May 14, 1963 F. KAISER 3,089,595

FLOW APPARATUS FOR SEPARATING GRANULAR PARTICLES

Filed July 24, 1961 3 Sheets-Sheet 2

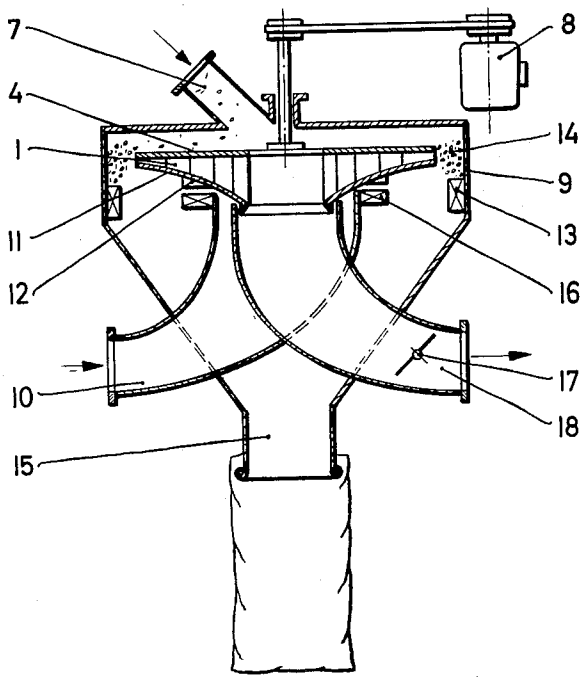


Fig. 6

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FLOW APPARATUS FOR SEPARATING GRANULAR PARTICLES

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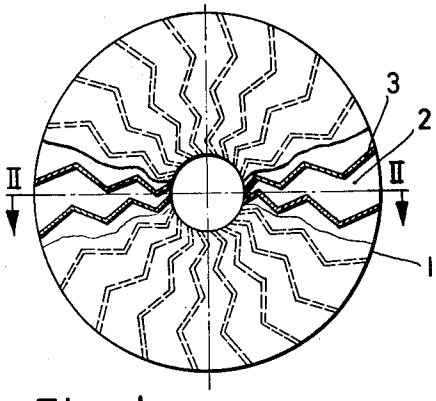


Fig. 1

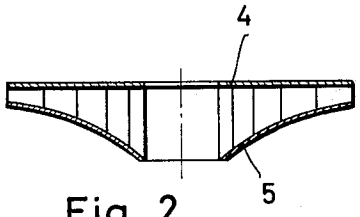


Fig. 2

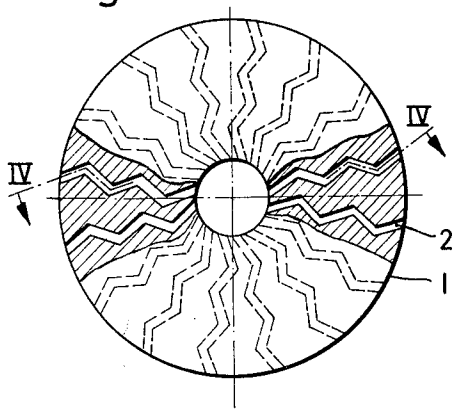


Fig. 3

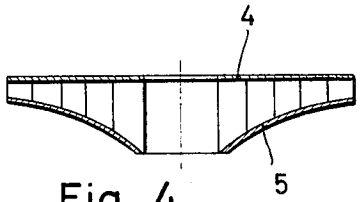


Fig. 4

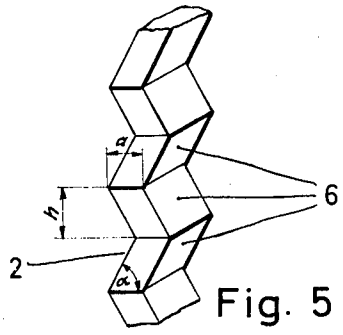


Fig. 5

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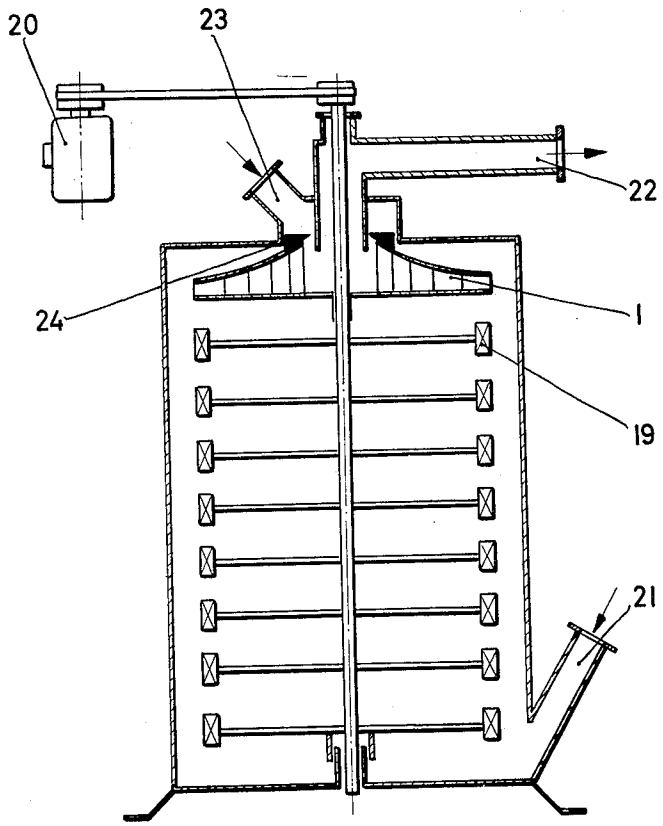


Fig. 7

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3,089,595

FLOW APPARATUS FOR SEPARATING GRANULAR PARTICLES

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8 Claims. (Cl. 209—144)

The invention concerns the separation of granular particles and in particular relates to an apparatus whereby particles above or below a given size may be separated into two distinct groups by means of a centrifugal type separator.

Conventional separating machines operate on one or more of the following principles:

1. Separating in a free flat cylindrical separating chamber in which the centrifugal force and the tractive force of the carrying medium towards the inside affects each particle. Either the centrifugal force or the tractive force predominates according to the size of the particle, although these forces have equal effect on the marginal or datum article. These separators, which are known by the name of "spiral wind separators" have proved themselves for effective and sensitive division.

2. Separating on a trellis bar on the perimeter of the separating chamber. Coarse particles are rejected whilst fine ones are passed through the holes in the trellis by the air stream.

These separators are known in many embodiments and have proved themselves for average fineness and sharpness of division.

3. Separating in channels of a separator wheel. The centrifugal force and the tractive force of the carrying medium flowing inwards in the tunnels affect the particle. The centrifgual force and the tractive force again have equal effect on the marginal particle. Numerous embodiments of this separator have become known, but none has been proved to be satisfactory.

The secondary currents of the flowing medium and the "coriolis" forces bring about too great a disturbance on the separating process.

The present invention shows a way in which outstanding results can be obtained with a separator wheel of the third type. The invention is based upon the appreciation that facts known per se in respect of stationary channel separators may be applied with advantage in centrifugal separators. The separation process in separators known as "Rising tube separators" relies on the fact that the force of gravity operates on the particle in a downward direction whilst the tractive force of the flow medium operates in the opposite direction. If a force of gravity predominates then the particle falls, and, conversely, if the tractive force predominates then the particle is carried upwards. Both forces have equal effect on the marginal particle.

In these "Rising tube separators" simple smooth channels have not been of any significant use, but the introduction of a cascade-like insert to break the channel up into a multiplicity of individual chambers has resulted in a more satisfactory assembly. Although the separation due to each individual chamber is low, by virtue of the number of chambers involved, a satisfactory separation is obtained. It is, of course, to be appreciated that the accuracy of separation can readily be increased by increasing the number of chambers.

The separator wheel of the assembly according to the present invention includes separating channels directed approximately radially thereof which are of cascade form.

In these separators the sharpness of separation, just as in the case of known "Rising tube separators" is improved

in the manner known per se through the amplification effect of the numerous chambers. In addition there are the following new effects which arise in a rotating channel:

1. In each separating chamber, that material to be separated which is adjacent the wall and is not subjected to the separating process, is returned to the body of the material and is therefore separated.

2. The higher flow resistance of the individual separating channels improves the evenness of distribution of flow through to the individual channels of the wheel.

3. The danger of sediment is considerably reduced owing to the effect of the centrifugal force. Whilst in stationary cascade separators, because of the build up of sediment, differentiation is only possible down to about 200 microns, differentiation in rotating cascade separators can be carried out down to about 3 microns.

4. As it is possible to alter both the rate of rotation and the amount of air a large range of separating accuracy is available. For example, a sensitivity of between 3 and 300 microns is possible.

5. Because of the increasing "sinking speed" of the marginal particle due to centrifugal acceleration the "Froude count" is higher in rotating channels, the maximum load of material in the flow medium also rises; that is to say, the throughput of the separator is increased due to rotation.

It is also known that through the combination of the two characteristics known per se, namely, the somewhat radially directed channels and the cascade shaped construction thereof, several new advantageous effects can be obtained.

A separating wheel is known which has approximately radially directed channels of zig-zag shape. These channels are, however, not enclosed and the walls are formed in individual plates arranged in the interstices so that the individual channels are in connection with one another.

There has been no reference to the amplifying effect of the separating chambers, neither has there been any reason expressed for the form of channel used.

It has been found in practice that this prior separator will not work because the material to be separated accumulates in a middle zone between adjacent separating channels.

The inutility of the prior arrangement is possibly due to the small number of separating channels being insufficient to ensure a clean separator and also to the fact that the radial channels are not enclosed and, furthermore, are in communication one with another.

According to the present invention a flow apparatus for separating granular particles which has a separator wheel through which the flow medium passes along substantially radially directed separating channels, is characterised by the combination of a cascade shaped formation known per se of the separating channels and means likewise known per se for feeding the flow medium and the material to be separated over the circumference of the separator wheel.

Of the various shapes of cascade channels used in stationary separators, one has been found to be most satisfactory. It consists of individual, short smooth channel pieces or chambers which are placed together, at angles of about 30° to the main axis, in a zig-zag shape.

Preferably according to the present invention the separtor channels are of zig-zag shape thus constituting separating chambers individually inclined at an angle of approximately 30° to the main axis of the channel.

Special advantages can be obtained if a ratio of 0.8 is chosen between the width "a" and height "h" of the channel. It can be further advantageous if the right-angled cross section of the separating channel increases in such a way, by increasing the axial stretch (height), that the theoretical margin of division in each individual chamber

is equal. The necessary speed value is calculated for each individual case from the generally known dependence of the sinking speed of the relative marginal grain on the centrifugal acceleration.

An increase or decrease of the margin of division towards the inside in a ratio of at the highest 2:1 can be advantageous. An increase improves the throughput, a decrease on the other hand the sharpness of separation, in each case at the cost of the other.

In order to obtain a still more even distribution of the flow medium and the material to be separated, it can be advantageous to build the housing which surrounds the separator wheel, symmetrical to rotation, most simply cylindrical.

If a clean coarse material is needed from the separator, special means have to be provided for the goods to remain for a fair time and for good washing at the circumference of the separator wheel.

For this any suitable construction can be used, it can however, be especially advantageous to arrange, in the cylindrical housing which surrounds the separator wheel, below the same screw shaped guide surfaces, which because of the rotary flow in caused by the housing of the separator wheel, if necessary through additional blades, takes the material up in front of the circumference of the separator wheel and holds in these in suspension.

The material remains there in a fluidised condition for a fair time and is at the same time well washed by the flow medium and fine material is prevented from getting into the coarse material.

The invention will now be described further, by way of example only, with reference to the accompanying drawings in which:

FIG. 1 is a plan view, partly in section, of a separator wheel constructed according to the invention;

FIG. 2 is a section along line II—II of FIG. 1;

FIG. 3 is a plan view, partly in section, of an alternative form of separator wheel;

FIG. 4 is a section along line IV—IV of FIG. 3;

FIG. 5 shows, in perspective, an individual separator channel;

FIG. 6 is a vertical section taken through a flow separator according to the invention; and

FIG. 7 illustrates, in longitudinal section, a beater mill including a separator wheel according to the present invention.

Referring to FIG. 1 a separator wheel **1** is illustrated, constructed in accordance with one form of the present invention, and having radial separator channels **2** of zig-zag form provided therein.

The width of the individual channels **2** decreases towards the axis of the wheel whilst the height, as is readily apparent in FIG. 2 increases towards such axis. The combined effect of such dimensional variations is that the transverse cross section of each channel increases towards the wheel axis.

The individual separator channels **2** are separated from one another by thin zig-zag shaped metal strips **3** which are covered above and below by discs **4** and **5**.

Referring now to FIGS. 3 and 4, the separator wheel **1** has separate channels **2** machined therein. In this separator wheel too the cross-section surface of the individual separating channels **2**, which are covered above and below by discs **4** and **5** increases towards the wheel axis.

In the zig-zag shaped separating channel **2**, see now FIG. 5, the individual chambers **6** which are placed on to one another in zig-zag formation at an angle of about 30° to the main axis whilst a ratio of width "*a*" to height "*h*" of 0.8.

FIG. 6 schematically portrays in section an air flow separator fitted out with a separator wheel **1** according to the invention.

The material to be separated which falls from above onto the upper wall **4** of the separator wheel through feed channel **7** is centrifuged by separator wheel **1**, which is driven by a motor **8** provided with a speed adjustment, towards the inner side of the cylindrical housing **9**. The separator-wind, which flows into the separator from below through feed pipe **10**, is set into rotating movement by the blades **12** mounted on the lower cover plate **11** of separator wheel **1**, and then enters at the periphery or circumference of separator wheel **1**. The screw shaped guide surfaces **13** on the inner side of housing **9**, guide the material, because of the rotary flow brought about in the housing by the lower cover plate **11** of separator wheel **1**, upward in front of the periphery or circumference of the separator wheel and holds it there in suspension.

The material **14** remaining there is picked up by the flowing medium and thereby prevents fine material getting into the coarse material falling below through coarse material channel **15**.

In many cases it can be advantageous to mount further guide surfaces or blades **16**. The fine material separated in separator wheel **1** is carried out through fine material channel **18** which is provided with a throttle or choke **17**.

In the beater mill portrayed in FIG. 7 a separator wheel **1** is mounted in the upper part above the beater mechanism **19**. The wheel **1** and the beater mechanism **19** are driven from above by motor **20**. The material entering from below with air through feed channel **21** enters from the outside, after it has been reduced by the beater mechanism **19**, as material to be separated, into the separator wheel **1** and is here put through a separating process. The fine material is led away together with the separator wind through pipe **22** whilst the coarse material is carried out of the separator wheel **1** to the outside and is then subjected to a further reduction through the beater mechanism **19**. Scavenging air is led in through pipe **23** to prevent material escaping through the slits **24**.

Flow apparatus for separating granular particles according to the invention can work either wet or dry; the flow medium is a fluid for wet working a gaseous one as for example air for dry working.

As a modified arrangement of the underlying ideas of the invention it can be provided that the feed of the flow medium and the material to be separated takes place according to the main idea of the invention from outside, that is, on the circumference of the separator wheel, whereby however in alteration from what has been previously stated the distribution over the separator wheel circumference need not be equal.

It has been proved that in certain cases even distribution is not necessary but feed to the separator wheel circumference remains essential.

I claim:

1. A flow apparatus for separating differently sized granular particles, comprising a rotatable separator wheel having a multiplicity of spaced substantially radially directed separating channels extending respectively from the outermost periphery of said wheel toward the center thereof, each of said separating channels being of enclosed substantially zig-zag configuration, means for feeding material to be separated onto an imperforate rotary boundary wall of said wheel at a position adjacent the axis of rotation of said separator wheel, means for rotating said wheel and boundary wall thereby to centrifuge said material away from said axis of rotation over said boundary wall to a position adjacent the outermost periphery of said rotating wheel, means supplying a flow medium at a like position adjacent the outermost periphery of said rotating separator wheel, said rotating wheel being operative to effect a flow of said medium and of portions of said material via said channels from the periphery toward the center of said separator wheel, and outlet means communicating with said separating channels adjacent the center of said wheel for discharging said portions of said material from said wheel.

2. The flow apparatus of claim 1 wherein the dimension of said channels in directions transverse to the axis

of rotation of said wheel decreases toward the axis of rotation of the wheel.

3. A flow apparatus for separating granular particles comprising a separator wheel having a plurality of substantially radially directed separating channels therein, each of said channels comprising a plurality of chambers angularly inclined to one another in a substantially zig-zag configuration extending between the periphery of said wheel and a position adjacent the center of said wheel, the side walls of said chambers being interconnected with one another to provide continuous side walls for said separating channels extending radially inwardly from the periphery of said wheeel, means for rotating said wheel, and feeding means arranged to feed a flow medium as well as a material to be separated to like positions adjacent the circumference of said separator wheel whereby, upon rotation of said wheel, said flow medium and at least portions of said material to be separated are caused to flow radially inward of said wheel via successively interconnected ones of said chambers from a position adjacent the periphery of said wheel toward a position adjacent the center of said wheel.

4. The apparatus of claim 3 wherein each of said channels is defined between a pair of zig-zag shaped walls extending in spaced generally converging configuration

to one another between the periphery of said wheel and points located radially inward of said periphery.

5. The flow apparatus of claim 3 wherein adjacent ones of said chambers are disposed at an angle of substantially 120 degrees to one another.

6. The flow apparatus of claim 3 wherein said wheel includes closure members disposed adjacent the upper and lower surfaces thereof for enclosing at least portions of the upper and lower edges of each said channel thereby to provide a plurality of continuous, separate, substantially enclosed channels extending radially inward from the periphery of said wheel toward the center of said wheel.

7. The apparatus of claim 6 wherein at least one of said closure members comprises a disk extending over an outer rotating surface of said wheel, said feeding means including means feeding said material to be separated onto a surface of said disk.

8. The flow apparatus of claim 3 including an outlet duct communicating with said separator wheel adjacent the center of rotation thereof.

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