Jan. 24, 1956 E. RÜEGG 2,732,073

MULTI-STAGE PUSH-TYPE CENTRIFUGAL MACHINE

Filed Nov. 18, 1954 2 Sheets-Sheet 1

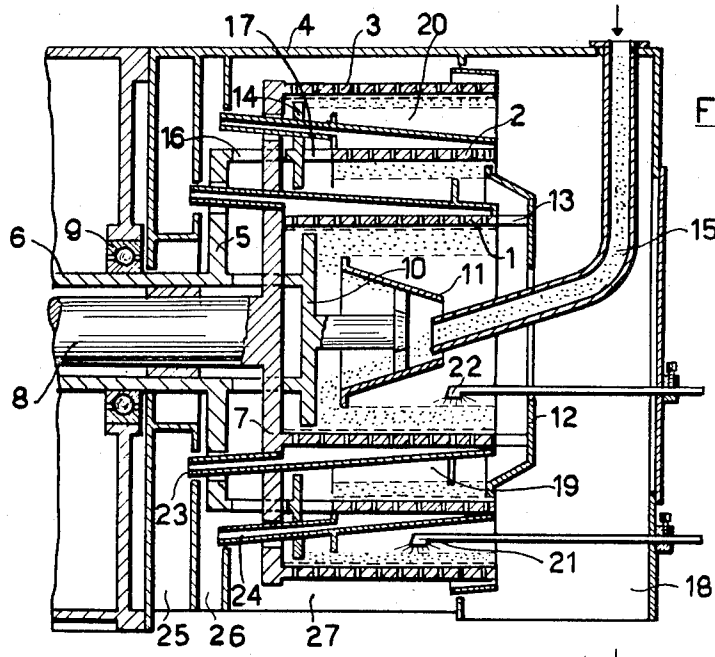

Fig. 1

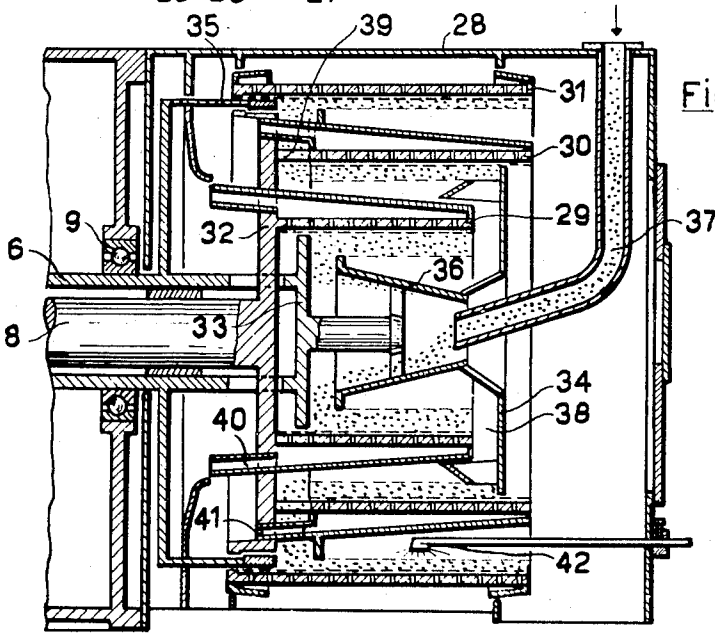

Fig. 2

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MULTI-STAGE PUSH-TYPE CENTRIFUGAL MACHINE

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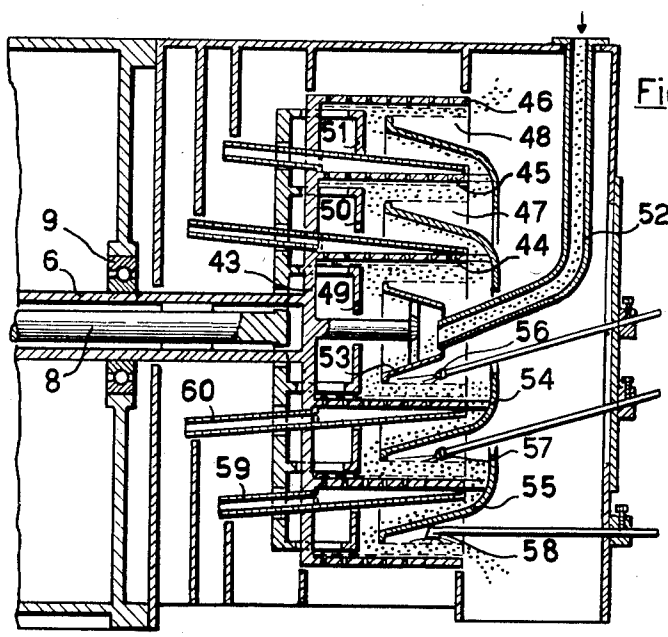

Fig. 3

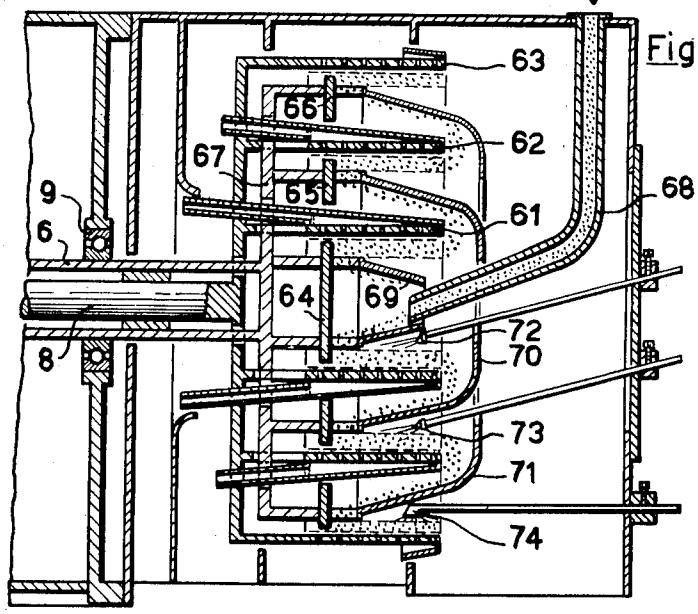

Fig. 4

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MULTI-STAGE PUSH-TYPE CENTRIFUGAL MACHINE

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12 Claims. (Cl. 210—67)

This invention relates to a push-type centrifugal machine having at least two separator cages arranged coaxially.

In the known push-type centrifugal machines, the solid material to be centrifuged is continuously conveyed through and out of the separator cages by an axially reciprocating pusher member. The ejected material is intercepted by a housing which surrounds the end of the cage, and downwardly discharged through an open shaft.

The so-called multi-stage push-type centrifugal machines operate in accordance with the same principle, but in these the solid material centrifuged out of a first cage is projected into a second cage arranged coaxially therewith, and in which it is moved further towards the delivery side. Depending upon the object in view, this second cage is succeeded by one or more further cages.

In these multi-stage push-type centrifugal machines, therefore, the centrifuged material passes successively to a number of coaxially arranged foraminous separator cages partially surrounding one another, but the centrifuged material is always moved axially forwards in the same direction. The layers of material to be centrifuged in the various cages succeed one another in the axial direction.

Each of the cages is equivalent to a continuation of the preceding cage, and the period during which the solid material to be centrifuged stays in the centrifugal machine can be increased as desired.

Multi-stage push-type centrifugal machines afford the advantage that the material to be centrifuged stays in the machine for a longer period of time. Moreover, the solid material is advantageously loosened in passing from one drum to the other and is thus rendered more capable of filtration. Since the stage diameters increase from stage to stage, the degree of dryness of the solid material is at the same time improved.

As heretofore constructed multi-stage centrifugal machines of the push type were unduly long, and necessairily included features objectionable from the design standpoint. To afford desirable access to the cages the latter must be mounted in overhung relation to their bearings, and this fact, and adherence to an axially offset relation of the cages and to unidirectional feed through all cages, introduced problems in the design and location of the bearings.

According to the invention, each cage (except the last) of a multi-cage unit, is encircled by the next, and transfer means are provided to guide the material from the exit end of one cage to the entrance end of the next outer cage. It is practicable, within the scope of the invention, so to arrange the transfer means, that feed to all cages is at the same end, so that material is pushed along all cages in the same axial direction. However, the transfer means may desirably be such that the feed to successive cages is to alternately opposite ends, in which case the material is pushed in opposite directions in successive cages.

The effect is to shorten the machine and improve its construction.

Four different constructional forms of a push-type centrifugal machine designed in accordance with the invention are illustrated by way of example in simplified form in the accompanying drawings, in which:

Figures 1 and 2 each show in axial longitudinal section a constructional form having three separator cages arranged coaxially to one another, wherein the material to be centrifuged is moved axially alternately in different directions, and

Figures 3 and 4 are axial longitudinal sections through two different constructions having three separator cages, on which the material to be centrifuged is moved unidirectionally.

In the push-type centrifugal machine illustrated in Figure 1, a rotor having three foraminous separator cages **1**, **2** and **3** is disposed in a housing **4**. The cage **2** is rigidly connected through a disc **5** to a hollow driving shaft **6**. The cages **1** and **3**, on the other hand, are rigidly connected through disc **7** to a rod **8** extending within the hollow shaft **6**, which rod is adapted to be axially shiftable to a particular extent in the hollow shaft and rotates therewith.

The hollow shaft **6** is mounted in a bearing **9** and is restrained against axial motion. In addition, it is rigidly connected to a push-bottom **10** arranged within the cage **1**, and to a distributor shell **11**. Furthermore, that end of the cage **1** which is further from the disc **7** carries an annular portion **12** which is connected by stays **13** to the cage **1** and serves as a pusher member for the cage **2**. The cage **2** furthermore has an annular projection **14** serving as a pusher member for the cage **3**.

The material to be centrifuged is introduced into the distributor shell **11** through a feed pipe **15**, and is distributed by the said shell in a layer on to the cage **1**.

For the forward movement of the material to be centrifuged on the said cage and the further movement to the succeeding cages, the cages **1** and **3** are reciprocated in the axial direction by an actuating mechanism of known type (not shown), which engages with the left-hand end of the rod **8**. When the cage **1** is moved from the position shown to the left, the layer of material to be centrifuged which lies thereon is moved to the right relatively to the cage by the push-bottom **10**. That part of the layer of material to be centrifuged which lies in the neighbourhood of the free end of the cage is expelled through the gaps between the stays **13** connecting the end of the drum to the annular portion **12** and guided on to the cage **2**.

Simultaneously with the movement of the cage **1** to the left, the annular portion **12** also moves in the same direction and displaces to the left the layer of material to be centrifuged which is situated on the cage **2**, which is fixed in the axial direction. The annular projection **14** is connected to the disc **5** only by individual supporting members **16** extending through the disc **7**, and is connected to the cage **2** by stays **17**. When the layer of material to be centrifuged is moved to the left, a portion of the said material escapes through the gaps between the stays **17** and on to the outermost cage **3**. The layer of material to be centrifuged in the outermost cage is further moved to the right relatively to the said cage, which is moved to the left simultaneously with the cage **1**, a corresponding quantity of material being expelled at the end of the cage and thereafter being downwardly discharged through an opening **18** in the housing.

This method of centrifuging the solid material is rendered possible by the fact that one of each two consecutive cages surrounds the other, an annular gap being left between the two. An annular gap **19** is left between the cage **2** and the cage **1**, and an annular gap **20** is left

between the cage 3 and the cage 2. Moreover, material fed in a layer on to the inner of each two successive cages is moved forward in the axial direction by the means 10, 12 and 14, whereafter it is conducted on to the outer cage surrounding the inner cage and is again moved forward axially thereon in a layer within the gap.

The material to be centrifuged is fed to the cage 1 through the distributor shell 11 on the left-hand side, conveyed to the right by the push-bottom 10 and fed by the annular portion 12 of the cage 2 on the right-hand side, that is to say, on the opposite side to the feed point of the cage 1, and axially moved forward on the cage 2 in the opposite direction to the feed point of the cage 1. The same applies to the cages 3 and 2. Thus, the constructional form illustrated comprises three coaxially arranged separator cages 1, 2, and 3, having between them annular gaps 19 and 20, to which cages the material to be centrifuged is successively fed, and in which in addition the pusher means 10, 12 and 14 are provided, by which the material to be centrifuged is alternately axially moved forward on the successive cages in one direction and in the other.

The cages to which the material is successively fed are furthermore alternately arranged so as to be shiftable and non-shiftable in the axial direction. The shiftable cages 1 and 3 co-operate with the pusher members 10 and 14 which cannot shift in the axial direction, while the non-shiftable cage 2 co-operates with the pusher member 12 which is shiftable in the axial direction and connected to the shiftable cages, for the forward movement of the material to be centrifuged.

In addition, two spray nozzles 21 and 22 are shown in the drawings, by which washing liquid can be fed to the material lying on the cages 1 and 3. The liquid centrifuged from the individual cages is discharged through ducts 23 and 24 into chambers 25 and 26 respectively in the housing. The centrifuged liquid flows directly from the outermost cage 3 into a chamber 27 in the housing.

Instead of the cages 1 and 3 being shiftably arranged and the cage 2 non-shiftable, the same purpose can be achieved by arranging the cages 1 and 3 so that they cannot shift axially, and the cage 2 so that it shifts in the axial direction.

The constructional form illustrated in Figure 2 differs from that according to Figure 1 in that all the cages are arranged to be shiftable in the axial direction and comprise pusher members which are fixed in the axial direction.

Disposed in a housing 28 is a rotor having three separator cages 29, 30 and 31. The said cages are rigidly connected through a disc 32 to the axially displaceable rod 8. For the innermost cage a push-bottom 33 is provided as the pusher member, for the second cage a pusher ring 34, and for the third cage a ring 35. A distributor shell 36 is again connected to the push-bottom 33, into which shell the material to be centrifuged is introduced through a feed pipe 37. All the pusher members are rigidly connected to the hollow driving shaft 6, which is non-displaceable in the axial direction.

When the cages move to the left, the material to be centrifuged passes through a gap 38 between the free end of the cage 29 and the pusher ring 34 on to the cage 30. As the cages return, the layer of material to be centrifuged on the cage 30 in pushed to the left relatively to this cage. The extreme left-hand part of the material is thereby projected through gaps 39 on to the outermost cage 31. When the cages are thereafter moved to the left again, the outermost layer of material is pushed to the right relatively to the cage, a corresponding part of the material being discharged.

Ducts 40, 41 again serve to discharge the centrifuged liquid into corresponding chambers in the housing. In addition, a spray nozzle 42 serves to feed washing liquid to the outermost cage.

The described arrangement has the advantage that the material to be centrifuged which is ejected from one cage on to the next cage always falls directly on to a space freed by the return movement of the pusher member of the next following cage. Temporary banking up of the material to be centrifuged is thus avoided.

Instead of the cages being shiftable and the pusher members fixed in the axial direction, as described, all the cages may be fixed in the axial direction, in which case they will co-operate with pusher members which are shiftable in the axial direction.

In the push-type centrifugal machine according to Figure 3, there are mounted on a disc 43 connected to the hollow driving shaft 6 three foraminous separator cages 44, 45, 46 coaxial in relation to one another, having between them annular gaps 47 and 48. In addition, the thrust rod 8 extending within the hollow shaft is connected to pusher members 49, 50, 51 co-operating with the various cages. The material to be centrifuged is fed through a feed pipe 52 into a flaring distributor shell 53, from which it passes to the first cage 44. All the cages are held against motion in the axial direction, while the pusher members are axially shiftable by the rod 8.

The material ejected to the right from the cage 44 is again conducted through a flaring shell 54 to the left-hand side of the cage 45 and the material ejected to the right from the drum 45 is conducted through a flaring shell 55 to the left-hand side of the cage 46. The flaring shells 54 and 55 are rigidly connected to the separator cages 44, 45 respectively, and extend within the radial space between the consecutive separator cages toward their fixed end. By the movement of the ejecting members, the material to be centrifuged is simultaneously moved forward to the free end on all the cages, and is led back through the shells 54 and 55 in the axial direction in passing from one cage to the next.

Such an arrangement is advantageous in that all the cages are accessible from the delivery side. Means may be provided which, if necessary, feed washing liquid to all the cages. To this end, spray nozzles 56, 57, 58 are provided in the arrangement according to Figure 3. The liquid centrifuged from the cages 44 and 45 is discharged into associated chambers in the housing by corresponding ducts 60 and 59 respectively.

Figure 4 shows a fundamentally similar arrangement, which differs from that according to Figure 3 only in that it comprises three cages 61, 62, 63 which are shiftable in the axial direction and connected to the thrust rod 8. A push-bottom 64 and two pusher rings 65 and 66 are employed as pusher members. In contrast to the construction illustrated in Figure 3, these pusher members are rigidly connected to the hollow shaft 6 through a disc 67 and are therefore fixed in the axial direction. The material to be centrifuged is conducted through a feed pipe 68 to a distributor shell 69 rigidly connected to the push-bottom 64. Two flaring shells 70 and 71 rigidly connected to the pusher members 65 and 66 respectively serve to return the material ejected to the right from the free end of the cages 61 and 62 respectively to the left-hand fixed end of the following cage. Washing liquid is again fed to the material to be centrifuged through the spray nozzles 72, 73, 74.

What is claimed is:

1. In a push-type centrifugal machine in combination a rotary driving shaft; a series of at least two radially spaced foraminous separator cages overhung on said driving shaft and arranged coaxially thereto, and connected to rotate with said driving shaft, the outer one of two consecutive separator cages surrounding the inner one in such a manner as to leave an annular gap between the two; means for supplying material to be centrifuged to the innermost of the separator cages; pusher means co-operating with each of the separator cages, each of said separator cages and said pusher means co-operating therewith being axially shiftable in relation to each other so that, by a relative reciprocating movement

of the two, material to be centrifuged situated in a layer on the separator cage is conveyed in axial direction and successively discharged therefrom; means for leading the materal discharged from each of the separator cages which precede the outermost separator cage to the next following separator cage by which it is surrounded; means for collecting the centrifuged material which is discharged from the outermost separator cage; and means for collecting liquid which is separated from the said layers of material situated on the separator cages.

2. The combination defined in claim 1 in which the series of separator cages consists of axially shiftable and axially fixed separator cages alternating with each other, the pusher means co-operating with the axially shiftable separator cages being rigidly connected with said axially fixed separator cages and the pusher means co-operating with the axially fixed separator cages being rigidly connected with said axially shiftable separator cages.

3. The combination defined in claim 1 in which the series of separator cages consists of at least two separator cages rigidly connected to each other and co-operating with a series of pusher members rigidly connected to each other, one associated to each separator cage, whereby the series of separator cages and the series of pusher members are axially shiftable in relation to each other.

4. The combination defined in claim 3 in which the separator cages are axially fixed in relation to the driving shaft and the pusher members are axially shiftable in relation to the driving shaft.

5. The combination defined in claim 3 in which the separator cages are axially shiftable in relation to the driving shaft and the pusher members are axially fixed in relation to the driving shaft.

6. The combination defined in claim 1 in which the means which lead the material discharged from one separator cage to the next following are arranged in such a manner that the material is fed to the following cage at the same end from which it is discharged from the preceding separator cage and the pusher means co-operating with the separator cages are arranged on that end of the respective separator cage to which the material is fed, so that with a relative reciprocating movement of the pusher means and the separator cages the material to be centrifuged is conveyed on the consecutive separator cages in alternating axial directions.

7. The combination defined in claim 1 in which the means which lead the material discharged from one separator cage to the next following are arranged in such a manner that the material is returned in axial direction and is fed to each separator cage at the same end, whereby all the pusher means are also arranged at that same end so as to convey the material to be centrifuged on all the separator cages in the same axial direction with a relative reciprocating movement of the separator cages and the pusher means.

8. The combination defined in claim 5 in which means are provided for feeding washing liquid to the material to be centrifuged laying on the separator cages.

9. In a push-type centrifugal machine in combination a rotary driving shaft; a first foraminous separator cage arranged overhung on said driving shaft so as to rotate therewith and in axially shiftable relation thereto; a second foraminous separator cage rigidly connected to said driving shaft, whereby said second separator cage surrounds said first separator cage with an annular gap between the two; a third foraminous separator cage rigidly connected with said first separator cage and surrounding said second separator cage with an annular gap between said third and said second separator cage; a first pusher member encircled by said first separator cage and rigidly connected with said driving shaft; a flaring distributor shell rigidly connected to said first pusher member; a feed pipe opening into said distributor shell, whereby material to be centrifuged is fed through said feed pipe and said distributor shell to said first separator cage; a flow passage leading from the free end of the first separator cage to the free end of the second separator cage; a second pusher member rigidly connected to the free end of said first separator cage so as to co-operate with said second separator cage; a flow path leading from the shaft side end of the second separator cage to the shaft side end of the third separator cage; a third pusher member rigidly connected to said shaft end of the second separator cage so as to co-operate with said third separator cage, whereby with an axial reciprocating movement of the first and the third separator cage and the second pusher member the material to be centrifuged which is situated on the first separator cage is conveyed to its free end, discharged therefrom on to the free end of the second separator cage, is then conveyed in the return direction on the second separator cage, discharged therefrom on to the third separator cage and conveyed thereon again toward its free end for being finally discharged; and means for collecting liquid which is centrifuged from the material during its stay on the separator cages.

10. In a push-type centrifugal machine in combination a rotary driving shaft; a disc arranged overhung on said driving shaft so as to rotate therewith and in axially shiftable relation thereto; three radially spaced foraminous separator cages arranged coaxially and rigidly connected to said disc; a first pusher member encircled by the innermost of said separator cages and rigidly connected with said driving shaft; a flaring distributor shell rigidly connected to said first pusher member; a feed pipe opening into said distributor shell, whereby material to be centrifuged is fed through said feed pipe and said distributor shell to said innermost separator cage; a second pusher member encircled by the intermediate one of said separator cages confining axially a flow path for leading material which is discharged from the free end of the innermost separator cage to the intermediate separator cage, said intermediate separator cage being provided with gaps in the region near the disc to which it is connected, thus allowing material to discharge through said gaps from said intermediate separator cage to the outermost of said separator cages; a third pusher member rigidly connected with said driving shaft and co-operating with the outermost of said separator cages in the region near the disc to which the said last named separator cage is connected, whereby, with an axial reciprocating movement of the separator cages, the material to be centrifuged which is fed to the innermost separator cage, is conveyed thereon to the free end thereof, discharged on to the intermediate separator cage, conveyed thereon to the region near the disc, discharged therefrom on to the outermost separator cage and conveyed thereon to the free end thereof for being finally discharged means for collecting the material which is finally discharged; and means for collecting liquid which is separated from the material situated on the separator cages.

11. In a push-type centrifugal machine in combination a rotary driving shaft; a disc rigidly connected to the free end of said driving shaft; at least two radially spaced separator cages arranged coaxially and rigidly connected to said disc; a flaring distributor shell encircled by the innermost of said separator cages and rigidly connected to said driving shaft; a feed pipe opening into said distributor shell, whereby material to be centrifuged is fed through said feed pipe and said distributor shell to said innermost separator cage; pusher members, one co-operating with each of said separator cages, arranged to rotate with said driving shaft and axially shiftable in relation thereto, whereby with an axial reciprocating movement of said pusher members material to be centrifuged is conveyed on the said separator cages toward the free end thereof; flaring shells one rigidly connected to each of the separator cages except the outermost and extending within the radial space between consecutive separator cages toward the fixed end of the separator cages for lead-

ing material which is discharged from the free end of the separator cage to which it is connected to the region near the fixed end of the outwardly next following separator cage; means for collecting the material which is discharged from the free end of the outermost separator cage; and means for collecting liquid which is separated from the material situated on the separator cages.

12. In a push-type centrifugal machine in combination a rotary driving shaft; a disc connected to rotate with said driving shaft and axially shiftable in relation thereto; at least two radially spaced separator cages arranged coaxially and rigidly connected to said disc; pusher members, one co-operating with each of the said separator cages, rigidly connected with said driving shaft; a flaring distributor shell arranged within the innermost of said separator cages and rigidly connected to the pusher member which co-operates with the innermost separator cage; flaring shells, one rigidly connected to each of the pusher members except the innermost and extending within the radial space between consecutive separator cages toward the supported end of the separator cages, for leading material which is discharged from the free end of the preceding separator cage to the region near the supported end of the separator cage next outward, a feed pipe opening into said distributor shell which is arranged within said innermost separator cage, whereby material to be centrifuged is fed through said feed pipe and said last named distributor shell on to the innermost separator cage, and, with an axial reciprocating movement of the separator cages, is conveyed toward the free end of the said innermost separator cage and successively passed to the following separator cages, being conveyed on each of the separator cages from the region near the supported end of the separator cages toward its free end and finally discharged from the free end of the outermost separator cage; means for collecting the material which is finally discharged; and means for collecting liquid which is separated from the material situated on the separator cages.

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