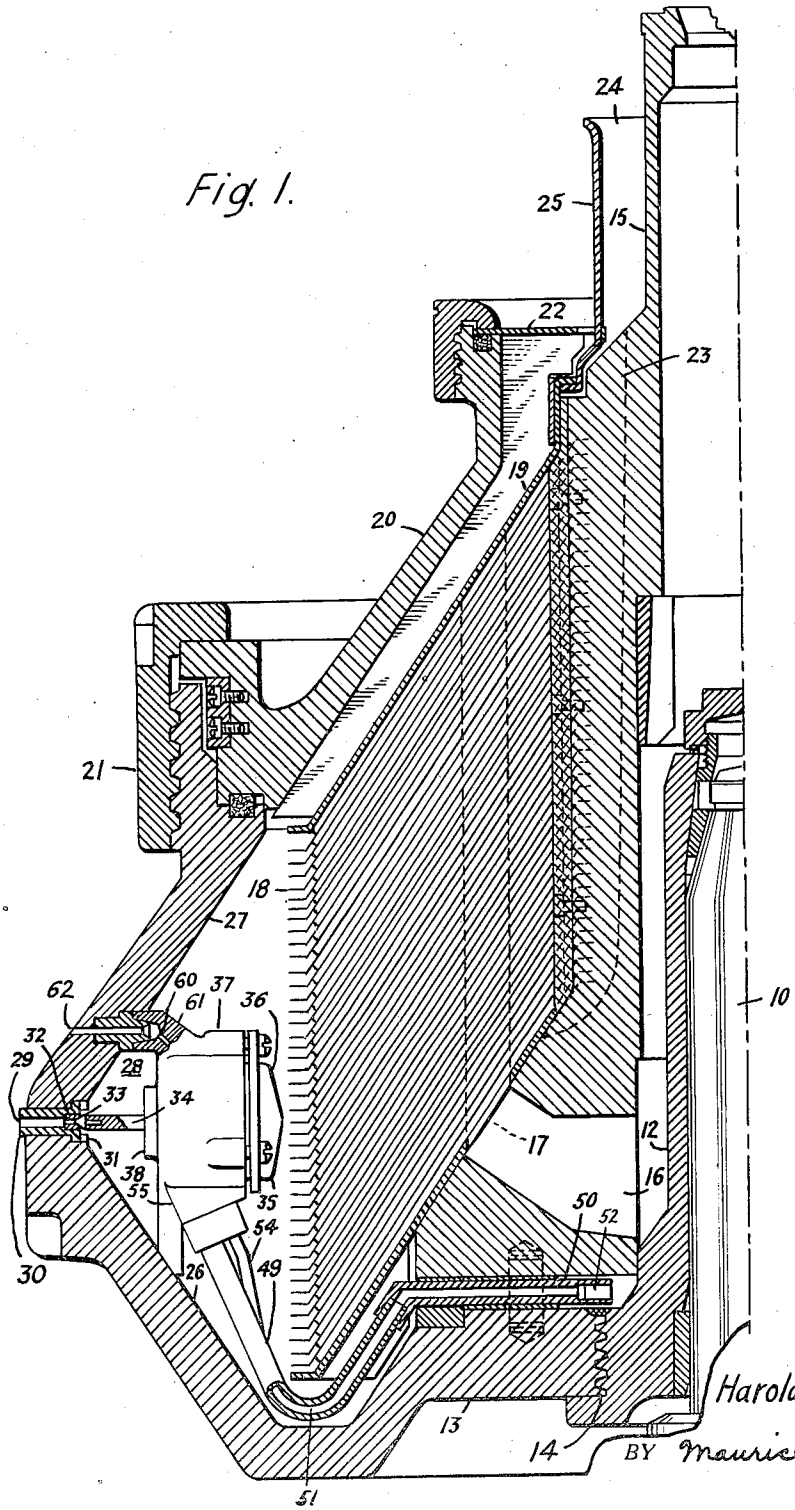
June 16, 1942. H. C. FITZSIMMONS 2,286,355

CENTRIFUGAL SEPARATOR

Filed April 16, 1941 3 Sheets-Sheet 1

Fig. 1.



INVENTOR

Harold C. Fitzsimmons

BY Maurice A. Crews

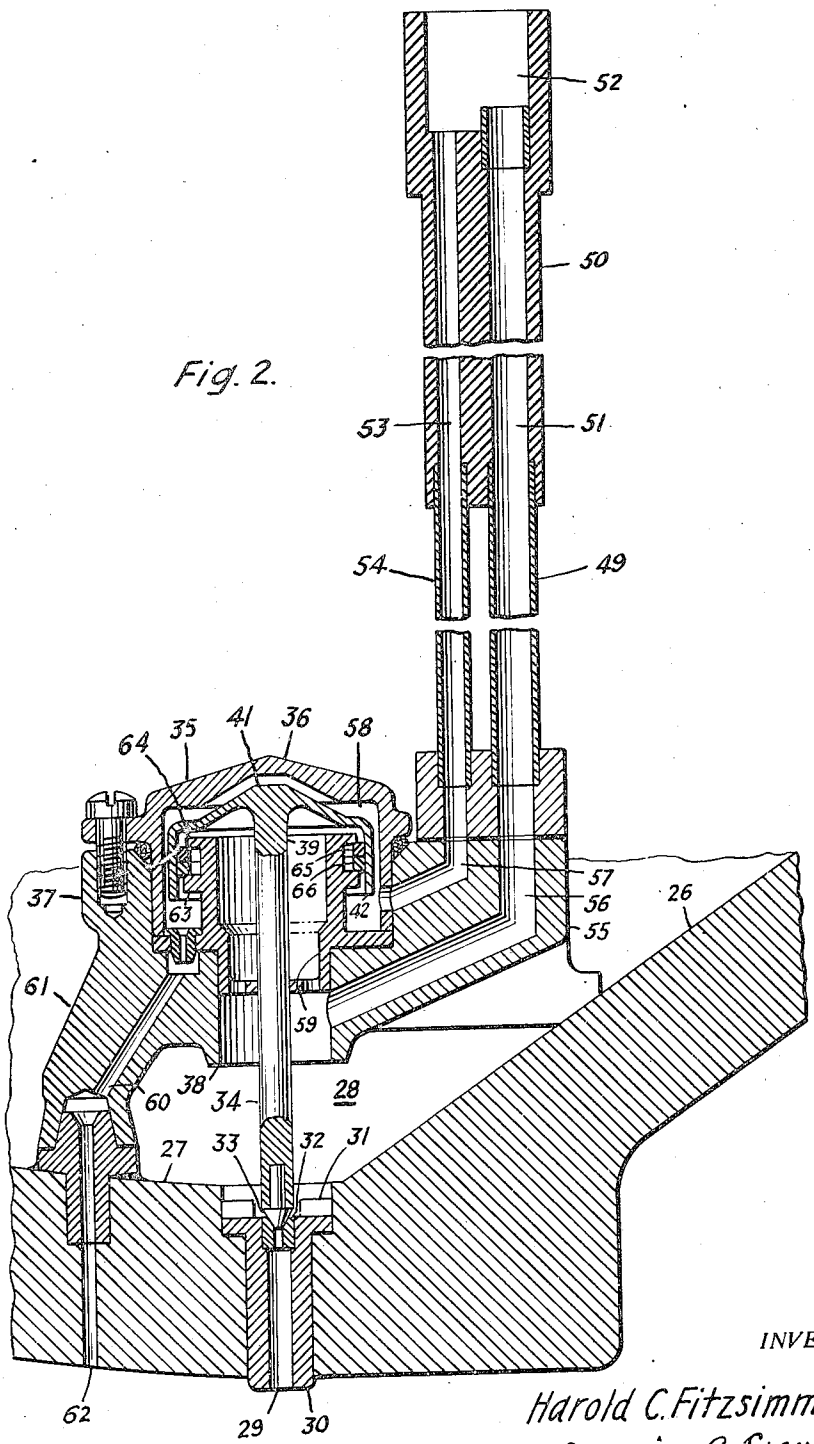
ATTORNEY

June 16, 1942. H. C. FITZSIMMONS 2,286,355

CENTRIFUGAL SEPARATOR

Filed April 16, 1941 3 Sheets-Sheet 2

Fig. 2.



INVENTOR

Harold C. Fitzsimmons

BY Maurice A. Crews

ATTORNEY

June 16, 1942. H. C. FITZSIMMONS 2,286,355

CENTRIFUGAL SEPARATOR

Filed April 16, 1941 3 Sheets-Sheet 3

Fig. 3.

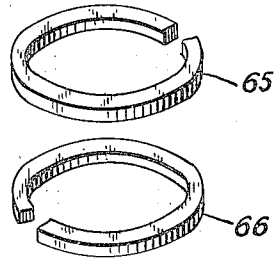
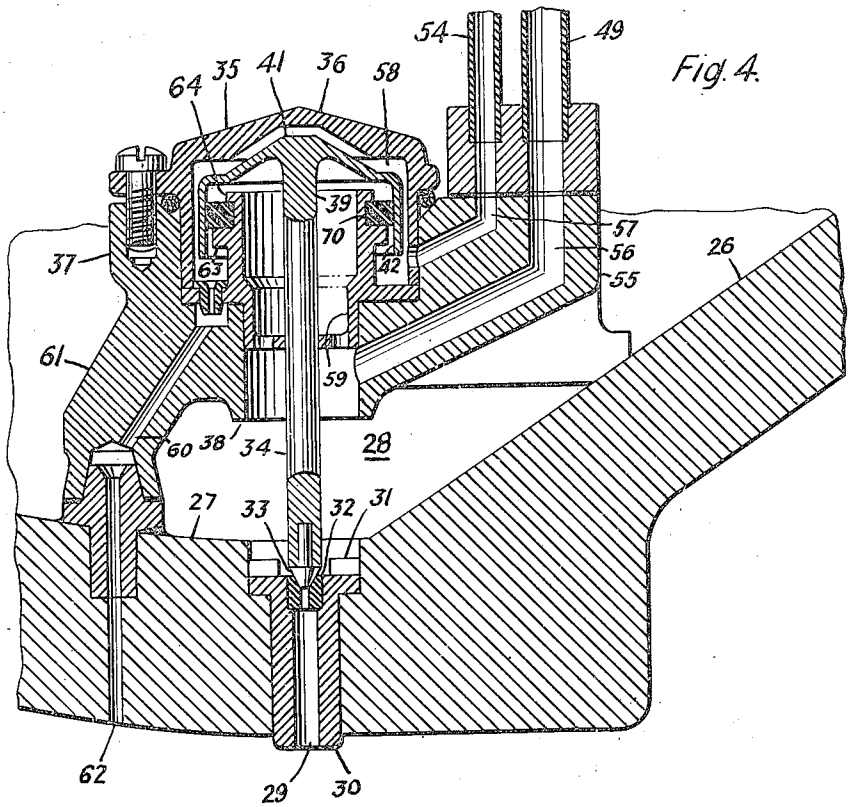


Fig. 4.



INVENTOR

Harold C. Fitzsimmons

BY Maurice A. Crews

ATTORNEY

Patented June 16, 1942 2,286,355

UNITED STATES PATENT OFFICE

2,286,355

CENTRIFUGAL SEPARATOR

Harold C. Fitzsimmons, West Chester, Pa., assignor to The Sharples Corporation, Philadelphia, Pa., a corporation of Delaware

Application April 16, 1941, Serial No. 388,749

10 Claims. (Cl. 233—20)

The present invention pertains to the art of centrifugal separators designed to effect separation of solids from a liquid, or separation of solids from a mixture of liquids. It pertains to the type of centrifugal in which solids are intermittently discharged through valve-controlled discharge passages in the wall of the centrifugal rotor, such as described in my prior application, Serial No. 318,672, filed February 13, 1940, for Centrifugal separator.

In the machine of that application, the valves are operated by fluid pressure motors to discharge the accumulated sludge periodically. In the design of a centrifugal separator equipped with valves and motors of this kind, it is important that an arrangement be provided which is durable, delicately responsive in operation, and proof against leakage from the main body of the rotor through the motor parts. A feature of the present invention consists in the fact that it embodies an arrangement which is an improvement over that of my prior application, No. 318,672, in these particulars. A further feature is that the invention includes a sealing connection in which the sealing is enhanced by the effect of centrifugal force in the rotation of the rotor.

In the drawings,

Figure 1 is a central axial section through the left-hand side of a centrifugal rotor of the invention,

Figure 2 is a detailed sectional view, partly diagramatic, illustrating a cross-section through a motor of one embodiment of the invention,

Figure 3 is a perspective view, illustrating the method of mounting the sealing rings of the motor of Figure 2, and

Figure 4 is a view similar to Figure 2, illustrating an alternative form of the invention.

The machine of the invention is similar in most particulars to that of my prior application No. 318,672, referred to above. The rotor is driven by a shaft 10 which is driven by any suitable form of motor, not shown. A sleeve 12 surrounds the shaft 10 and is driven by this shaft through driving connections of conventional design. The main body portion 13 of the rotor may be secured to the sleeve 12 in any conventional manner, such as by the screw threaded connection 14. A feed tube 15 surrounds the sleeve 12, and serves to direct the mixture of liquids and solids passed to the rotor through the space between tube 15 and sleeve 12, and through openings 16 in the lower end of the tube 15 into the zone of the main body of the rotor occupied by registering openings 17 in the stratifying discs 18. Material fed to the main body of the rotor through the openings 16 passes upwardly through the openings 17 into the space between the stratifying discs.

The solids in the liquid fed to the rotor pass outwardly to the peripheral wall of the rotor and the heavier liquid also passes outwardly toward the peripheral wall, and forms a stratum within the deposited solids. This liquid passes inwardly through the space between a dividing wall 19 toward the upper end of the rotor, and the upper portion 20 of the rotor, which may be secured to the main body of the rotor by the screw threaded connection 21. This heavier constituent passes outwardly from the rotor across the ring dam 22. The lighter liquid passes inwardly through the spaces between the superposed discs 18 into a space 23 within the discs, and upwardly through the space 24 between a tubular extension 25 of the dividing wall, and feed tube 15. The liquid centrifugal effluents discharged over ring dam 22 and from tube 25 are collected in separate centrifugal covers, as will be understood by those skilled in the art. The inner peripheral wall of the main body of the rotor consists of opposed frusto-conical surfaces 26 and 27, and the point of maximum diameter of the main body of the rotor is located approximately centrally of this portion of the rotor.

It will be seen that, when a mixture of liquids and a solid is introduced into the tube 15, and the centrifugal rotor is rotated at high speed during the continuous feed of the mixture, the solids will be deposited along the surfaces 26 and 27 and flow outwardly along these surfaces to the zone 28, while the liquids are separated and separately discharged from the rotor as indicated above. The rotor is provided with a plurality of small passages 29 through which these solids are intermittently discharged. These passages may be provided with bushings 30, radially extending valve guide members 31 (Fig. 2), and valve seats 32, as illustrated. A reciprocating valve 33 is provided for co-action with each of the valve seats 32, and each of these valves 33 is connected with a valve stem 34, which is actuated by means to be described hereinafter for intermittent discharge of deposited solids through the valve seats 32 and bushings 30.

Fluid pressure motors 35 operate to move the valves, an individual motor being attached to each of the individual valve stems 34, and the motors being secured within the rotor for rotation therewith. Each of these motors comprises a housing which consists of an end portion 36

and a base portion 37 secured to the portion 36. This housing surrounds the moving parts of the motor. The base portion 37 has an annular extension 38 (see Fig. 2) which lies adjacent the zone 28 of accumulation of solids. The inner end 39 of the valve stem 34 has an inner end portion 41 which is the moving member of the fluid pressure motor and is provided with a depending annular flange 42.

The housing base 37 is provided with a lateral extension 55 through which liquid is passed from the main body of the centrifugal rotor for actuating the fluid pressure motor.

A bore 56 in extension 55 communicates with the space 28 for accumulation of sludge, through the passage provided by the annular flange 38. The bore 56 is in turn connected with a conduit 49, which extends downwardly and inwardly around the lower end of the stack of discs. (The showing of bores 56 and 57 and associated conduits in Figure 2 has been made more or less diagrammatic, in the interest of simplicity of illustration of the principles of the invention.) The inner end of conduit 49 is connected to a member 50, which has a bore 51 (see Fig. 2) communicating with the conduit 49, and also a channel 52 communicating with the inner end of bore 51. A bore 53 extends outwardly from the channel 52, and is connected to a second, and smaller, conduit 54, which extends outwardly from the member 50 to a connection with a bore 57 in the lateral extension 55 of the housing base 37.

The bore 57 communicates with the space 58 between the end portion 36 of the housing and the outer surface of the movable member 41 of the fluid pressure motor. The inner surface of this member 41 communicates with the sludge space 28 of the rotor, through the hollow interior of the member 59 of the motor, which is a stationary member having a cylindrical outer surface along which the flange 42 of the movable member or piston 41 reciprocates. The space 58 is also in communication, through an orifice connecting this space with a bore 60 in an extension 61 of the base portion 37 of the motor housing, with an outlet 62 in the rotor wall, through which motor actuating fluid is discharged from the machine. It will be noted that material discharged through the outlet 62 is discharged at a separate point from the solids discharged through the valve 32, and this material is collected separately from the solids.

The most impotrant feature of the invention consists in the provision of motor sealing devices designed to function in such a way that the centrifugal force due to rotation of the rotor exerts a sealing effect on the sealing members. In the form illustrated in Figures 2 and 3 of the drawings, the stationary member or cylinder 59 is provided with flanges 63 and 64, and split metal sealing rings 65 and 66 are confined between these flanges, with their outer surfaces contacting the inner surface of the flange 42 of the movable member or piston 41. The splits in the rings are disaligned in order to prevent leakage between them, being preferably spaced 180° apart in the assembly of the rings with the motor, as illustrated in Figure 3 of the drawings. The outer (lower, Fig. 2) surface of the outer ring 66 abuts the inner (upper, Fig. 2) surface of the flange 63 of the cylinder 59, and the outer (lower, Fig. 2) surface of the ring 65 abuts the inner (upper, Fig. 2) surface of the ring 66. The natural resilience of the rings causes them to effect sealing contact with the inner surface of the flange 42 of the piston 41, and centrifugal force, operating when the machine is rotating, exerts a sealing force on ring 66 against flange 63 and on ring 65 against ring 66. These sealing effects are best obtained by mounting the motors with their axes extending substantially radially with respect to the axis of the rotor, as illustrated.

In the operation of the machine described above, when the machine is first brought up to speed, the valve 33 is forced against the valve seat 32 under the influence of the centrifugal force operative upon the valve stem 34 and the piston 41. As the rotor fills with liquid, a part of this liquid enters the space between the extension 38 and the valve stem 34, and the pressure applied to this liquid by reason of the rotation of the main body of liquid within the rotor forces the valve stem 34 to move inwardly and remove the valve 33 from the valve seat 32. As the body of liquid in the rotor becomes deeper, liquid entering between the parts 38 and 34, passing through bore 56, enters conduit 49 and passes inwardly through this conduit (see Fig. 2). The inner end of the bore 51 in the member 50 is slightly further removed from the rotor axis than the inner edge of the ring dam 22. Accordingly, when the liquid reaches a sufficient depth of the rotor to cause the heavier liquid to be discharged over ring dam 22, the liquid entering the conduit 49 and bore 51 will overflow the inner end of the bore 51, and enter the bore 53. The liquid entering the bore 53 flows outwardly through tube 54 into bore 57 and into the space 58 between the inner wall of the housing end portion 36 and the piston 41. As the pressure in this space, due to the head of liquid in conduit 54, increases, this pressure becomes sufficiently great to actuate the piston to cause the valve to be forced against its seat again. After this ocurs, the valve will be retained against its seat, until it is forced away from that seat in response to factors automatically resulting from accumulation of sludge in the space 28. During the part of the cycle of operations when liquid is flowing from bore 51 into bore 53 the quantity of liquid passed into bore 57 is more than sufficient to offset the amount of leakage from the rotor through outlet 60.

After the valves 33 are moved into closed position as discussed above, solids accumulate within the space 28 during the continued feed of material to the rotor and rotation thereof, and these solids form a wall within the space 28 which gradually approaches the extension 38 of the housing base portion 37. As the accumulation of solids increases, the resistance to flow of liquid into the interior of the housing base portion 37 between the inner surface of the accumulated solids and the base 38 of the skirt also increases, until the flow resistance becomes sufficiently great to offset the difference in hydrostatic balance between the inner edge of the ring dam 22 and the inner end of the bore 51. When this condition occurs, liquid will no longer flow into the channel 52 and bore 53 from the bore 51, and leakage of liquid through the outlet 60 causes diminution of the head of liquid in the conduit 54, and hence of the pressure against the inner (upper, Fig. 2) end of the piston 41. The pressure of liquid from the sludge space 28 against the opposite side of the piston 41 then causes the piston to move radially inwardly and draw the valve 33 away from its seat 32, thereby

permitting discharge of accumulated solids through passage 29.

As the solids discharge, the wall of solids recedes from the base 38 of the housing base portion 37, and the hydrostatic pressure operative through the space between the bed of solids and the extension 38, the bore 56, and associated connections gradually increases until liquid is again forced into channel 52 and through conduit 54 into the space within the housing end portion 36. After liquid has again passed into conduit 54 to increase the liquid head sufficiently, the valve will again be closed and the cycle of operations may be repeated indefinitely.

During the operation of the machine as discussed above, the rings 65 and 66 perform their sealing function under the influence of centrifugal force, thereby effectively preventing leakage through the space between the relatively moving parts of the fluid pressure motor.

An alternative form of the invention is illustrated in Figure 4. This form of the invention is similar to that of Figures 2 and 3 with respect to general assembly and hydraulic connections, but it involves a different type of sealing connection. Instead of using a pair of split metal rings as sealing members, a single ring 70 of rubber or similar elastically deformable material is mounted between the stationary flanges 63 and 64 in the motor of Figure 4. When the rotor is in operation, centrifugal force acts upon the ring 70 both to force it in tight sealing relation to flange 63 and to expand it laterally to force it into liquid-tight sealing relation with piston 41 and cylinder 59, thereby preventing leakage.

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

I claim:

1. In a centrifugal separator, the combination comprising a centrifugal rotor provided with a discharge outlet adapted to be alternately opened and closed to control the discharge of an effluent from said rotor, a valve adapted to be moved into discharge-permitting and discharge-preventing positions, respectively, with respect to said discharge outlet, a valve extension connected to said valve and extending inwardly into said centrifugal rotor and a fluid pressure motor within said rotor secured to said rotor for rotation therewith and connected to said valve extension for operating the same, said fluid pressure motor including a member which is stationary with respect to said rotor and a member mounted for longitudinal movement relative to said stationary member in a direction having a substantial radial component under the impelling force of fluid pressure, said stationary member having an abutment for supporting a sealing member, and a sealing member mounted between said relatively movable and stationary members of said motor and adjacent said abutment at the inner side thereof, whereby the influence of centrifugal force generated by rotation of the rotor forces said sealing member into engagement with said abutment.

2. In a centrifugal separator, the combination comprising a centrifugal rotor provided with a discharge outlet adapted to be alternately opened and closed to control the discharge of an effluent from said rotor, a valve adapted to be moved into discharge-permitting and discharge-preventing positions, respectively, with respect to said discharge outlet, a valve extension connected to said valve and extending inwardly into said centrifugal rotor and a fluid pressure motor within said rotor mounted on a substantially radial axis and secured to said rotor for rotation therewith and connected to said valve extension for operating the same, said fluid pressure motor including a member which is stationary with respect to said rotor and a member mounted for longitudinal movement relative to said stationary member in a direction having a substantial radial component under the impelling force of fluid pressure, said stationary member having an abutment for supporting a sealing member, and a sealing member mounted between said relatively movable and stationary members of said motor and adjacent said abutment at the inner side thereof, whereby the influence of centrifugal force generated by rotation of the rotor forces said sealing member into engagement with said abutment.

3. In a centrifugal separator, the combination comprising a centrifugal rotor provided with a discharge outlet adapted to be alternately opened and closed to control the discharge of an effluent from said rotor, a valve adapted to be moved into discharge-permitting and discharge-preventing positions, respectively, with respect to said discharge outlet, a valve extension connected to said valve and extending inwardly into said centrifugal rotor and a fluid pressure motor within said rotor secured to said rotor for rotation therewith and connected to said valve extension for operating the same, said fluid pressure motor including a member which is stationary with respect to said rotor and a member mounted for longitudinal movement relative to said stationary member in a direction having a substantial radial component under the impelling force of fluid pressure, said stationary member having an abutment for supporting a sealing member, and an elastically deformable sealing member mounted between said relatively movable and stationary members of said motor and adjacent said abutment at the inner side thereof, whereby the influence of centrifugal force generated by rotation of the rotor forces said sealing member into engagement with said abutment.

4. In a centrifugal separator, the combination comprising a centrifugal rotor provided with a discharge outlet adapted to be alternately opened and closed to control the discharge of an effluent from said rotor, a valve adapted to be moved into discharge-permitting and discharge-preventing positions, respectively, with respect to said discharge outlet, a valve extension connected to said valve and extending inwardly into said centrifugal rotor and a fluid pressure motor within said rotor secured to said rotor for rotation therewith and connected to said valve extension for operating the same, said fluid pressure motor including a member which is stationary with respect to said rotor and a member mounted for longitudinal movement relative to said stationary member in a direction having a substantial radial component under the impelling force of fluid pressure, said stationary member having an abutment for supporting a sealing member, and a rubber sealing member mounted between said relatively movable and stationary members of said motor and adjacent said abutment at the inner side thereof, whereby the influence of centrifugal force generated by rotation of the rotor forces said sealing member into engagement with said abutment.

5. In a centrifugal separator, the combination comprising a centrifugal rotor provided with a discharge outlet adapted to be alternately opened

and closed to control the discharge of an effluent from said rotor, a valve adapted to be moved into discharge-permitting and discharge-preventing positions, respectively, with respect to said discharge outlet, a valve extension connected to said valve and extending inwardly into said centrifugal rotor and a fluid pressure motor within said rotor secured to said rotor for rotation therewith and connected to said valve extension for operating the same, said fluid pressure motor including a member which is stationary with respect to said rotor and a member mounted for longitudinal movement relative to said stationary member in a direction having a substantial radial component under the impelling force of fluid pressure, said stationary member having an abutment for supporting said sealing ring, and a metal sealing ring mounted between said relatively movable and stationary members of said motor and adjacent said abutment at the inner side thereof, whereby the influence of centrifugal force generated by rotation of the rotor forces said sealing ring into engagement with said abutment.

6. In a centrifugal separator, the combination comprising a centrifugal rotor provided with a discharge outlet adapted to be alternately opened and closed to control the discharge of an effluent from said rotor, a valve adapted to be moved into discharge-permitting and discharge-preventing positions, respectively, with respect to said discharge outlet, a valve extension connected to said valve and extending inwardly into said centrifugal rotor and a fluid pressure motor within said rotor secured to said rotor for rotation therewith and connected to said valve extension for operating the same, said fluid pressure motor including a member which is stationary with respect to said rotor and a member mounted for longitudinal movement relative to said stationary member in a direction having a substantial radial component under the impelling force of fluid pressure, said stationary member having an abutment for supporting a pair of sealing rings, and a pair of split metal rings mounted in superposed relationship with respect to each other with their split portions disaligned, between said relatively movable and stationary members of said motor, and adjacent said abutment at the inner side thereof, whereby the influence of centrifugal force generated by rotation of the rotor exerts a sealing force on the outermost ring to seal the space between said ring and said abutment, and a sealing force on said innermost ring to seal the space between said innermost ring and said outermost ring.

7. A centrifugal separator as defined in claim 3, in which said fluid pressure motor is mounted on a substantially radial axis.

8. A centrifugal separator as defined in claim 4, in which said fluid pressure motor is mounted on a substantially radial axis.

9. A centrifugal separator as defined in claim 5, in which said fluid pressure motor is mounted on a substantially radial axis.

10. A centrifugal separator as defined in claim 6, in which said fluid pressure motor is mounted on a substantially radial axis.

HAROLD C. FITZSIMMONS.