United States Patent [19]

Günnewig

[11] **3,797,736**

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[54] **METHOD AND APPARATUS FOR CONTROLLING THE CONCENTRATION FACTOR OF A DISCHARGE**

[75] Inventor: **Hubert Günnewig**, Oelde, Germany

[73] Assignee: **Westfalia Separator AG**, Orelde/Westf., Germany

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[52] **U.S. Cl.** ..... **233/20 R**

[51] **Int. Cl.** **B04b 1/12**

[58] **Field of Search** .... 233/14 R, 19 R, 19 A, 20 R, 233/20 A, 46, 47 R, 22

[56] **References Cited**

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Primary Examiner—George H. Krizmanich

Attorney, Agent, or Firm—Burgess, Dinklage & Sprung

[57] **ABSTRACT**

A centrifugal separator having a drum with concentrate discharge nozzles disposed at a shorter distance from the axis of rotation than the outer periphery of the separating chamber. The drum is provided with auxiliary discharge nozzles or bores disposed at the outer periphery of the separating chamber and leading radially outward. Valves are provided for the auxiliary discharge nozzles for closing and opening thereof in accordance with need for discharge of concentrate in excess of that discharged from the first-mentioned nozzles, and control means are provided for controlling the operation of the auxiliary nozzles in accordance with said need.

11 Claims, 3 Drawing Figures

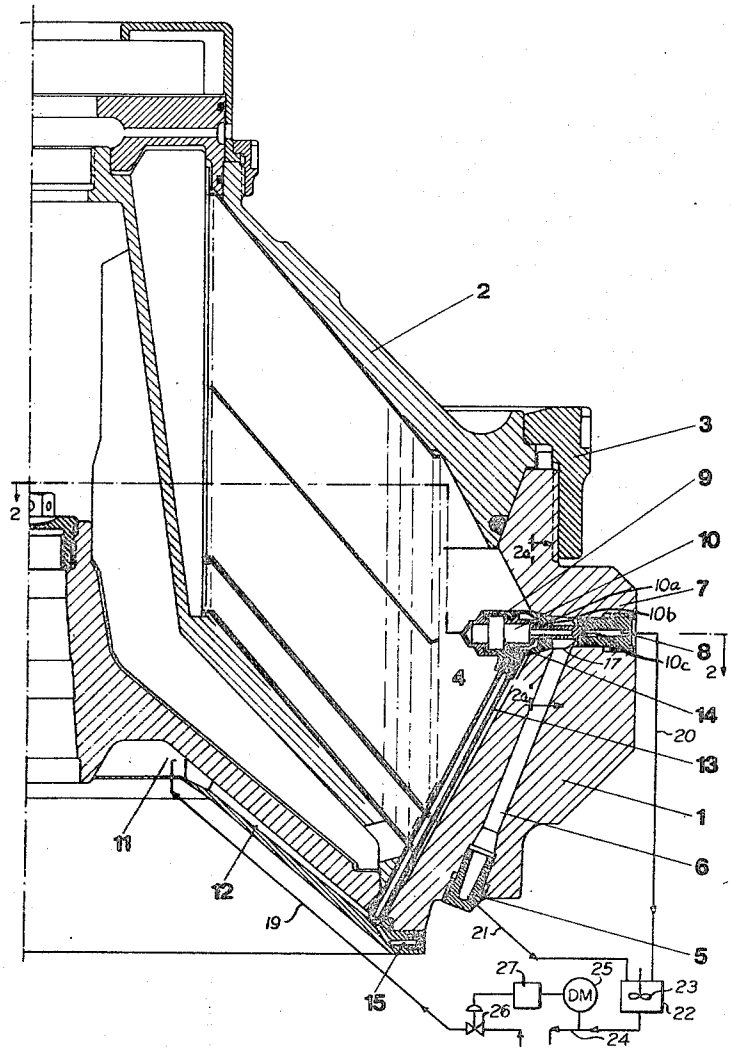


Fig. 1

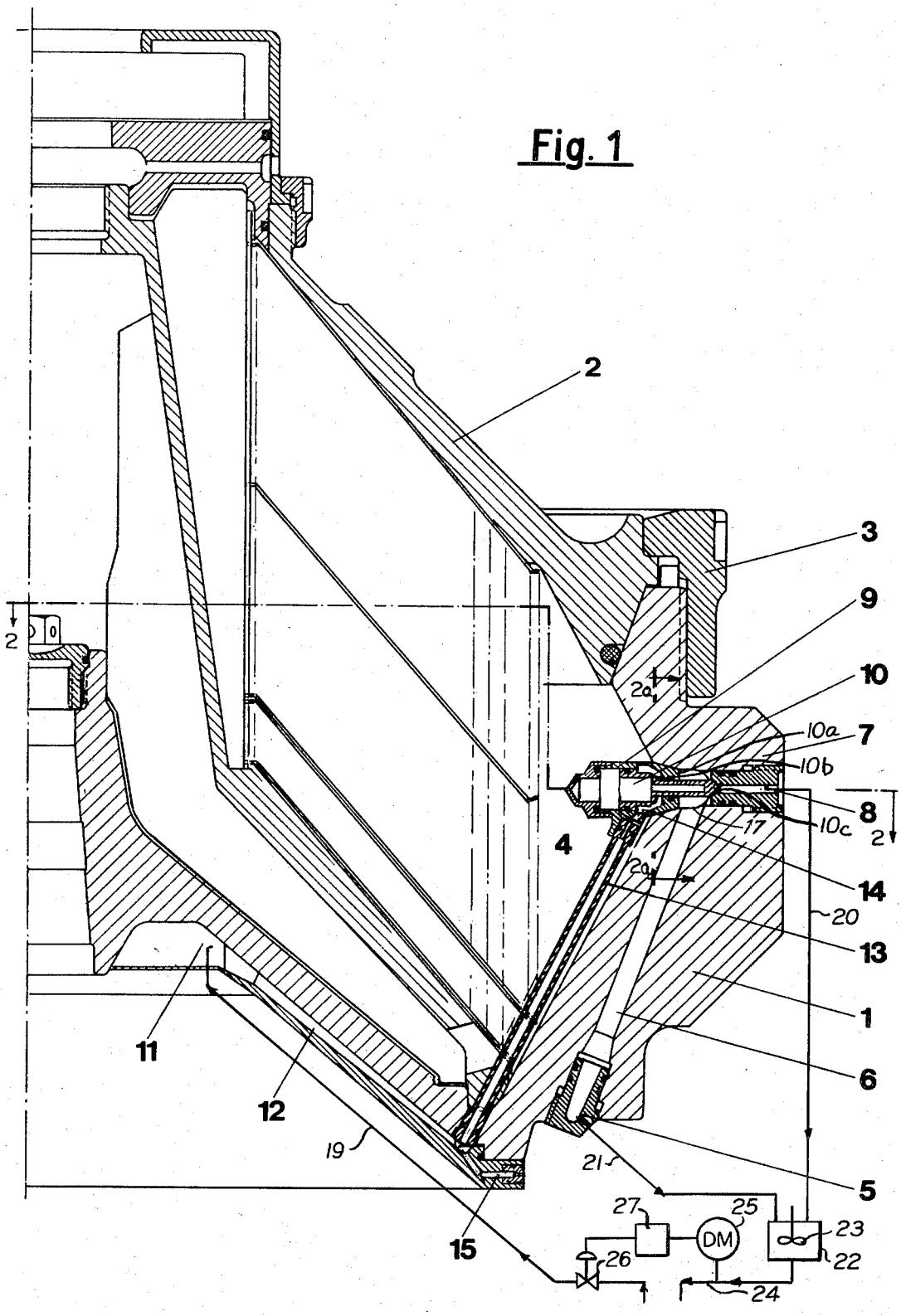

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Fig. 2

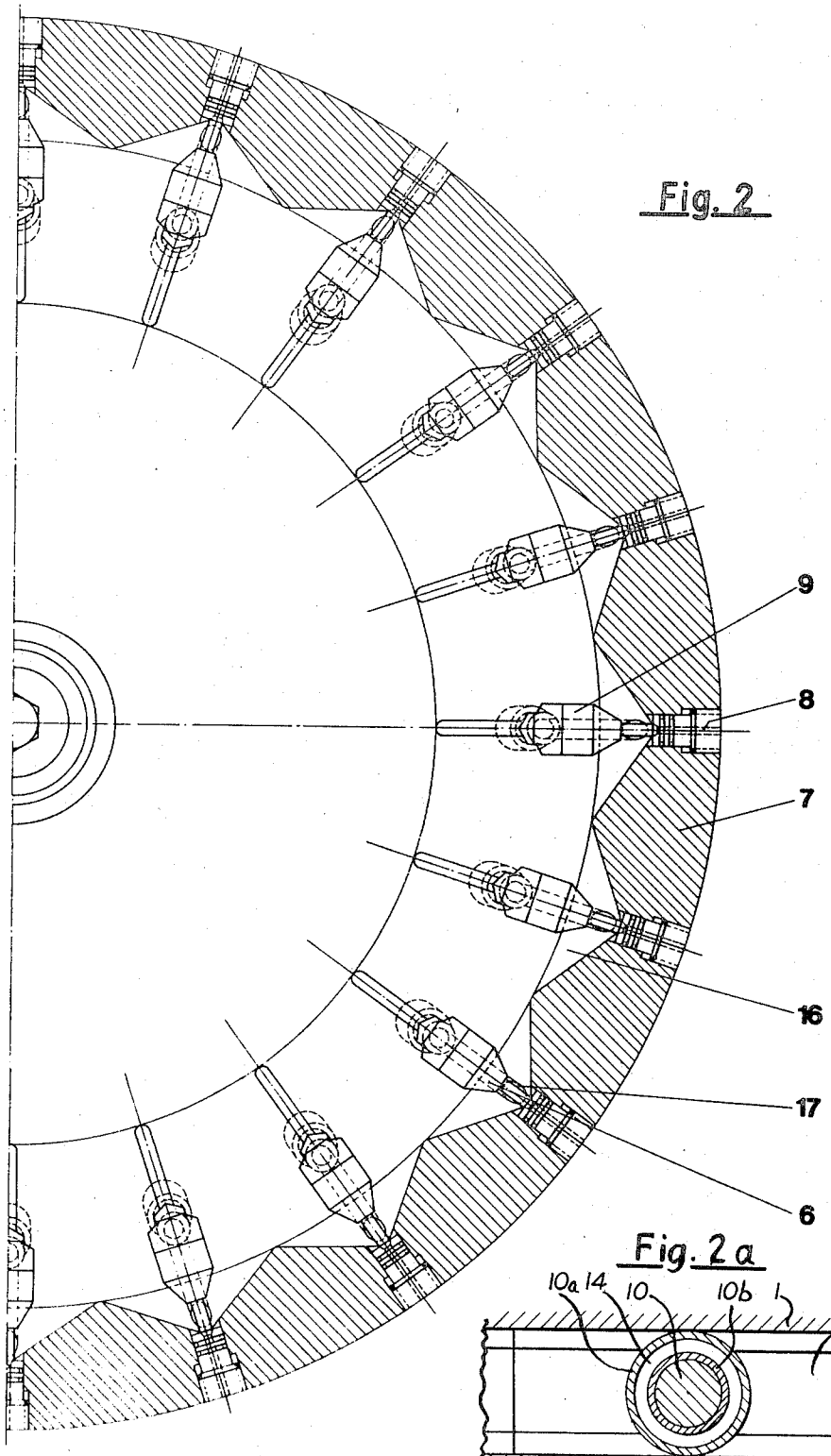


Fig. 2a

METHOD AND APPARATUS FOR CONTROLLING THE CONCENTRATION FACTOR OF A DISCHARGE

BACKGROUND

The invention relates to a nozzle drum for concentrating suspended solids, in which a plurality of discharge passages for the removal of the concentrate lead inwardly from the concentrating chamber, i.e., the outer portion of the separating chamber. These passages terminate in discharge nozzles which are uniformly distributed about the circumference at a lesser distance from the axis of rotation than the inlet of the passages.

The concentration factor of a nozzle drum depends on the nozzle efficiency, the throughput of the drum and the solid content of the material being separated.

The nozzle efficiency is represented by the product of the discharge speed times the total nozzle cross section. Disregarding the internal friction, the discharge speed is equal to the circumferential velocity of the drum at the point of discharge. It is thus dependent upon the drum speed.

The total nozzle cross section is represented by the product of the cross section of the nozzle bore times the number of nozzles. Since in a given drum the number of nozzles is fixed, the total nozzle cross section can be changed only by replacing the nozzles step-wise with nozzles of different cross section, and this can be done only with the drum stopped.

The throughput of the drum and the solid content of the material being separated determine the amount of solids fed to the drum per unit of time. The difference between this quantity of solids and the nozzle efficiency is constituted by the vehicle liquid emerging through the nozzles with the solids. If the solids are discharged through the nozzles with nothing but the adhering moisture, no further improvement of the concentration factor is possible; there is, therefore, an upper limit to it.

On the basis of the information available, prior to the commencement of the separating process, nozzles of such bore cross section have to be inserted into the drum that the required or desired nozzle efficiency and therefore the desired concentration factor will be achieved as nearly as possible. During operation the only possibility of varying it is by varying the throughput.

Nozzle separators are frequently used in continuous processes where the flow of material to be separated is constant. In this case there is no possibility of varying the concentration factor by varying the throughput, and the concentration factor can deviate from the desired value to a greater or lesser extent depending on the nozzles used. It may also happen that the solid content of the constant flow of suspension may vary during operation, which will further result in deviations or variations of the concentration factor from the desired level.

THE INVENTION

The invention is addressed to the problem of constructing a nozzle drum for the concentration of suspended solids, having diversion passages for the concentrate which extend inwardly from the outer portion of the concentration chamber and which communicate with discharge nozzles which are disposed at a shorter distance from the axis of rotation than the inlet to the diversion passages, in such a manner that a variation of the concentration factor during operation will be possible without regulating the input.

The invention is characterized by additional discharge bores which are disposed in the periphery of the drum and extend radially outward, and which can be opened in a known manner by hydraulically controllable valves.

In this manner the discharge cross section for the concentrate phase, and hence the amount of liquid emerging with the solids, can be varied periodically during operation. Since the concentrate ejected through the nozzles and the bores in the drum periphery can be combined and mixed with one another, the concentration of the total mass is susceptible of a relatively fine degree of control.

The valves may be controlled by a continuously operating composition meter or a density meter disclosed e.g., in German Pat. No. 1,271,426.

It is desirable to select the bore of the continuously operating discharge nozzles such that, to achieve the desired concentration factor, the valves will have to open the apertures in the drum periphery at certain intervals of time and for a certain period of time. This will make it possible to vary the concentration factor either way by varying the frequency of operation or the timing.

By means of these valves it will furthermore be possible to empty the drum completely at the end of the separating operation and flush it out with water.

Valves for the periodical discharge of solid concentrates from a centrifugal separator are known. U.S. Pat. No. 2,286,355 shows a drum with automatically operating valves which automatically release openings in the periphery of the drum in dependency on the amount of accumulated solids. U.S. Pat. No. 2,723,799 shows a drum having valves controlled hydraulically from the outside for the purpose of purging thickened solids from the drum. Neither type of separator is a concentrator with continuous removal of the thickened or concentrated solids. Regulation of the concentration factor in accordance with the invention is not possible in these prior-art separators.

Thus, the invention provides a centrifugal separator comprising a rotatably mounted drum providing a drum housing defining a separating chamber for effecting the separation by delivery of a concentrate to the outer portion of the separating chamber. The separator includes principal discharge nozzles for discharge of concentrate from the outer portion of the separating chamber, and disposed on the drum in a shorter distance from the axis of rotation than the periphery of the separating chamber. Diversion passages communicate the outer periphery of the separating chamber with the principal discharge nozzles for delivery of concentrate from the outer periphery of the separating chamber to the discharge nozzles. According to the invention, the separator is outfitted with auxiliary discharge nozzles leading directly from the outer periphery of the separating chamber to the outside for additional discharge of concentrate from the separating chamber. A valve is provided for each auxiliary discharge nozzle for closing and opening thereof in accordance with need for discharge of concentrate in excess of that discharged through the principal discharge nozzles. The machine

further includes control means for controlling the operation of the auxiliary discharge nozzles for opening and closing thereof in accordance with the need for discharge of additional concentrate. The control means can be hydraulic.

Desirably, the auxiliary valves comprise a body member, carrying the valve plug, slidably mounted in the valve housing, and the auxiliary valves are arranged so that the centrifugal force tends to move the valve body member, and therefore the valve plug, to the closed position. The control means can be a hydraulic control means which by feeding a control liquid thereto forces the valve into its open position.

The apparatus can further include a density meter responsive to the density of concentrate discharged from the separator, and effective to actuate the control means for operation thereof in dependency on the density of the concentrate.

In a preferred construction, outwardly converging, conical recesses are provided in the outer portion of the drum housing, and the diversion passages leading from the separating chamber to the principal discharge nozzles, and the auxiliary discharge nozzles are communicated with the outer portion of the conical recesses leading directly to the outside. The valves can be positioned and supported in the conical recesses.

THE DRAWINGS

In the drawing is shown an embodiment of the invention.

FIG. 1 shows a longitudinal cross section through the drum in accordance with the invention;

FIG. 2 is a simplified cross section taken along line 2—2 of FIG. 1; and

FIG. 2*a* is taken on line 2*a*—2*a* in FIG. 2.

The bottom of the drum is identified as 1 and the cover of the drum is marked 2. These two parts are joined together to form the drum housing defining the separating chamber 4, by a joining ring 3. Diversion passages 6 for the concentrate, which are provided with the principal nozzles 5, extend from the outer portion of the separating chamber 4 to a shorter discharge radius. In the plane of the greatest diameter of the drum there is located in the periphery 7 of the bottom 1 of the drum a plurality of auxiliary discharge nozzles or discharge bores 8 extending radially outwardly, which can be opened and closed by valves 9. The valve bodies 10, contained in valve housings 10*a* and outfitted with a cap 10*b*, are constructed with such a mass that they keep bores 8 closed under the action of centrifugal force which tends to force the valve plug 10*c* to the closed position. To shift the valves 9 to their open position, control fluid is injected through a line 19, into the capture groove 11 from which it passes through passages 12 and 13 into the chamber 14 behind the valve bodies 10.

The passages 12 are provided with calibrated drain bores 15 through which the control fluid escapes from passages 12 after the input of fluid into a capture groove 11 is shut off. The force acting upon the valve bodies 10 to open them, which is produced by the liquid remaining in passages 13, is smaller than the closing force developed by the valve bodies under the effect of centrifugal force.

As shown in FIG. 2, the drum periphery 7 in the plane of greatest drum diameter is provided with outwardly converging, conical recesses 16 through which the concentrate passes from the side to the entrance apertures 17 of the diversion passages 6 and to the radially extending outlet bores 8. On account of the conical shape of the recesses 16, a complete emptying of the drum is achieved at the end of operation when the valves 9 are opened. The valves 9 are positioned and supported in the recesses 16.

Control of the operation of the auxiliary nozzles or discharge bores 8 is indicated in FIG. 1. Concentrate from auxiliary nozzles 8 enters line 20, while concentrate from the principal discharge nozzles 5 enters line 21, and the two concentrate streams are discharged into the mixing vessel 22, which is outfitted with a stirr 23 for the mixing of the concentrates. Mixed concentrate leaves the vessel 22 via line 24. A density meter 25 is operatively connected to line 24, and senses the density of the mixed concentrate. The meter is effective to actuate a control means 27 which opens the valve 26 in line 29 in dependency on the metered density in such time intervals, that the desired density of mixed concentrate is maintained.

What is claimed is:

1. In a centrifugal separator comprising:

a. a rotatably mounted drum comprising a drum housing defining a separating chamber for effecting the separation by delivery of a concentrate to the outer portion of the separating chamber,

b. principal discharge nozzles mounted on the drum for continuous discharge of concentrate from the outer portion of the separating chamber, disposed a shorter distance from the axis of rotation than the outer periphery of the separating chamber,

c. diversion passages communicating the outer periphery of the separating chamber with the principal discharge nozzles for delivery of concentrate from the outer periphery of the separating chamber to the discharge nozzles,

the improvement which comprises:

d. auxiliary discharge nozzles at the outer periphery of the separating chamber leading radially outward for discharge of concentrate from the separating chamber at the outer periphery thereof,

e. a valve for each auxiliary discharge nozzle for closing and opening thereof in accordance with the need for discharge of concentrate in excess of that discharged from the principal discharge nozzles,

f. sensing means operatively associated with said principal and auxiliary discharge nozzles for sensing discharge therefrom,

g. control means operatively associated with said sensing means and said valve controlling the operation of the auxiliary discharge nozzles for opening and closing said valve in accordance with said need.

2. Separator according to claim 1, and hydraulic control means for the auxiliary discharge nozzles.

3. Separator according to claim 1, said valves each having a valve housing, and a valve body member having a valve plug thereon for closing of the valve, each valve body member being slidably mounted in its valve housing so that centrifugal force tends to move the valve plug to the closed position.

4. Separator according to claim 3, and hydraulic control means for the auxiliary discharge nozzles for application of hydraulic force in opposition to the centrifugal force tending to close the valve.

5. Separator according to claim 1, wherein said sensing means includes a composition meter effective to sense the composition of concentrate discharged from the separator and effective to actuate the control means for operation thereof in dependency on the composition of the concentrate.

6. Separator according to claim 4, wherein said sensing means include a composition meter effective to sense the composition of concentrate discharged from the separator and effective to actuate the control means for operation thereof in dependency on the composition of the concentrate.

7. Separator according to claim 1, and means defining outwardly converging conical recesses in the drum housing, said diversion passages leading to the principal discharge nozzles and said auxiliary discharge nozzles, both communicating with the outer portion of the conical recesses for receiving concentrate therefrom.

8. Separator according to claim 7, said valves being positioned and supported in the conical recesses.

9. Separator according to claim 6, and means defining outwardly converging conical recesses in the drum housing, said diversion passages leading to the principal discharge nozzles and said auxiliary discharge nozzles, both communicating with the outer portion of the conical recesses for receiving concentrate therefrom.

10. Separator according to claim 9, said valves being positioned and supported in the conical recesses.

11. Process of separating solids from a suspension

a. in a centrifuge having a rotatably mounted drum comprising a drum housing defining a separating chamber for effecting the separation by delivery of a concentrate to the outer portion of the separating chamber,

b. principal discharge nozzles mounted on the drum for continuous discharge of concentrate from the outer portion of the separating chamber, disposed a shorter distance from the axis of rotation than the outer periphery of the separating chamber,

c. diversion passages communicating the outer periphery of the separating chamber with the principal discharge nozzles for delivery of concentrate from the outer periphery of the separating chamber to the discharge nozzles,

d. auxiliary discharge nozzles at the outer periphery of the separating chamber leading radially outward for discharge of concentrate from the separating at the outer periphery thereof,

e. a valve for each auxiliary discharge nozzle for closing and opening thereof in accordance with the need for discharge of concentrate in excess of that discharged from the principal discharge nozzles,

f. sensing means operatively associated with said principal and auxiliary discharge nozzles for sensing discharge therefrom,

g. control means operatively associated with said sensing means and said valve controlling the operation of the auxiliary discharge nozzles for opening and closing said valve in accordance with said need,

which comprises: centrifuging the suspension in the centrifuge, continuously withdrawing concentrate from the outer portion of the centrifuge chamber via said principal discharge nozzle and periodically withdrawing concentrate from the outer portion of the centrifuge chamber via said auxiliary discharge nozzles thereby controlling the concentration factor for the separation.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,797,736 Dated March 19, 1974

Inventor(s) Hubert Gunnewig

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The data sheet, add:

--[30] Foreign Application Priority Data

May 14, 1971 Germany P 21 24 140--

Signed and sealed this 4th day of February 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents