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## (54) IMPROVEMENTS RELATING TO CENTRIFUGAL SEPARATORS


(71) We, WESTFALIA SEPARATOR AG, A German Body Corporate, of, 4740 Oelde 1/Westfalen, Postfach 2420, Federal Republic of Germany, do hereby declare

the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a centrifuge drum with discharge valves for concentrating solids suspended in a solids-liquid mixture, in which the valves are uniformly peripherally distributed in the plane of the largest diameter of the drum separating chamber, each valve having a movable valve plunger which is shielded in the closing direction relative to the pressure of the mixture which is being centrifuged in the drum by means of a valve housing and in which during operation at the full rotational speed of the drum a nozzle orifice associated with the plunger is closed by the action of the centrifugal force on the plunger and openable by the introduction of a control liquid.

Centrifuge drums of the above type are known. It is disadvantageous in these drums that the valves provided for the discharge of the concentrate in operation can assume either only a closed or only an open position and fine regulation of the nozzle orifice is not possible, because the valves have bevel seats which are not suitable for a fine setting as a function of the concentration and particle size of the solids.

When concentrating suspended solids a high concentration of the solids is sought, whereby the nozzle orifice and the number of nozzles provided are established as a function of a constant solids quantity and particle size of the solids particles. Under the high liquid pressure in the drum and in particular in the case of small quantities of solids the nozzle orifices, if arranged on the drum periphery, must be kept very small, e.g. below 1 mm in order to bring about an adequate concentration of the solids. Larger nozzles can only be used if they are arranged on a smaller drum diameter, the solids particles having a lighter consistency and being capable of sliding inwards on a smaller diameter. However, the nozzles must be arranged on the drum periphery if the solids particles have a higher specific gravity and cannot slide on a smaller diameter.

In the case of nozzles with a small opening cross-section it is easily possible for the nozzles to become clogged even when the centrifuged material undergoes good prior screening, e.g. by dissolving solids deposits. This not only impairs the operation of the centrifuge but can lead to unbalance which can cause considerable damage. The smaller the nozzle orifice the greater the danger, so that it is not possible to reduce the nozzle orifice below certain minimum diameters. As a result in the case of low solids contents in the centrifuged liquid it is only possible to use nozzle centrifuges through partly disadvantageous measures, either by a smaller number of nozzles or by the recycling of the concentrate. A special disadvantage of fixed nozzle cross-sections is that there can be no variation in the quantity of solids obtained during operation, because otherwise the centrifuged concentrate is too thin or clogging of the nozzles occurs in the case of a too high concentration.

The problem of the invention is to so construct the discharge valves of centrifuge drums that during operation there is an automatic adjustment of the nozzle orifice size in accordance with the concentration obtained and any possible clogging of the nozzle is automatically eliminated.

According to the present invention this problem is solved in a centrifuge drum of the kind described in that the nozzle orifice is formed by a wedge shaped calibrated groove and during operation the outlet cross-section of the groove is adjustable by movement of the valve plunger, the control liquid for controlling the valve plunger being constituted by a partial flow of the clarified, pressurised liquid discharge via a paring chamber, the paring chamber and the valve plunger being interconnected by means of ducts, and the position of the liquid level in the paring chamber determining the degree of opening of the groove.

According to a special construction the wedge shaped groove is closed towards the drum periphery and has a larger cross-section towards the drum axis.

The construction of the nozzle with a wedge shaped calibrated groove permits a constant fine regulation of the nozzle orifice cross-section during operation, whereby an automatic setting of the nozzle orifice cross section is possible as a function of the liquid pressure in the paring chamber.

The valve plunger may have a shoulder which, in use, is constantly subject to the action of the concentrated solids. The groove may be of conical or parabaloid shape.

The position of the liquid level of the paring chamber may be adjustable by means of a throttling member arranged in the discharge pipe for the clarified liquid, the discharge pipe being connected to a paring member arranged in the paring chamber and immersed in the liquid to be drained off.

The liquid pressure is firstly determined by the immersion depth of the paring member in the paring chamber, which as mentioned above is adjustable by the throttling member, and secondly by the quantity of liquid delivered by the paring member. As the quantity of liquid increases, the immersion depth of the paring member is increased due to the displacement of the inner liquid level towards the drum axis and consequently also the liquid pressure on the valve plunger which is connected to the paring chamber by a connecting passage. Therefore a greater opening pressure is exerted on the plunger, which brings about an increase in the groove cross-section of the nozzle. In the case of a reduced quantity of liquid the inner liquid level is displaced outwards, the liquid or opening pressure is reduced and brings about a reduction in the groove cross-section.

The special construction of the plunger brings about an opening pressure which acts as a function of the viscosity or density of the discharged concentrate whereby a larger force is exerted on the plunger with increasing viscosity or density and a smaller force is exerted thereon with decreasing viscosity or density, so that as a function of the viscosity or density of the concentrate an automatic regulation of the groove cross-section is also obtained.

In conjunction with a viscosity of density measurement performed in the concentrate drain it is also possible to regulate the immersion depth of the paring member and consequently the groove cross-section by means of a throttling member provided in the discharge pipe for the clarified liquid.

A clogged nozzle, e.g. when the concentration is too high can also lead to the clarified liquid becoming turbid or to an unbalance of the centrifugal drum, so that for example via a turbidimeter or an unbalance switch the throttling member in the discharge pipe for the clarified liquid is brought into a pronounced throttling or closing position, thereby providing a maximum nozzle cross-section, i.e. maximum open position of the plunger which leads to an automatic cleaning of the throttling member.

An embodiment of the invention is discussed hereinafter relative to the drawings, in which:

Fig. 1 is a longitudinal section of the left-hand half of a centrifugal drum constructed according to the invention.

Fig. 2 is an enlarged section through the half-open discharge valve.

Fig. 3 is an enlarged nozzle with plunger in perspective view.

Fig. 4 is another embodiment of the wedge-shaped groove in the nozzle in an enlarged perspective view.

In fig. 1 the solids-containing liquid mixture to be centrifuged is fed by supply pipe 1 centrally into distribution chamber 2, from where it flows into separating chamber 3 from which the specifically lighter liquid component flows inwards through the set of discs 4 for clarification purposes and then passes via duct 5 into paring chamber 6, being led away through the paring member 7. In the drain pipe 8 for the clear lighter liquid component is provided a throttling member 9 and a not shown clear phase monitoring device, e.g. a turbidimeter. The specifically heavier solids separated in separating chamber 3 are centrifuged in a radial direction to the drum periphery and collect in the radially outer part of the separating chamber. Discharge valves 11 are uniformly peripherally distributed in the drum jacket 10. In drum jacket 10 and drum cover 12 are located ducts 13 and 14, sealed relative to one another by gaskets 15 and serving to supply control liquid from paring chamber 6. The drum is closed by the drum cover 12 which is connected to the drum jacket 10 by means of locking ring 16. The solids concentrate is centrifuged out of the drum by the discharge valves 11 into a sludge catcher (not shown), whereby the viscosity or density of the concentrate is continuously measured in known and not shown manner.

Fig. 2 shows an enlarged section through a half-open discharge valve 11, which substantially comprises valve housing 17, a nozzle 18 arranged according to the invention with a wedge-shaped calibrated groove 19 and a plunger 20, guide piece 21, nozzle holder 22 and various seals. Plunger 20 is brought into the closed position by cup springs 23 under light pressure. Valve housing 17 has ducts 24 for draining the solids

and an annular duct 25 with bores 26 connected to said annular duct 25. Annular duct 25 is also connected to the supply ducts 13, 14 for the control liquid and the paring chamber 6. Due to the calibrated wedge-shaped groove 19 in nozzle 18 solids are discharged when plunger 20 is in the open position and are centrifuged from the drum through bores 27, 28 in nozzle 18 and nozzle holder 22. Duct 29 in plunger 20 is used for ventilation purposes.

Fig. 3 shows nozzle 18 with radially movable plunger 20 in an enlarged perspective view with a conical construction of groove 19a.

Fig. 4 shows another construction of the calibrated groove in nozzle 18, whereby the slot 19b can have a paraboloid shape or some similar wedge-like configuration.

The valve functions in the following manner:

During operation under the action of the centrifugal force and the spring tension, plunger 20 movably and sealingly guided in valve housing 17 and in guide piece 21 seals with its front face 30 bore 27 and substantially with a sliding face 31 groove 19 in nozzle 18, thereby preventing the discharge of liquid or concentrate from solids chamber 3. As soon as the drum is charged with liquid the liquid and/or the concentrate exerts a radial opening force on the shoulder 32 of plunger 20. In addition there is an increasing opening force on the plunger with increasing filling of paring chamber 6 with liquid, whereby said liquid acts on the plunger via ducts 13 and 14 and annular duct 25. This force acting on the plunger is controlled by adhering the immersion depth of the paring disc by operating throttling member 3 in drain pipe 8 of the clear lighter liquid component, whereby the inner liquid level 34 is displaced towards the drum axis and consequently the liquid pressure on the plunger can be regulated. With the increase in the opening pressure on plunger 20 the latter frees the calibrated groove 19 in nozzle 18, so that the solids concentrate is discharged. The higher the pressure on the plunger the greater the opening of the nozzle. Thus, with a constant throttling position of the valve in the drain pipe 8 there is an automatic modification of the immersion depth of the paring disc with changing discharge capacity, i.e. in the case of a large quantity of liquid a large immersion depth of paring member 7 and consequently a high opening pressure on the plunger and large opening width of the groove, so that it is possible to drain off a larger quantity of solids concentrate. In the same way the opening width of the groove in the nozzle is reduced when the liquid supply decreases.

Independently of the quantity of concentrate the nozzle orifice automatically varies as a function of the viscosity or density of the concentrate, whereby the pressure of the concentrate increases with increasing concentration and density on the shoulder 32 of the plunger, with a corresponding action with reduced concentration.

According to a special embodiment annular duct 25 is connected to a calibrated bore 33, so that a small quantity of control liquid is constantly discharged from the drum. This embodiment is advantageous if the control liquid is not free from solids particles and consequently a clogging of the annular duct must be avoided.

The discharge valve arranged according to the invention is not only used in centrifugal drums for concentrating suspended solids and can also be used in centrifugal separators for separating two liquids accompanied by the simultaneous concentration of the solids. In the same way the discharge valve can be used on a small diameter drum.

WHAT WE CLAIM IS:

1. A centrifuge drum with discharge valves for concentrating solids suspended in a solids liquid mixture comprising valves uniformly peripherally distributed in the plane of the largest diameter of the drum separating chamber, each valve having a movable valve plunger which is shielded in the closing direction relative to the pressure of the mixture which is being centrifuged in the drum by means of a valve housing and in which during operation at the full rotational speed of the drum the nozzle orifice associated with the plunger is closed by the action of the centrifugal force on the plunger and openable by the introduction of a control liquid, in which the nozzle orifice is formed by a wedge shaped calibrated groove and during operation the outlet cross-section of the groove is adjustable by movement of the valve plunger, the control liquid for controlling the valve plunger being constituted by a partial flow of the clarified, pressurized liquid discharged via a paring chamber, the paring chamber and the valve plunger being interconnected by means of ducts, and the position of the liquid level in the paring chamber determining the degree of opening of the groove.

2. A centrifuge drum as claimed in claim 1 in which the groove is closed towards the periphery of the drum and has a larger cross-section towards the drum axis.

3. A centrifuge drum as claimed in claim 1 or claim 2 in which the valve plunger has a shoulder which in use is constantly subject to the action of the concentrated solids.

4. A centrifuge drum as claimed in claim 1, claim 2 or claim 3 in which the groove is of conical or paraboloid shape.

5. A centrifuge drum as claimed in any one of claims 1-4 in which the position of

the liquid level in the paring chamber is adjustable by means of a throttling member arranged in a discharge pipe for the clarified liquid, the discharge pipe being connected to a paring member arranged in the paring chamber and immersed in the liquid to be drained off.

6. A centrifuge drum as claimed in any one of claims 1-5 in which the paring chamber is connected to an annular duct in the plunger.

7. A centrifuge drum is claimed in claim 6 in which the annular duct is connected to a calibrated discharge opening in the outlet valve for draining off control liquid.

8. A centrifuge drum with discharge valves substantially as described herein with reference to and as shown in the accompanying drawings.

For the Applicants.
G. F. REDFERN & CO.
High Holborn House,
52/54 High Holborn,
London WC1V 6RL.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

FIG.1

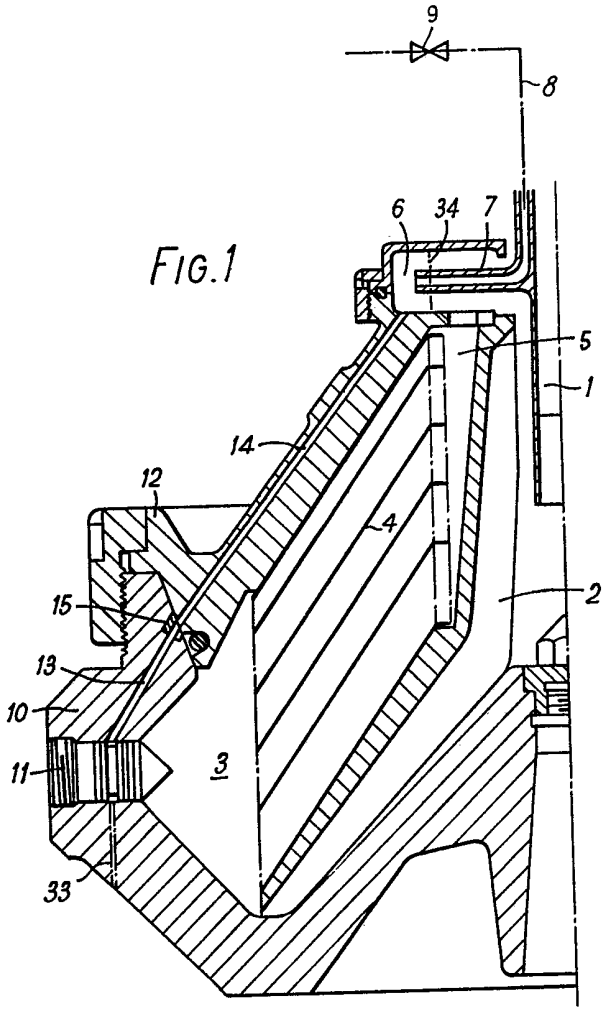

FIG.2

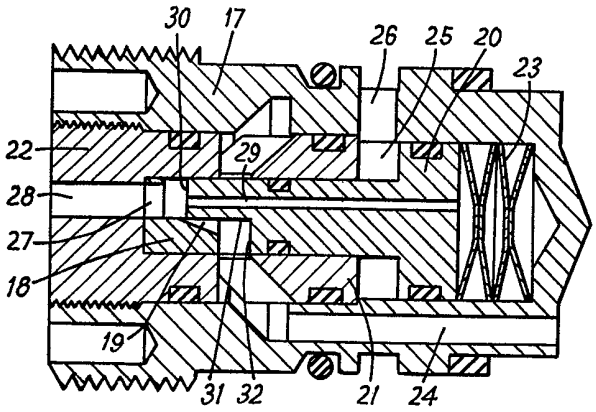


FIG.3

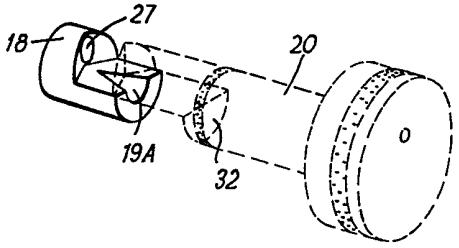


FIG.4