Oct. 13, 1931. E. VAN DER MOLEN 1,827,681

CENTRIFUGAL SEPARATOR

Filed Oct. 17, 1929 2 Sheets-Sheet 1

Fig.1.

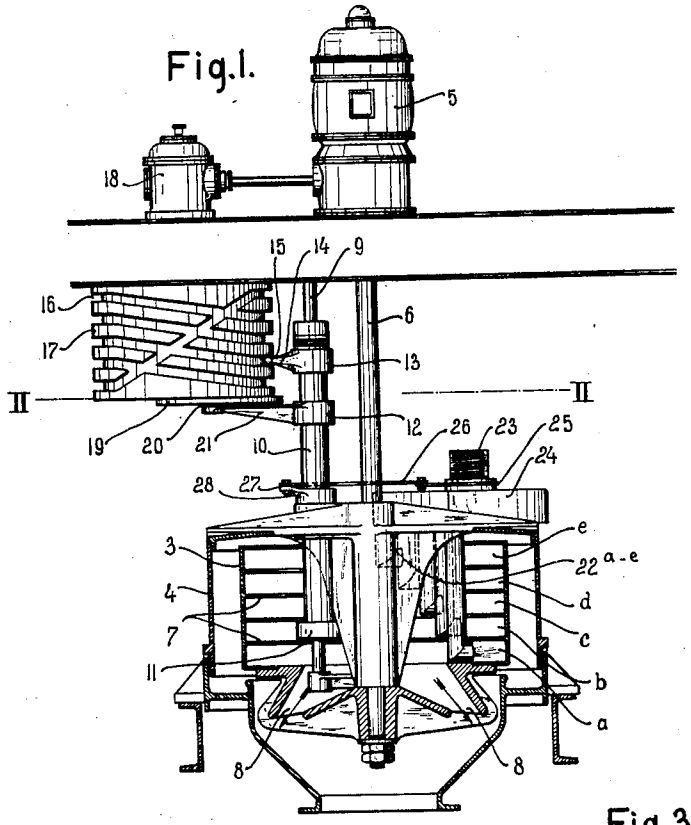


Fig.2.

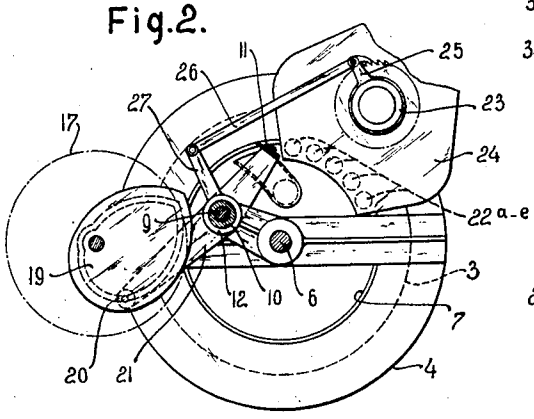
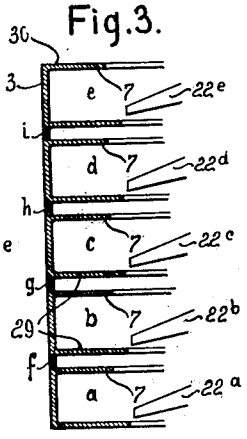


Fig.3.



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Filed Oct. 17, 1929 2 Sheets-Sheet 2

FIG. 4.

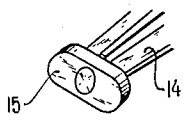
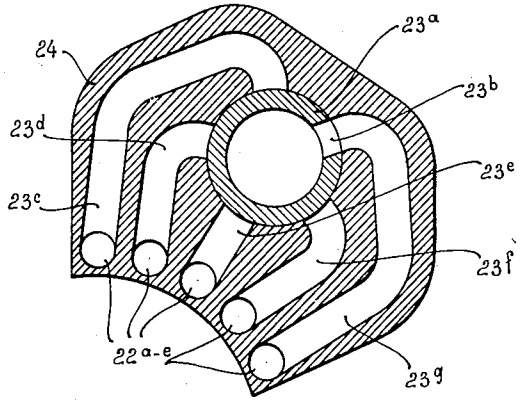


FIG. 5.



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UNITED STATES PATENT OFFICE

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CENTRIFUGAL SEPARATOR

Application filed October 17, 1929, Serial No. 400,322, and in Germany October 20, 1928.

This invention relates to centrifugal separators.

Ordinary centrifugals, in which the rotor or basket is provided with a foraminous lining, do not operate automatically but are adapted for batch operation only. After the rotor has received a batch of the material, in which the more or less solid matter should be separated from the liquid with which it is associated, the latter is by centrifugal effect expressed and extruded through the filtering wall. Thereafter, the residue adhering to the peripheral wall of the basket is removed by hand and the rotor receives a fresh deposit of feed. Such centrifugals allow of a very efficient separation to be obtained, but they have the disadvantage that the charging and the emptying of the rotor require human effort and that the rotary speed of the basket must be alternately very high (during the centrifugal operation) and comparatively low (during emptying and charging).

It has already been suggested to render the separation automatic, i. e. continuous. In such machines the material to be treated is continuously fed into the rotor near the bottom thereof and forced along the peripheral wall, in axial direction, towards the upper edge, over which the dry or practically dry residue is discharged. In order to promote the axial movement of the mass in the rotor, it has been proposed to make the latter conical, but also with this construction the axial movement of the material under treatment is difficult to obtain. Moreover, separators of this type have the drawback that the material from which the liquid has already been partly extracted, remains in contact with moister material, whereby the separation is impaired.

My present invention has for its object to combine the advantages of both types of centrifugal separators but to avoid the said disadvantages. That is to say, the primary object of my invention is a centrifugal separator which ensures perfect separation of the liquid from the more solid matter in continuous operation and throughout automatically. The gist of the invention is that the feed of the rotor and the discharge thereof progress axially and in the same direction, but in offset relation with each other.

The progress of the feed and that of the discharge may take place continuously from the bottom to the top edge, or vice versa. Preferably, however, the rotor is subdivided by annular partitions secured to the peripheral wall of the rotor into a plurality of annular compartments, in which case means are provided whereby the progress of the feed and that of the discharge take place intermittently in such a manner that the said compartments are successively charged and also successively emptied.

In a separator in accordance with my present invention, the material under treatment is separated at the same point where it has been introduced into the rotor, so that it cannot come into contact with moister material and this, as will be understood, favorably affects the separation. Moreover, the rotor can always be driven at a uniform speed, so that the load on the driving gear is practically constant.

In order that my invention may be fully understood, I shall now proceed to describe the same with reference to the annexed drawings, on which:

Fig. 1 illustrates a side elevational view, partly vertical section of a centrifugal separator embodying my invention.

Fig. 2 is a horizontal section taken along the line II—II in Fig. 1, and

Fig. 3 is a vertical axial section of the rotor of a second embodiment,

Figure 4 is a perspective view of the cam follower, and

Figure 5 is a horizontal sectional view through the multi-way valve.

The rotor 3 (Figs. 1 and 2) has a vertical filtering wall and is suspended within a casing or jacket 4 from a spindle 6 driven by an electromotor 5. Said rotor is subdivided, by horizontal annular partitions 7 secured to its peripheral wall, into five compartments *a*, *b*, *c*, *d* and *e* of equal capacity. The bottom 8 of the rotor is open.

A stationary vertical rod 9 serves to guide a hollow spindle 10 adapted for rotary and

axial sliding movement relative thereto. Secured to the lower end of the said hollow spindle 10 is a scraping tool or plow 11. The spindle 10 has freedom of axial sliding movement within a collar 12, relative to which however it cannot turn. Furthermore, it is rotatably but non-slidably mounted in a collar 13 secured to an arm 14 which has a cam follower 15 projecting into a circumferential cam groove 16 of a vertical controlling cylinder 17. Said cylinder is driven by a worm wheel transmission 18, to which the required movement is imparted by the motor 5.

In Figure 4 a perspective view of the cam follower is shown of elongated form having a pivotal connection with the part 14. The cam follower is of sufficient length to bridge the gaps formed by the crossing of the outwardly and downwardly sloping grooves upon the cam 16.

The cam groove 16 is composed of four complete windings, each of which runs horizontally through an angular distance of about 270° and thereafter helically upwards through an angular distance of about 90°. The helical portion of the fourth winding from the bottom merges into a horizontal groove extending through about 270°, which itself is connected with the horizontal portion of the lower winding through a steep helical groove running downward and extending through about 90°.

It is clear that rotation of the controlling cylinder 17 results in relatively quick intermittent upward movements of the hollow spindle 10 with the scraper 11 through distances equal to the vertical distance which the compartments *a–e* are spaced apart, and that after each vertical displacement the scraper 11 remains at the same level during a comparatively long time.

From its highest position the scraper returns in one run to its lowermost position, from which it restarts its intermittent upward movement.

Secured to the spindle of the cylinder 17 is a cam 19 coacting with a cam follower in the form of a roller 20 revolubly mounted to one end of a lever arm 21, the other end of which is secured to the collar 12. When rotating, the cam 19, the shape of which is clearly shown in Fig. 2, imparts swinging motion to the hollow spindle 10 in such a manner, that the scraper 11 during the period in which it remains at the same level, that is to say coincident with the movement of the cam follower 15 through a horizontal portion of the circumferential cam groove of the cylinder 17, is first horizontally swung outwards into one of the annular compartments *a—e* to remove the residue accumulated on the foraminous lining of the rotor, and thereafter again horizontally swung inwards so far that the annular partitions 7 cannot interfere with its vertical movement. During its vertical upward and downward movements, however, the scraper does not change its angular position.

Opposite each annular compartment *a—e* opens the nozzle of a vertical feed pipe 22*a*, 22*b*, 22*c*, 22*d* and 22*e*, respectively. These feed pipes are all connected with one common supply pipe 23 through a multiway cock 24, the plug of which, when turned unidirectionally, successively connects the feed pipes 22*a*–22*e* with the supply pipe 23.

In Figure 5 a horizontal sectional view of the multi-way valve 24 is shown. The plug of the valve is indicated at 23*a*. This plug is engaged by the lever 25 of the device and has a part 23*b* adapted on each rotation of plug 23 through an angular distance of 22°, to connect the supply pipe 23 which is coaxial with said plug, with one of the passages 23*c*, 23*d*, 23*e*, 23*f* and 23*g* leading to the feed pipes 22*a*–22*e* respectively.

Intermittent unidirectional rotation is imparted to the plug of said multiway cock by means of a ratchet device, the lever 25 of which is pivotally coupled through a rod 26 with the arm 27 of a collar 28, which is slidably but non-rotatably mounted on the hollow spindle 10.

As a consequence, each complete swinging movement of said spindle results in a complete swinging motion of the lever 25 of the ratchet, whereby the plug of the cock 24 is quickly turned, always in one direction, through an angular distance of 72° and thereafter remains in rest during a comparatively long time, so that fresh supply is introduced into the corresponding annular compartment *a–e*.

The five feed pipes 22*a*—22*e*, in combination with the multiway cock 24 and the associate driving gear, constitute the "axially progressing feed" referred to above, whereas the scraper 11 with associate controlling gear form an "axially progressing discharge." The various parts should be so arranged and adjusted that, immediately after one of the annular compartments *a–e* (for instance compartment *a*) has been emptied by the scraper 11, the feed pipe of that particular compartment is connected, through the multiway cock, with the supply pipe 23 so as to supply said compartment with the appropriate quantity of fresh material, until the scraper 11 has emptied the next higher compartment (*b*). Thereupon, the feed through pipe 22*a* is cut off and the next feed pipe 22*b* connected with the supply pipe 23, etc. That is to say, the progressing feed is arranged to take place in offset relation with the progressing discharge in such a manner as to lag with respect thereto.

The progression of the feed and of the discharge can, if desired, also take place in continuous operation without departing from the scope and the spirit of this invention.

That is to say, the scraper may be arranged to slowly move in axial direction along the peripheral rotor wall and very closely to the inside surface thereof to discharge the residue adhering thereto, and thereafter, in retracted position, to return to the bottom of the rotor to again start its upward operative stroke.

In that case, the five feed pipes 22*a*—22*e* could be replaced by one single, vertically telescoping pipe or hose, the nozzle of which lags with respect to the scraper but performs the same up and down movements.

Also in the illustrated apparatus the five feed pipes 22*a*—22*e* could be replaced by one single, vertically movable pipe or by a flexible hose, whereas in lieu of the single scraper 11, five scrapers, that is to say one for each compartment and adapted for swinging or for radial sliding movement only, could be provided.

Furthermore it will be understood that the rigid mechanical scraper could be substituted by a flexible scraper in the form of an air jet directed towards the foraminous lining and projected forcibly from the nozzle so as to remove the solid residue accumulated on the filtering wall. With such an air jet it is possible to remove all the deposit, which is not the case with a plow or other scraping tool, because such a rigid member may not be run very closely to the inside surface of the cloth for fear of rupturing it.

If it is desired for the solid matter detached from the filtering wall to be discharged in an upward direction, instead of through an open bottom, I may provide for a suitable deflector cooperating with or secured to the scraper or its equivalent. With such a deflector it may be necessary to also use an air jet so directed as to assist in discharging the loose powder guided by the said deflector.

The centrifugal may further be provided with additional means for supplying water, steam or other substances into the rotor. It will be understood that also these means should operate automatically substantially in the same manner in which the scraper performs its function.

The required rotary speed of the controlling cylinder 17 depends upon local circumstances and upon the nature of the material under treatment, so that it is desirable to provide for means whereby said speed can be regulated.

The vertical controlling cylinder 17 could be replaced by a disk revoluble about a horizontal shaft and provided with a cam groove cooperating with the cam follower of the arm 14.

It is not necessary for the controlling cylinder to be continuously driven at a uniform speed. It could be provided with a clockwork or a similar device adapted to drive the said cylinder at intervals.

The invention can be applied with equal advantage to centrifugal separators having an impervious wall. Also in that case the rotor may be subdivided into a plurality of annular compartments, reference being had to Fig. 3, according to which the rotor 3 is divided, by partitions 7, into five compartments *a*—*e*. Vertically spaced from each partition 7 there is a second partition 29 having a somewhat greater width, so that relatively narrow annular compartments, *f*, *g*, *h*, *i* respectively alternate with the annular compartments *a*—*e*. The cylindrical wall of the rotor is foraminous in the compartments *f*—*i*, but impervious in the compartments *a*—*e*. Each feed pipe 22*a*—22*e* supplies the material to be treated on to the bottom of its annular compartment *a*—*e*, where it immediately spreads into a cylindrical layer on the peripheral wall by the centrifugal effect. The solid matter is thrown outward into direct contact with said wall, whereas the liquid flows over the top edge of the compartment *a*—*e* into the next higher compartment *f*—*i*, as soon as the first named compartment is filled. From the chambers *f*—*i* the liquid is extruded through the filtering wall. From the top compartment *e* the liquid flows over the inwardly projecting top edge 30 of the rotor 3.

Also in the last described apparatus the solid deposit can be removed from the compartments *a*—*e* in the manner hereinbefore explained, for instance, by means of one single scraper adapted for intermittent vertical and swinging movements. The feed, however, should take place in such a manner that there are always four feed pipes in open communication with the main supply pipe and that only one feed pipe is shut off at a time, viz. the feed pipe cooperating with the compartment *a*—*e* which is being discharged.

What I claim is:—

1. A centrifugal separator comprising a casing, a rotor in said casing, a fixed spindle mounted parallel to the axis of said rotor, discharging means for said rotor mounted upon said spindle and means for oscillating said discharging means and intermittently sliding the same along said spindle.

2. A centrifugal separator comprising a casing, a rotor located in said casing, a fixed spindle mounted parallel to the axis of said rotor, discharging means upon said spindle, a cam cooperating with said discharging means to move the same axially upon said spindle, a second cam cooperating with said discharging means to oscillate the same about said spindle and means for rotating said cams.

3. A centrifugal separator comprising a casing, a rotor located in said casing having a series of annular compartments, a supply pipe, a multiway valve connected to said pipe, a series of feed pipes connected to said

valve leading to each of said compartments, means for discharging said rotor and means operated by said discharging means for operating said valve to progressively feed said compartments.

4. A centrifugal separator comprisng a casing, a rotor located in said casing having a series of annular compartments, a supply pipe, a multiway valve connected to said pipe, a series of feed pipes connected to said valve leading to each of said compartments, a scraper for discharging said compartments, means for intermittently operating said scraper and means operated by said scraper operating means for operating said valve to feed said compartments.

5. A centrifugal separator comprising a casing, a rotor, means for feeding material to said rotor at axially spaced points successively, means for discharging the material from said rotor and means for moving said discharging means in the same direction as said feeding takes place and in spaced relation thereto,

6. A centrifugal separator comprising a casing, a rotor having a series of compartments therein, means for feeding material successively to said compartments, means for discharging said compartments in spaced sequence to the feeding thereof and means for moving said discharging means in the same direction as said feeding takes place.

7. A centrifugal separator comprising a casing, a rotor, means for intermittently feeding material successively to said rotor at axially spaced points, means for discharging the material from said rotor and means for moving said discharging means in the same direction as said feeding takes place and in spaced relation thereto.

8. A centrifugal separator comprising a casing, a rotor having a series of compartments therein, means for intermittently feeding material successively into said compartments, means for intermittently discharging the material from said compartments and means for moving said discharging means in the same direction as said feeding takes place.

9. A centrifugal separator comprising a casing, a rotor of cylindrical form adapted to rotate in said casing, a series of annular partitions in said rotor extending at right angles to the axis of rotation of said rotor, means for feeding material successively into said compartments, means for intermittently discharging the material from said compartments and means for moving the said discharging means in the same direction as said feeding takes place.

10. A centrifugal separator comprising a casing, a rotor of cylindrical form adapted to rotate in said casing, a series of annular partitions in said rotor extending at right angles to the axis of rotation of said rotor, means for feeding material successively into said compartments, means for discharging the material from said compartments and means for moving said discharge means in the same direction as said feeding takes place.

11. A centrifugal separator comprising a casing, a rotor of cylindrical form adapted to rotate in said casing, a series of annular partitions in said rotor extending at right angles to the axis of rotation of said rotor, means for feeding material successively into said compartments, means for intermittently discharging the material from said compartments in spaced sequence to the feeding and means for moving said discharging means in the same direction as said feeding takes place.

In testimony whereof I affix my signature.

EVERT VAN DER MOLEN.