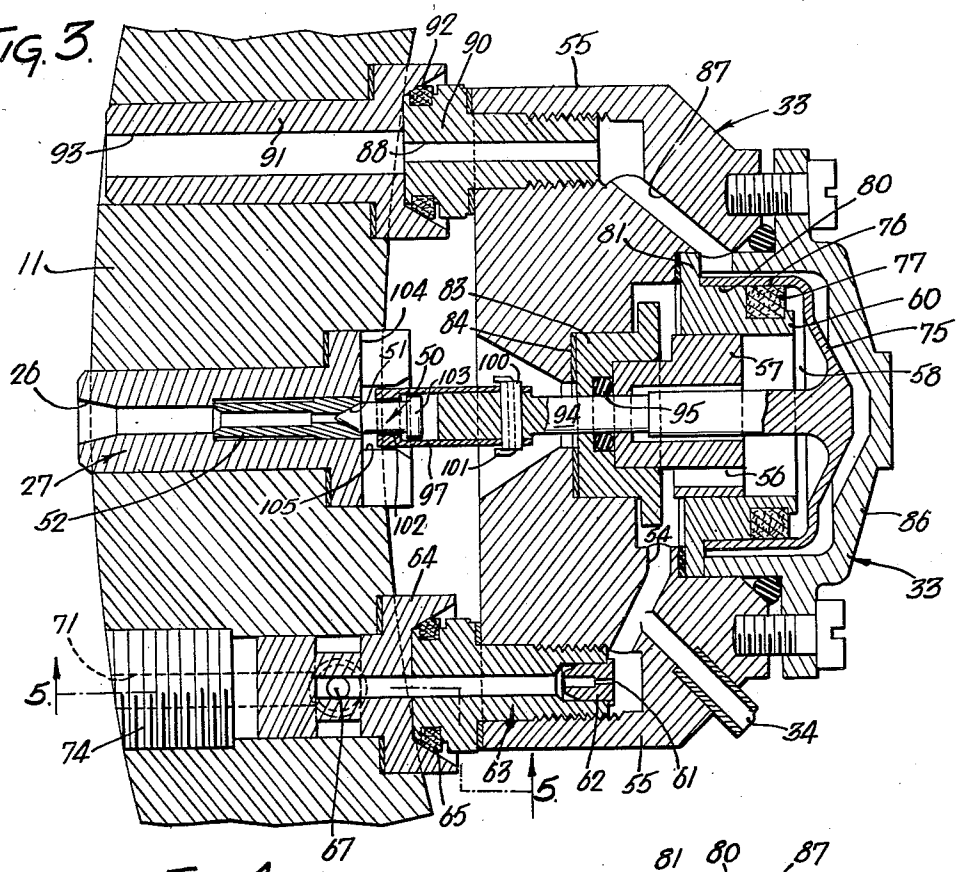
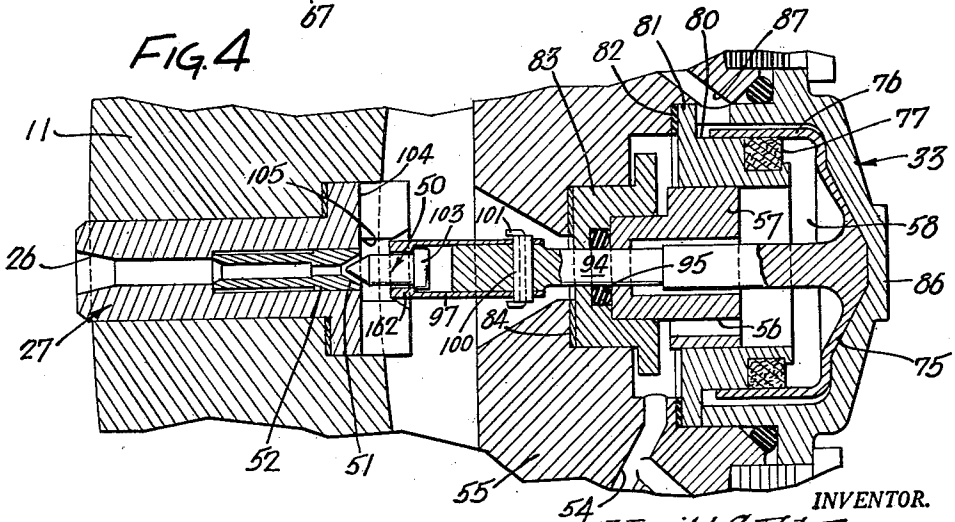


FIG. 4



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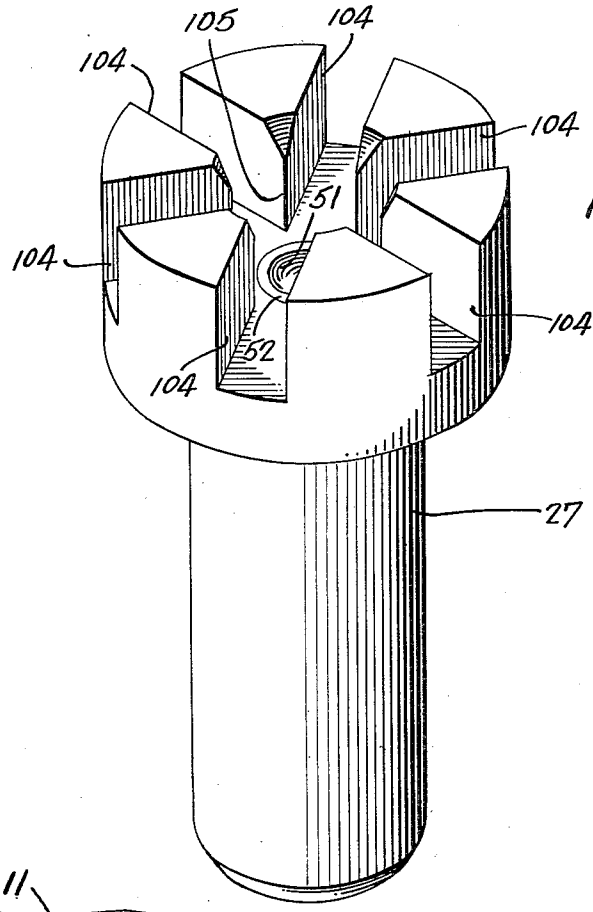


FIG. 6.

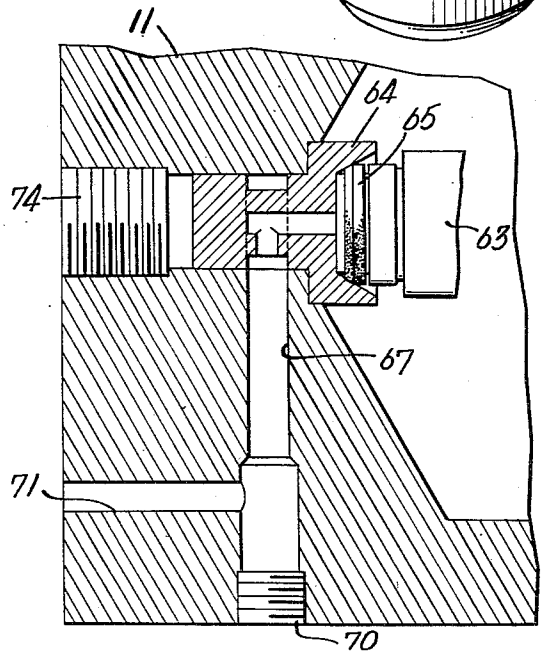


FIG. 5.

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United States Patent Office 2,820,589 Patented Jan. 21, 1958

2,820,589

CENTRIFUGAL SEPARATOR

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Continuation of abandoned application Serial No. 315,725, October 20, 1952. This application March 23, 1956, Serial No. 573,385

6 Claims. (Cl. 233—20)

This invention relates generally to centrifuges, and it relates particularly to centrifuges of the type designed to effect sedimentation or separation of solids from liquids. For convenience the solids or high-density material will be referred to herein as sludge, and the lower-density materials will be called the liquid, although it is to be understood that the liquid may be separated by the centrifuge into various phases of different densities. Thus, the primary purpose of the centrifuge may be to remove sludge from a liquid, or the removal of sludge may be incidental to the centrifugal separation of the liquid into two or more phases.

This application is a continuation of the prior application for Harold C. Fitzsimmons for Industrial Process and Apparatus, Serial No. 315,725, filed October 20, 1952, and now abandoned.

It has heretofore been proposed to remove sludge from a rapidly rotating centrifuge rotor through a plurality of sludge valves spaced around the periphery of the rotor, the inner surfaces of the rotor sloping toward the valves in order that the sludge will be carried to the valves by centrifugal force.

In machines of this kind, the valves are usually operated by fluid pressure or other motors to discharge the accumulated sludge periodically. In the design of such a centrifugal separator it is important that an arrangement be provided which is durable, and capable of operating over a long period of time without damage to the valve disc or valve stem or valve seat, while being sealed against leakage at all times when the valve is in a closed position. In the past, however, these results have not been attained because in the prior art constructions when the valves are moved to their closed position the large centrifugal force generated by the mass of the valve operating parts is imparted directly to the valve element and seat in hammer-like blows which cause rapid wear and damage to these parts.

With the foregoing in mind, the principal object of the present invention is to provide an improved sludge valve construction for centrifuge machines in which the valve parts are not subject to rapid wear and damage caused by heavy hammer-like blows imparted to them by closing of the valve.

Further objects and advantages of the invention will be apparent from the following more detailed description thereof with reference to the accompanying drawings, in which:

Fig. 1 is a side elevational view, partly in section, of a centrifuge embodying the invention with portions thereof shown broken away to disclose internal structure thereof;

Fig. 2 is a horizontal sectional view taken just above the sludge valves of Fig. 1 with other parts omitted;

Fig. 3 is an enlarged sectional view of one type of sludge valve assembly taken on the line 3—3, Fig. 1;

Fig. 4 is a fragmentary sectional view similar to Fig. 3 showing the valve in open position;

Fig. 5 is a sectional view taken on line 5—5, Fig. 3; and,

Fig. 6 is an enlarged detached perspective view showing a detail of the construction of the sludge valve bushing.

Referring to the drawings, the invention in one form has been shown as applied to a centrifuge **10**. The rotor **11** is driven by a shaft **12**, mounted for rotation within a support **13**, and itself driven by any suitable form of motor, not shown. The rotor **11** is secured to a sleeve **14** which is secured to and rotates with shaft **12**.

The mixture of liquids and solids supplied through a feed or inlet pipe **15** flows downwardly through the space between tube **16** and sleeve **14** and outwardly below the skirt **17** of tube **16**. The easily separable solids move into the space or chamber **20** formed by the inclined walls **21** and **22** of the rotor **11**. Efficient separation or sedimentation of the remaining solids takes place as liquid flows inwardly of the stratifying discs **23** and the sludge or heavier solid material flows outwardly therefrom. The liquid flows upwardly in the space adjacent the periphery of tube **16** and over a ring dam **24** for discharge by way of stationary outlet **25**.

Sludge collecting anywhere in the region of intersection of walls **21** and **22** is discharged through openings **26** of a plurality of bushings **27** and is deflected downward by a conical skirt or ring **30** and is discharged from a chute **31**. The deflecting skirt **30** may be supported in any suitable way such as by bolts **32** extending through the stationary housing.

Associated with each of the plurality of bushings **27**, ten of them being shown in Fig. 2, is a sludge valve assembly **33**. Each such assembly has connected thereto a tube or pipe **34** forming a passageway in flow communication with an external source of an auxiliary liquid. In Fig. 1 the auxiliary liquid from a supply pipe **35**, under control of a manually operable valve **36** of the fast-opening and closing type, is directed upwardly by a spray ring **37** into proximity with the overhanging lip **40** of a cup **41** secured to the rotor **11**. The ring **37** is supported as by a bracket **42** secured to the stationary support **13**.

In accordance with the present invention, upon opening of the valve **36**, as by a lever **43**, liquid is directed through each of a plurality of openings **44** toward the inner edge of lip **40** and into the annular recess formed thereby. With the aid of a plurality of fins **46**, the auxiliary liquid is quickly brought up to the speed of the rotor **11**. The liquid flows upwardly through each flow channel **47** into one of the connecting passageways or tubes **34**.

Before valve **36** of Fig. 1 is opened to admit the auxiliary liquid, centrifugal force, due to the high speed rotation of rotor **11**, is effective in maintaining the valve element **50** firmly seated against the valve seat **51** at the inner end of bushing **27**. The valve seat **51** may be formed in a removable insert **52** of suitable wear-resistant material. Each valve-operating assembly **33** is supported by the tube **34** attached to the valve body and it is also supported from inclined surface **22**, for example, by the angularly disposed surface **53** of the valve body **55** (see Fig. 1).

Referring to Fig. 3 of the drawings, it will be seen that the pipe or tube forming passageway **34** is connected in flow communication with a channel **54** in valve body

55 which leads by way of openings 56 in cylinder plug 57 into chamber 58 of the cylinder 60. From a branch of channel 54 liquid may flow to an orifice or leak-port 61 formed in a member 62 snugly fitting into a leak bushing 63 threaded into the valve body 55. A flat end of bushing 63 engages a flat surface of bushing 64 inserted into the rotor 11, and the opening in rotor 11 in which the bushing 64 is located is closed by a screw plug 74. A seal ring 65 is provided in the region of the flared end of bushing 64 to form a liquid-tight connection. Leakage liquid flows downwardly through a passage 67 closed at its lower end by screw plug 70, Fig. 5, and outwardly through opening 71 of rotor 11, two of such openings 71 appearing in Fig. 1. With further reference to Fig. 1, it will be seen that the leak openings 71 are disposed below the upper edge of skirt or annular member 72 of the frame, and the auxiliary liquid is thus kept from mixing with the sludge discharged above the upper edge of member 72. The auxiliary liquid is discharged from the centrifuge through passage 73.

Movement of each valve element 50 with respect to its seat 51 is accomplished by a piston 75 which is operatively connected to the valve element 50 as hereinafter set forth. The piston 75 is provided with a skirt 76, the inner finished surface of which slides in substantially liquid-tight engagement with a packing or piston ring 77 supported by the cylinder 60. The piston skirt 76 also slides upon the outer wall 80 of the cylinder member 60 which is provided with an outer peripheral flange 81 engaging an annular sealing ring 82.

The cylinder plug 57 has a reduced end portion which fits into the recess of a cup 83 whose base engages against a gasket or seal 84 which is seated on a flat surface portion of body 55. When the centrifuge is operating, centrifugal force urges the respective parts 81 and 83 outwardly against the seals 82 and 84, the cylinder plug 57 having sufficient mass to insure a liquid-tight seal at the ring 84. Of course, the plug 57 is free to move outwardly relative to cylinder 60.

While little leakage may be anticipated between ring 77 and the skirt 76 of piston 75, provision is made to prevent accumulation of liquid between the outer face of the piston 75 and the cap or cylinder head 86. This is accomplished by providing a passage 87 in the body 55 which is in flow communication between the space at the outer side of the piston 75 and the opening 88 through a bushing 90 which in turn abuts a bushing 91 in the rotor 11, a sealing ring 92 being provided to engage the flared end of bushing 91. Any accumulation of liquid at the outer face of the piston 75 is discharged through the bore 93 of bushing 91. Cylinder head 86 is secured in place by means of bolts, as shown, or other suitable means. Carried by the piston 75 is a valve rod or stem 94 which extends through aligned openings in cylinder plug 57 and cup 83, the latter having a recess in which there is disposed packing or a sealing ring 95. Centrifugal force and fluid pressure acting upon the packing or seal ring 95 keeps it in liquid-tight sealing relation with piston stem 94 and the adjacent enclosing wall.

Connection between the valve element 50 and the valve stem or rod 94 is effected by means of a tubular sleeve 97 which provides a lost-motion connection between stem 94 and the element 50. The inner end of the sleeve 97 is telescoped over the end portion of the stem 94 and is secured thereto by means of a small tube 100 which extends diametrically through the sleeve and stem as shown particularly in Figs. 3 and 4 of the drawings, a wire 101 being passed through the tube 100 and having its ends bent to secure said tube against displacement. The valve element 50 has an enlarged head portion 103 at its inner end which is slidably received within the outer end portion of the sleeve 97 and is retained against displacement therefrom by end wall portions 102. By this construction the valve element 50 is afforded limited movement axially with respect to the sleeve 97 and stem 94.

Assume that valve 36 is opened to admit auxiliary liquid to the annular chamber formed by the lip 40. As the liquid comes up to speed, it flows upwardly through channel 47 and outwardly through passageway 34 to the inner chamber 58 of the valve cylinder 60. Within a short interval of time, of the order of a tenth of a second, the pressure head exerted by the liquid in the passageway 34 upon the inner face of piston 75 due to centrifugal force on this liquid operates to actuate the piston 75 to the right with respect to Fig. 3, thus unseating the element 50 from its seat 51 and opening the valve to discharge sludge or solid material outwardly through openings 26 of bushing 27.

Referring to Fig. 6 of the drawings, radially extending recesses 104 are provided in the face of the enlarged head portion of bushing 27. These recesses permit the solids or sludge to reach the discharge opening through the bushing 27 while the valve sleeve 97 is still within the central bore 105 of the enlarged head portion of said bushing 27, for example, as shown in Fig. 4 of the drawings. The outward flow of the separated solids due to the sedimentation that has taken place is rapid due to the magnitude of the centrifugal force exerted thereon.

In operation of the centrifuge all of the valve assemblies 33, as shown in Fig. 2, are simultaneously operated and after deflection by skirt 30, the sludge is rapidly discharged from chute 31. The valves need be opened for only a short interval of time and only long enough to empty the chamber 20 of solids. By suitably controlling the supply valve 36, Fig. 1, loss of liquid from rotor 11 may be minimized. The supply valve 36 may be and preferably is automatically opened and closed by a timing mechanism of any suitable type, of which there are several readily available on the market and known to those skilled in the art. In this manner the open and closed times may be selected in conformity with the requirements of the process, whether the main function of the centrifuge be the recovery of sludge present in large quantity, or whether it be clarification of liquids containing only a small amount of sludge.

While the sludge valves are in open position, it will be understood that auxiliary liquid is continuously discharged through orifice 61, but since the admission of liquid is at a rate materially greater than its flow through orifice 61 this orifice does not affect valve operation. However, as soon as supply valve 36 is closed, the passageway 34 is quickly emptied through orifice 61 and, in a time interval of the order of one-tenth of a second after closure of supply valve 36, the piston 75, stem 94 and sleeve 97 are caused to move outwardly under the influence of centrifugal force until the skirt 76 impinges the flange 81 of cylinder 60, which will arrest this motion. Due to the lost-motion connection between the stem 94 and valve element 50, the latter will continue to move outwardly under the influence of centrifugal force until it seats in valve seat 51.

Since the operation of the valves is regulated in relation to the accumulation of solids in the rotor, the frequency of the functioning of the valves may vary widely, depending on the percentage of solids present in the liquid being centrifuged. The valves may, therefore, operate once every few minutes, or once every few seconds. By means of the lost-motion connection between the valve element 50 and stem 94 and the positive limit to movement of the piston 75 provided by the cylinder flange 81, the large centrifugal force engendered by the weight of the stem 94 and piston 75 is not transmitted to the valve element 50 or by the latter to the valve seat 51. As a result, the engagement of the valve element 50 with valve seat 51 is solely the result of centrifugal force exerted on the valve element 50 itself. This force is adequate to create a leakproof seal between the valve parts, but it is a very much reduced

blow upon the valve seat 51 with the result that the motor may operate at high frequencies over long period of time without damage to the valve element 50 and the valve seat 51 which has been found to result in cases where the valve parts are subjected to the full impact of the force generated by the piston and its stem. In addition, since the flange 81 positively limits travel of the piston 75 as set forth no large stresses are developed in the small diameter stem 94 with the result that the possibility of the stem being bent or otherwise damaged is entirely eliminated.

Although the above is illustrative of the practice of this invention in relation to a particular representation of valve, its use is not limited to any one type of valve, but it may be generally applied to different constructions, one of which is illustrated in U. S. Patent No. 2,286,354. Its usefulness does not depend upon whether the valve is actuated by a feed of valve operating liquid as described above, or whether the valve is opened or closed by such an auxiliary liquid, or whether the operation of the valve is automatic in relation to a build-up of solids as described in U. S. Patent No. 2,286,354. It may be applied with advantage wherever a motor-operated valve is subject to the influence of centrifugal force.

While preferred embodiments of the invention have been described herein, modifications thereof may be made within the spirit and scope of the invention as set forth in the following claims.

I claim:

1. In a centrifuge having a rotor for effecting centrifugal sedimentation of solids from a mixture thereof with liquid, means defining a radial discharge passage through the wall of the rotor, a valve seat within said rotor at the inner end of said passage, a valve element of small mass movable coaxially of the valve seat and normally urged into closing engagement with said valve seat by centrifugal force acting thereon, a piston comparatively greater mass movable coaxially of the discharge passage to and from an outer limit position to which it normally is urged by centrifugal force acting thereon, means connecting the valve element to said piston providing axial movement of said valve element relative to the piston between predetermined fixed inner and outer limits, said valve element when engaged upon said valve seat being spaced outwardly from the inner limit of its movement relative to the piston so that seating engagement of the valve element upon the valve seat is effected independently of the piston by the centrifugal force acting solely on the small mass of said element.

2. In a centrifuge having a rotor for effecting centrifugal sedimentation of solids from a mixture thereof with liquid, means defining a radial discharge passage through the wall of the rotor, a valve seat within said rotor at the inner end of said passage, a valve element of small mass movable coaxially of the valve seat and normally urged into closing engagement therewith by centrifugal force acting thereon, a piston of comparatively greater mass movable coaxially of the discharge passage to and from an outer limit position to which it normally is urged by centrifugal force acting thereon, means connecting the valve element to said piston providing axial movement of said valve element relative to the piston between predetermined fixed inner and outer limits, said valve element when engaged upon said valve seat being spaced outwardly from the inner limit of its movement relative to the piston so that seating engagegent of the valve element upon the valve seat is effected independently of the piston by the centrifugal force acting solely on the small mass of said valve element, and means to effect actuation of the piston inwardly of the rotor from its outer limit position to disengage the valve element from said valve seat and open the discharge passage.

3. In a centrifuge having a rotor for effecting centrifugal sedimentation of solids from a mixture thereof with liquid, means defining a radial discharge passage through the wall of the rotor, a valve seat within said rotor at the inner end of said passage, a valve element of small mass movable coaxially of the valve seat and normally urged into closing engagement with said valve seat by centrifugal force acting thereon, a piston of comparatively greater mass movable coaxially of the discharge passage to and from an outer limit position to which it normally is urged by centrifugal force acting thereon, means connecting the valve element to said piston providing axial movement of said valve element relative to the piston between predetermined fixed inner and outer limits, said valve element when engaged upon said valve seat being spaced outwardly from the inner limit of its movement relative to the piston so that seating engagement of the valve element upon the valve seat is effected independently of the piston by the centrifugal force acting solely on the small mass of said valve element, and means to effect actuation of the piston inwardly of the rotor from its outer limit position, said valve element in its closed position being adjacent the outer limit of its movement relative to the piston so that actuation of the piston from its outer limit position in turn actuates the valve element inwardly to disengage the same from said valve seat and open the discharge passage.

4. Apparatus as claimed in claim 2 wherein the means connecting the valve element to the piston comprises a tubular sleeve connected at its inner end to said piston and having at its outer end an opening of smaller size than the bore of the sleeve, and the valve element has a head portion mounted for axial movement within the sleeve, the said head portion of the valve element being larger than the opening in the outer end of the sleeve to prevent displacement of the valve element therefrom and provide a fixed limit for outward movement of said element axially with respect to the piston.

5. In a centrifuge having a rotor for effecting centrifugal sedimentation of solids in admixture with liquid, a plurality of circumferentially spaced radial discharge passages through the wall of said rotor, a valve seat at the inner end of each of said discharge passages, a plurality of valve elements of small mass, each valve element being movable coaxially of an associated valve seat and normally urged into closing engagement therewith by centrifugal force acting thereon, a plurality of valve stems, each valve stem positioned coaxially of a separate discharge passage, each said valve stem being movable coaxially of its associated discharge passage to and from an outer limit position to which said valve stem normally is urged by centrifugal force acting thereon, a lost-motion connection between each said valve element and the associated valve stem providing limited axial movement of each said valve element relative to its associated valve stem, each said valve element when engaged upon its associated valve seat being in lost-motion position with respect to its associated valve stem so that seating engagement of each valve element upon its associated valve seat is effected independently of its associated valve stem by the centrifugal force acting solely on the small mass of said valve element, and means for effecting actuation of each said valve stem inwardly of the rotor from its outer limit position to disengage its associated valve element from its associated valve seat to open said discharge passages.

6. In a centrifuge having a rotor for effecting centrifugal sedimentation of solids from an admixture of solids and liquid, a radial discharge passage through the wall of said rotor, a valve seat at the inner end of said discharge passage, a valve element of small mass, said valve element being radially movable with respect to said valve seat and normally urged into closing engagement therewith by centrifugal force acting thereon, radially movable valve operating means normally urged radially outward by centrifugal force acting thereon, means for limiting the radial outward travel of said valve operating means, a lost-

motion connection between said valve element and said valve operating means providing limited movement of said valve element relative to said valve operating means, said valve element when engaged upon said valve seat being in lost-motion position with respect to said valve operating means so that seating engagement of said valve element upon said valve seat is effected independently of said valve operating means by centrifugal force acting solely on the small mass of said valve element, and means for effecting actuation of said valve operating means radially inwardly of the rotor from its outer limit position to disengage said valve element from said valve seat to open said discharge passage.

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