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The invention concerns a device for purposes of separating granular material into at least three fractions, with at least one static separator forming a first separation stage, and at least one dynamic separator forming a second separation stage,

wherein the static separator has a plurality of baffle and guide fittings, arranged in a staircase-like manner under one another, in a separator housing with at least one first material entry port, at least one separator gas inlet and at least one coarse grade material exit port,

wherein the dynamic separator is designed as a rod basket separator with a rotating rod basket, and has a second separator housing with at least one medium grade material exit port and a fine grade material exit port.

The granular material that is to be separated can take the form, for example, of cement, substances containing cement, cement raw material, limestone, or slag, but can also take the form of ores, or similar materials. In practice, it is in particular roll presses, or material bed roller mills, that are employed for the grade reduction of such granular materials. In the said high pressure grade reduction of the granular material that is being ground the latter is crushed in the gap between two pressure rolls (material bed grade reduction). In the course of the grade reduction agglomerates are formed, which are designated as slag. Such material bed roller mills can be operated in a closed circuit with a static and/or a dynamic separator. The material bed roller mill is then, for example, positioned underneath a separator such that the coarse grade material fraction exiting from the separator is (again) fed into the roller mill. The material exiting from the roller mill is in turn supplied to the material entry port of the separator device, which is composed as a multi-stage device with a static separator and a dynamic separator. In the static separator the slag is broken down by means of the baffle and guide fittings, and at the same time the coarse grade material fraction is separated out and supplied to the roller press. The "finer" material, together with the separator gases, proceeds to the dynamic separator, where it is subjected to a fine grade separation process. The fine grade material separated out of the said separator, together with the separator gas, is led out and captured in the downstream cyclones and/or filters as finished material. The medium grade fraction separated out of the dynamic separator can, for example, likewise be returned to the roller press, or to a further grinding stage. Such measures are of known prior art (compare, for example, DE 43 37 215 A1).

A generic separation device of the type described in the introduction is known, for example, from DE 42 23 762 B4. The said separator unit has a rotating driven rod basket in a housing with turbulence-generating elements arranged distributed over the rotor periphery, and with inlet ports and outlet ports for separation air, material to be separated, fine grade material, medium grade material and coarse grade material. An initial separation chamber in the form of a shaft is positioned upstream at the same height and at the side of the rod basket, which is arranged in a horizontal location; the chamber has: above, an entry port for the material to be separated, which is segregated from the separation air, at the side, an opening for the separation air that is arranged opposite the rod basket, below, a discharge opening for a coarse grade fraction that has been separated out, and two shaft boundary walls that allow the separation air to pass through, located opposite one another, and forming between them an initial separation zone. The said shaft boundary walls of the initial separation chamber, which allow the separation air to pass through, have louver-type guide vanes inclined downward in the direction towards the discharge opening for the coarse grade material fraction that has been separated out; as baffle and guide fittings these vanes at the same time serve to break down the slag. Likewise of the generic kind is the separation device in JP 6-106 135 A, wherein here the screening basket of the dynamic separator rotates about a vertical axis.

In addition in the case of air separators it has been recommended that roof-shaped fittings be provided; these are arranged in the form of a cascade such that the ridge of each fitting lies approximately vertically underneath the throw-off edge of the surface, facing towards the airflow, of the fitting arranged above (cf. DE 1 002 600).

From WO 03/097241 A1 a generic separator device is also familiar, wherein the dynamic separator is fitted with a rod basket rotating about a horizontal axis - as is also the case in DE 42 23 762 B4. In order to minimise the problems of mechanical transport of the material that is being ground as it is fed through the circuit, it is recommended in this previously known prior art to arrange the static cascade separator underneath the roller gap of the roller press, and to arrange the final separation stage above the said roller press, which final separation stage is to be configured in particular as a dynamic rod basket separator. What is disadvantageous in this form of embodiment is the significant height of the structure. As a result of the connecting pipe between the two separators the investment costs and operating costs are increased

An alternative form of embodiment of a multi-stage separator with a compact design is of known art from US 7 854 406 B2. The separator unit consists of a plurality of concentric housings, wherein a rod basket rotating about a vertical axis is provided as the final separation stage. The initial separation stage is formed by a simple cyclone, wherein the material to be separated and the separator gas are supplied via a common supply line, which is connected onto the separator housing in the form of a spiral. Any breaking down of the slag is only possible to a limited extent in the static separation stage.

From DE 10 2004 027 128 A1 a device is known for purposes of separating granular material into at least three grade fractions with a static separator and a dynamic separator; these are arranged axisymmetrically about a common axis in a common housing.

Finally, from DE 10 2006 039 775 A1 a separator unit in a specialised design with a static cascade separator and a further separator as a final separation stage is of known art, wherein the cascade separator has two packs of cone rings, arranged in each case spaced apart one above another, and concentrically with one another.

In addition DD 253771 A1 describes an air separator for purposes of classifying in particular, fine grade bulk solids into at least two fractions, consisting of a cylindrical housing upper section, to which is connected underneath a grit cone with a grit discharge port. The rod basket rotates about a vertical axis. In this manner the material distribution in the separation space of separators with rod baskets is to be improved, so that the selectivity is improved and the energy consumption in terms of the end product is reduced, independently of the rotational speed and shape of a spreading disk. For this purpose an annular container with a whirl tray as a dispersal device is provided; this is arranged above the separator gas entry pipe in the region of the rod basket, inside or outside the separator housing, and is connected with the separation space via an annular gap and/or an annular passage.

The separators of known art of the type described have fundamentally proved themselves in practice, but are capable of being further developed, in particular with regard to their separation efficiency.

The task underlying the invention is therefore that of creating a device for the separation of granular material into at least three fractions of the type described in the introduction, which is distinguished not only by a particularly compact structure, but in particular also by low investment and operating costs and a higher separation efficiency. In particular such a separator unit should enable economical operation of a grinding facility with at least one roller press, with a high separation efficiency.

For purposes of solving this task the invention provides a device for purposes of separating granular material into at least three fractions, which has the features of claim 1.

The invention thereby starts in the first instance from the knowledge, fundamentally of known art, that it is advantageous to combine a static separator and a dynamic separator, in the form of embodiment of a rod basket separator, with one another, since a first coarse grade material fraction can be separated out by means of the static separator, such that the dynamic separator, with its relatively sensitive rotating components, is not unnecessarily loaded with coarse grade material. In accordance with the invention the static and dynamic separators are combined together in a particularly efficient and compact build, in which on the one hand a rod basket is employed with a vertical axis of rotation, and on the other hand the static separator is connected directly onto the side of the dynamic separator, wherein in terms of technical processes the static separator fulfils both the task of breaking down the slag, and also that of a first deposition of coarse grade material. The static separator and the dynamic separator are consequently brought close together spatially, so that both separators operate particularly efficiently in terms of energy, and at the same time the static separator can fulfil the task of breaking down the slag.

In combination with the inventive connection of the static separator to the dynamic separator, the employment of a rod basket separator rotating about a vertical axis has particular significance. This is because the said configuration with a "vertical" rod basket separator is distinguished by uniform incident flow onto the rod basket, or rotor, and thus by an improved separation efficiency. The problems arising in the case of the prior art, with "horizontally" arranged rod basket axes, are avoided within the context of the invention, so that in overall terms, an improved separation efficiency is achieved.

In accordance with the invention the separator housing of the static separator with a tangential or spiral-form orientation leads into the separator housing of the dynamic separator.

In all cases the separator housing of the static separator is always connected compactly onto the side of the separator housing of the dynamic separator, such that the static separator housing merges into the dynamic separator housing. The inventive separator consequently has housing regions, which can be assigned as transition regions between static separator and dynamic separator and can be assigned to both the static separator and the dynamic separator. Thus provision is furthermore made for the separator housing of the dynamic separator to have an upper housing section, in which the rotating rod basket is arranged, and a lower housing section in which is arranged a discharge hopper for the medium grade material, wherein the static separator with its housing is connected onto the lower housing section of the dynamic separator and merges into the said lower housing section. The said lower housing section of the dynamic separator consequently forms the transition region between static separator and dynamic separator. The housing of the dynamic separator is of a cylindrical design, such that the upper housing section and the lower housing section are designed to be cylindrical. The lower housing section of the dynamic separator then also acquires the function of a cyclone, which can influence both the function of the static separator and also the function of the dynamic separator. Thus the cyclone formed by the lower housing section can affect the action of the static separation stage. However, at the same time the said cyclone can also be considered to be a part of the dynamic separator, since it forms an incident flow channel for perpendicular impingement onto the rod basket, and since the discharge hopper of the dynamic separator can also be arranged within the said housing section, or cyclone. By this means it also becomes clear that in accordance with the invention the static separator and the dynamic separator are connected closely with one another both spatially and also functionally.

As described the static separator is preferably connected onto the lower housing section of the dynamic separator. The static separator (in a side view) as a general rule is then positioned underneath the rod basket. Alternatively, however, it is also within the context of the invention for the static separator or separators to be arranged at the same height, or at least in some regions at the same height, as the rotating rod basket.

Within the static separator not only does a first segregation of coarse grade material and medium grade material take place, but a breaking down of the slag can also take place. The breaking down of the slag is achieved with the aid of the baffle and guide fittings integrated into the static separator. The baffle and guide fittings can be formed, in a manner known per se, from baffle plates and guide vanes that are inclined relative to one another. In a preferred form of embodiment the said plates and vanes can be adjusted in their inclination; they can, for example, be pivoted or rotated about a horizontal axis. Since the mode of operation of the static separator can only be influenced to a limited extent during operation - in contrast to the dynamic separator - such a possibility for adjustment is expedient. The desired circumstances for the static separator can be adjusted such that, in particular, the flow conditions can be optimised. Alternatively the baffle and guide fittings can also be formed from roof-type fittings, such as are of known art, for example, from DE 1 002 600. The roof-type fittings can optionally be movable in the horizontal direction. In the static separator the task of breaking down the slag on the one hand and a first coarse grade material separation on the other hand are always combined with one another.

While the (second) separator housing of the dynamic separator as a general rule is designed to be cylindrical or at least cylindrical in some sections, the static separator has a shaft-type, that is to say, a box-type housing, which is preferably aligned at an angle to the vertical, so that the baffle and guide fittings arranged in the interior are arranged along an inclined face. The shaft-type housing has on the one hand the material entry port or entry ports for the material to be separated, and on the other hand has at least one separator gas inlet port, via which air, for example, is supplied. For this purpose the shaft-type housing can have a (lower) shaft wall which is oriented at a prescribed angle α of between 10° and 80°, for example 40° to 60°. In overall terms the housing can consequently (in the side view) be arranged at an angle to the vertical. The same is true for the baffle and guide fittings arranged under one another in the form of a staircase within the housing. Between these fittings is formed the separation zone of the first separation stage, which is orientated at a prescribed angle ß of between 20° and 70°, for example 20° to 40°, with respect to the vertical. However, the invention also comprises a shaft-type housing, which is not aligned at an angle to the vertical, but rather is parallel with the vertical.

The separator gas entry port can, for example, be formed by at least one entry port opening arranged at an angle above the fittings. Alternatively or additionally, the possibility exists that the separator gas entry port is formed from one or a plurality of openings arranged in the shaft wall. The said openings can, for example, be closed by means of flaps, such that by opening and closing the latter the supply of separator gas can be varied. Consequently it lies within the context of the invention either that one (upper) entry port opening of the type described is provided, or that openings are provided in the shaft wall. Preferably, however, a combination of these measures is implemented, such that both at least one entry port opening arranged at an angle above the fittings, and also one or a plurality of openings arranged in the shaft wall, are then provided, wherein the said openings can optionally be closed, for example, by means of flaps. The possibility then exists of operating with a "variable" supply of air, and consequently, with regulation of the quantity of air. Here it is expedient if the individual flaps can be opened and closed individually, in groups, and/or all together, wherein, a variable and targeted adaptation is particularly preferably possible by adjusting the openings. Within the context of the invention, the word "flaps" means in general terms, means for the opening and closing of the openings, and in particular for purposes of adjusting the quantity of air passing through. By suitable regulation of the quantity of air, the possibility exists of increasing the separator efficiency further.

Optionally or additionally, the possibility further exists that the separator gas entry port is formed from a region of the separator housing that does not feature the shaft wall. In this form of embodiment the shaft wall can be dispensed with, so that operation is then undertaken with an open incident flow.

Of particular importance within the context of the invention is the combination of the first separator housing connected, for example, in tangential-form or spiral-form, laterally with the rod basket, which is arranged in a vertical orientation. The direction of rotation of the rod basket can be oriented with or against the tangential or spiral-type direction of connection of the static separator housing.

In the upper part, for example, in the upper housing section the dynamic separator is particularly preferably provided with one or a plurality of further material entry ports. This is in particular expedient if the separator is then integrated into a multi-stage grinding facility, because via this (second) material entry port the ground material can then be supplied to a second stage for purposes of separation. Here this can take the form, for example, of discharge material from a second grade reduction device, for example, a ball mill. The integration of the separator unit into a single-stage or multi-stage grinding facility is explained further in what follows.

It fundamentally lies within the context of the invention that an individual static separator is connected in the inventive manner, for example, in a tangential or spiral-form manner, onto the dynamic separator. Preferably however, in particular in the case of large units, two or even a plurality of static separators, in each case with a separator housing, are connected onto the dynamic separator. The initial separation process for purposes of separating out a coarse grade material fraction and breaking down the slag can consequently be carried out in parallel in a plurality of initial separation stages, wherein the individual initial separation stages then impinge in parallel onto the one and the same dynamic separator. Here the connection of the plurality of static separators preferably takes place symmetrically (as seen in plan view). It thus lies within the context of the invention that the plurality of static separators are arranged "symmetrically" over the periphery, and consequently are equidistant from one another. Here the displacement between them with regard to the periphery is 360°/n, wherein "n" means the number of static separators. Consequently, if two static separators are used, these are preferably connected onto the dynamic separator with an angular displacement between them of 180° in plan view. If three static separators are used these are thus preferably arranged at an angular displacement from one another of approximately 120°, and if four static separators are used these are thus preferably arranged at an angular displacement from one another of 90°, etc.

In addition to the baffle and guide fittings that are in all cases provided in the static separator it can be expedient to provide baffle fittings also in the region of the dynamic separator, for example, inside the separator housing of the dynamic separator, preferably in its lower housing section, which for the reasons that have been explained can undertake the function of a cyclone. Baffle fittings can be connected onto the housing wall of the said cyclone internally; these can function as "tripping edges" or "peeling edges". They are designed to act against the cyclone action of this part of the separator, and consequently reduce the said cyclone action. This is because, with the aid of the said fittings arranged on the wall, material that is collecting in the wall region can be brought back towards the centre, or axis, so that the separation function is optimised.

In accordance with a further recommendation provision is optionally made for the separator housing of the dynamic separator to be provided with one or a plurality of additional air supplies, which undertake the function of an air bypass. Not only is then the air supplied via the air entry port of the static separator, but also additional air can be supplied via the dynamic separator. This then leads to the result that the air supply in the region of the static separator is reduced, so that in this manner an optimised adaptation of the air flow can be implemented. The said additional air supply can, for example, be implemented in the upper housing section of the separator housing of the dynamic separator.

Finally it lies within the context of the invention optionally to provide additional air distribution devices in the region of the static separator, for example, perforated sheets or similar. These can be arranged in the separator housing of the static separator, upstream of the baffle and guide fittings in the flow direction. They lead to a better air distribution over the total height of the static separator.

The inventive separator unit can be employed for the separation of a very wide variety of granular materials, in particular, for the separation of cement, cement raw materials, limestone and similar substances. However, the invention, alternatively also comprises the separation of ores or similar. The natural stocks of such raw materials are in part to a large extent exhausted, so that extraction has moved to regions that are difficult to access without sufficient water supplies There the inventive separators can be employed in a particularly efficient manner.

Also the subject of the invention is a single-stage (circulatory grinding facility) or multi-stage grinding facility for the grade reduction of granular material, with:

- at least one first grade reduction device, and

- at least one separator unit of the type described,

wherein the material exiting from the first grade reduction device enters via the first material entry port into the separator device, and wherein the coarse grade material exiting from the coarse grade material exit port of the separator device (that is to say, the static separator) is supplied to the first grade reduction device, wherein the medium grade material, that is to say, the medium grade fraction exiting from the separator device (that is to say, the dynamic separator) is similarly supplied to the first grade reduction device, or alternatively also to a second grade reduction device. Consequently, a second grade reduction device is also particularly preferably provided in addition to the first grade reduction device, so that a grinding facility with at least two stages is then implemented. The first grade reduction device can preferably take the form of a material bed roller mill and then a roller press. The second grade reduction device can take the form, for example, of a ball mill. The medium grade material separated out of the separator device (namely the second separation stage), can consequently be supplied to this second grade reduction device, for example, the ball mill, wherein this material is reduced with the second grade reduction device, and can then in turn be supplied via the second material entry port to the second separation stage, namely the dynamic separator. The coarse grade material separated out from the first separation stage is consequently supplied to the roller press, while the medium grade material ("grits") is fed to the ball mill, wherein discharge material from the ball mill is fed to the dynamic separator, and the material discharged from the roller press is fed to the static separation stage. In this manner, in overall terms, a particularly favourable grade reduction of the material is achieved in terms of energy consumption, in particular with the use of the described multi-stage separator, without the second grade reduction stage needing its own separator.

However, as an alternative a multi-stage, for example, a two-stage grinding facility can also be implemented, in which, in addition to the inventive separator, a further separate separator is provided. The medium grade fraction of the inventive first separator as described is in turn fed to a second grade reduction device, for example a ball mill. The discharge material from this ball mill is then however not - as previously described - once again supplied to the first separator, but instead to the second separate separator, wherein the coarse grade material exiting from this second separator is once again supplied to the ball mill, while the fine grade material exiting from the second separator can be led out in turn as product.

Finally, however, single-stage grinding plants are also included within the context of the invention, in which both the coarse grade material exiting from the inventive separator unit and also the medium grade material is supplied to a first (single) grade reduction device, for example a roller press, and wherein the material exiting from the said grade reduction device once again enters via the material entry port into the inventive separator device. By this means a single-stage circulatory grinding facility is implemented.

Here it lies within the context of the invention for the first grade reduction device, e.g. roller press, to be arranged above the separator unit. Particularly preferably, however, the roller press is positioned underneath the separator unit. In what follows the invention is explained in more detail in terms of figures representing just one example of embodiment. Here:

Fig. 1 shows a partial vertical section through an inventive separator unit in a simplified representation,

Fig. 2 shows a plan view onto the lower part of the subject matter in Fig. 1 in a first form of embodiment,

Fig. 3 shows a plan view onto the lower part of the subject matter in Fig. 1 in a second form of embodiment,

Fig. 4 shows a modified form of embodiment of the subject matter in Fig. 1 (detail section in the region of the lower part),

Fig. 5 shows a plan view onto the lower part of the subject matter in Fig. 4, and

Fig. 6 shows schematically a two-stage grinding facility with an inventive separator unit.

The separator device 1 represented in Figs. 1 to 5 serves the purpose of separating granular material, for example cement, into at least three fractions. The device 1 is composed of a static separator 2, and a dynamic separator 3, which are combined with one another in a particularly compact manner. The static separator 2 forms a first separation stage, and the dynamic separator 3, arranged downstream of the static separator 2 in the flow direction of the medium that is being separated, forms the second separation stage.

The static separator 2 has a separator housing 4, with a first material entry port 5, a separator gas inlet port 6, and a coarse grade material exit port 7. Within the separator housing 4 a plurality of baffle and guide fittings 8, 9 are arranged under one another in the form of a staircase. In the example of embodiment the said fittings are designed as baffle plates 8, 9, which at the same time undertake the function of guide vanes for the static separator. In Fig. 1 it can be discerned that these take the form of two groups of baffle plates 8, 9 that are inclined relative to one another, wherein the said baffle plates 8, 9 can be adjusted about pivot axes 10 such that the inclination of the baffle plates 8, 9 can be adjusted.

The second separation stage is formed by the dynamic separator 3, which has a separator housing 11. The said cylindrical separator housing 11 has an upper cylindrical section 11a and a lower cylindrical section 11b. In the upper part 11a of the said separator housing 11 is arranged a rotating rod basket 12, which is surrounded by a set of guide vanes 13. These take the form of stationary guide vanes, which are arranged at a fixed or also an adjustable angle of attack relative to the axis of rotation of the rod basket. The rod basket rotates about a vertical axis 14. For this purpose a drive 15 is connected to the rod basket 12. Within the second separator housing 11, underneath the rod basket 12, is connected a discharge cone 16, which in turn is connected to the medium grade material exit port 17. The fine grade material exit port 18 is connected onto the upper part 11a of the separator housing 11, wherein the mixture of gas and fine grade material is led out via the exit port 18. In addition, other material entry ports 19 are connected onto the housing upper part 11a.

The starting material that is to be separated is supplied to the separator device 1 via the first material entry port 5. Via the latter the material that is to be separated consequently proceeds to the first separation stage and consequently enters the static separator 2. The separator gas, for example air, is supplied through the gas entry port 3 Here this can also take the form, for example, of hot drying gases. The material that is to be separated now falls onto the system of baffle plates and guide vanes 8, 9, wherein the result is in particular a breaking down of the slag and agglomerates that have been generated during the grinding process in a roller press. Here the separating medium can flow through the material at the same time in an optional drying process. The static separator operates as a cross-flow air separator, such that the coarse grade material falls through the housing 2 into the lower discharge cone 20, and from there is discharged via the coarse grade material discharge port 7. Structurally the said discharge cone 20 is connected onto the lower part 11b of the separator housing 11 of the dynamic separator 3.

The static separator and the dynamic separator are connected with one another in a very compact manner, such that the static separator 2 merges into the dynamic separator 3. This is because the static separator, with its separator housing 4, is connected onto the side of the separator housing 11 of the dynamic separator 3. In the example of embodiment it can be discerned that the separator housing 4 of the static separator 2 merges into the lower housing section 11b of the separator housing 11, such that the housing section 11b of the separator housing 11 in some regions can be functionally assigned, on the one hand to the static separator, and on the other hand to the dynamic separator. It produces the connection between the static separator and the dynamic separator, wherein the cylindrical lower housing section 11b also fulfils the function of a cyclone.

In all cases the fraction separated out from the static separator 2 enters together with the separator gas into the dynamic separator 3, namely into the upper region 11a of the separator housing, and there into the region of the rod basket 12. The desired fine grade separation takes place between the said rotating rod basket 12 and the guide vanes 13. The "coarser", that is to say, medium grade components proceed via the inner discharge hopper, or discharge cone 16 to the discharge pipe and consequently to the medium grade material exit port 17 ("grit discharge pipe"). The said medium grade fraction is also designated as "grits". The fine grade material, together with the gases, is discharged from the separator through the fine grade material and gas exit port 18. It is possible to supply further material directly to the second separation stage via the additional material entry ports 19. Here this can take the form, for example, of material that is supplied from an additional grade reduction device, for example, a ball mill. More detail will be provided on this subject in the context of Fig. 6.

Figs. 2 and 3 now show that in accordance with the invention the static separator 2 with a shaft-type first separator housing 4 arranged at an angle to the vertical is connected directly onto the second separator housing 11 of the dynamic separator 3, and in particular with a tangential or spiral-form orientation in the example of embodiment. Here Fig. 2 shows a form of embodiment with a spiral-form connection, while Fig. 3 shows a form of embodiment with a tangential connection.

Here it can be discerned in the two examples of embodiment that in each case two static separators 2 with two separator housings 4 are connected onto the separator housing 11 of the dynamic separator 3. The dynamic separator 3 is consequently impinged upon by two static separators 2 in parallel. For this purpose the two static separators 2 in the example of embodiment are positioned displaced apart by 180°. The direction of rotation of the rod basket can correspond to the direction of connection of the tangential or spiral-form connection, or can also be oriented against the said direction of connection.

The form of embodiment represented in Figs. 4 and 5 essentially corresponds to the form of embodiment in Figs. 1 and 3. It differs geometrically in particular in terms of the arrangement and configuration of the discharge hopper 16 of the dynamic separator, which in the case of the form of embodiment in Figs. 4 and 5 extends over the total height of the lower section 11b of the separator housing 11, and also over the total height of the separator housing 4 of the static separator 2. Apart from that the forms of embodiment in Figs. 1 to 3 on the one hand, and Figs. 4 and 5 on the other hand, differ in their geometric design in particular in the region of the static separator and its guide fittings. The

fundamental structure and mode of operation are identical.
Particular significance is attributed to the shaft-type first separator housing, which is connected onto the second separator housing with a tangential or spiral-form orientation. Here the figures show that the said shaft-type first housing, or more particularly, its (lower) shaft wall 21, is oriented at a prescribed angle α relative to the vertical. In the example of embodiment the said angle α is of the order of 40° to 60°, for example, approx. 50°. In addition it can also be discerned that the separation zone of the static separator, formed between the baffle plates 8, 9 arranged under one another in the form of a staircase, is orientated at a prescribed angle ß relative to the vertical. In the example of embodiment the said angle ß is of the order of 20° to 40°, for example, 25°. The said housing 4, oriented at an angle in overall terms, in accordance with the invention is connected in the form of a spiral, or tangentially, onto the housing of the dynamic separator.

Here the figures show a form of embodiment in which the static separator is connected onto the side of the dynamic separator, but is positioned spatially underneath the rotating rod basket. Optionally, however, forms of embodiment can also be implemented in which the static separator (at least in some regions) is arranged at the same height as the rotating rod basket. The same is true for forms of embodiment with a plurality of static separators.

In addition, in the forms of embodiment represented the air supply takes place in particular via the separator gas entry port 6 as represented. Alternatively or additionally, additional separator gas entry ports can be provided, which in particular are formed from openings arranged in the shaft wall 21. This feature is not represented in the figures. Such openings can be opened and closed by suitable means, for example by flaps, sliders, or similar, wherein, in particular variable adaptation and thus regulation of the air quantity is possible by adjustable means.

In the figures the arrangement of the baffle plates 8, 9 is only shown in the form of one example. It is indicated that the pivot points of the baffle plates 8, 9 do not have to lie on the same straight line, but can be arranged spaced apart from one another. This is indicated in particular in Fig. 4. However, as an alternative it also lies within the context of the invention for the pivot points of the baffle plates or guide plates to be (approximately) arranged on a straight line, or also to be designed so as to be intermeshed and consequently in engagement with one another. However, they can also - as represented in the figures - be implemented with spacings between the pivot points, wherein in the case of Fig. 4 this spacing is significantly larger than it is in Fig. 1. The vertical spacing between the individual plates does not have to be the same, instead it can vary from plate to plate. The plates can also be set at different angles of attack.

The inventive multi-stage separator can particularly preferably be integrated into a single-stage or multi-stage grinding facility, as is represented in the example of Fig. 6. A cement grinding facility is represented in this example. In the centre of the figure can be discerned the multi-stage separator 1, which is composed of the static separator 2 and the dynamic separator 3. Underneath the separator 1 is represented a first grade reduction device 22 in the form of embodiment of a roller press and then a material bed roller mill 22. In addition, a second grade reduction device 23 is represented in the form of embodiment of a ball mill 23.

The two-stage grinding facility as represented operates as follows:

The starting material that is to be reduced is supplied from one or a plurality of bunkers 24, for example, via the transport units 25, 26, which lead via the material entry port 5 into the separator device 1. There the separation of the material into three fractions takes place in the manner already described. The coarse grade material that has been separated out via the coarse grade material exit port 7 is returned to the roller press 22. From there it returns via the transport units 27 and 25, 26 into the separator device 1. The medium grade material that is separated out in the second separation stage, that is to say, the medium fraction, is supplied via the medium grade exit port 17 and the transport unit 28 to the ball mill 23. The grinding facility thus has the roller press 22 for the initial grinding of the material, and the ball mill 23 for the final grinding of the material. The ball mill 23 is, for example, equipped with a material discharge unit 29, a dust removal filter 30, and a mill fan 31. The material exiting from the ball mill 23 is then fed via the transport units 29, 32, 33, with which it is brought to the dynamic separator 3. There it returns to the second separation stage via the material entry ports 19.

The finest fraction is drawn off from the separation device, namely from the dynamic separator 3, together with the gases, through the fine material exit port

18 and into the following separation cyclones 34. Here it is separated out from the gases as a finished product; the gases are drawn off with the fan 35, and partially are fed back into the separator unit 1, and partially or even completely to a dust removal unit.

The two-stage grinding facility as represented can be modified into an alternative configuration. Thus in contrast to the arrangement as represented, for example, the roller press 22 can be positioned above the separator unit 1. In this case the fresh material that is to be ground is then firstly delivered to the roller press, from which the initially ground material is fed to the inventive separator unit. There the material is classified into three fractions in the manner described. This form of embodiment is not represented.

Alternatively the possibility also exists of integrating a second, separate separator device into the two-stage grinding facility, such that the material discharge from the ball mill is then supplied not to the first separator device as represented in the figures, but to a separate second separator device that is not represented. Alternatively operation can also take place with just a single grade reduction device, for example, the roller press as represented, such that the additional ball mill can then be omitted. The final stage of grinding then takes place in the roller press, wherein the inventive separator device and the roller press then form a "simple", "single-stage" circulatory grinding facility. This feature is also not represented in the figures. The inventive, multi-stage separator can, however, equally well be employed in any of the various types of grinding facility.

P a t e n t k r a v

1. Indretning (1) til sigtning af kornformet materiale i mindst tre fraktioner, med mindst en statisk sigte (2), der danner et første sigtetrin, og mindst en dynamisk sigte (3), der danner et andet sigtetrin, hvor den statiske sigte (2) er udformet som tværstrømssigte og i et sigtehus (4) med mindst en første materialeindgang (5), mindst en sigtegasindgang (6) og mindst en grovmaterialeudgang (7) har flere pral- og/eller føringsenheder (8, 9), der er anbragt neden under hinanden på en trappelignende måde,
hvor den dynamiske sigte (3) er udformet som en stavkurvsigte med roterende stavkurv (12) og har et i det mindste områdevist cylindrisk sigtehus (11) med mindst en gennemsnitsmaterialeudgang (17) og en finmaterialeudgang (18),
kendetegnet ved, at
den statiske sigte (2) med sit sigtehus (4) er tilsluttet direkte på siden af den dynamiske sigtes (3) sigtehus (11) og går over i dette i tangential eller spiralformet orientering og
den dynamiske sigtes (3) stavkurv (12) roterer omkring en vertikal akse (14) og
den dynamiske sigtes (3) sigtehus (11) har en øvre hussektion (11a), i hvilken den roterende stavkurv er anbragt, og en nedre hussektion (11b), hvor den statiske sigte (2) med sit hus (4) er tilsluttet til den nedre hussektion (11 b) og går over i denne, og
hvor der i den nedre hussektion (11b) er anbragt en udtømningstragt (16) til gennemsnitsmaterialet.

2. Indretning ifølge krav 1, **kendetegnet ved, at** pral- og/eller føringsenhederne dannes af pral- og/eller føringsplader (8, 9) der er hældende mod hinanden.

3. Indretning ifølge krav 2, **kendetegnet ved, at** pral-og/eller føringspladernes (8, 9) hældning kan indstilles.

4. Indretning ifølge krav 1, **kendetegnet ved, at** pral- og/eller føringsenhederne (8, 9) dannes af taglignende enheder.

5. Indretning ifølge krav 4, **kendetegnet ved, at** de taglignende enheder er forskydelige i horisontal retning.

6. Indretning ifølge et af kravene 1 til 5, **kendetegnet ved, at** det skaktlignende hus (4) eller i det mindste en skaktvæg (21) af dette hus af den statiske sigte (2) er orienteret skråt i forhold til vertikalen, f.eks. med en på forhånd angivet vinkel (a) på mellem 10° og 70° i forhold til vertikalen.

7. Indretning ifølge et af kravene 1 til 6, **kendetegnet ved, at** den statiske sigtes (2) sigtezone, der er dannet mellem pral- og/eller føringsenhederne (8, 9), der er anbragt neden under hinanden på en trappelignende måde, er orienteret med en på forhånd angivet vinkel (ß) på mellem 10° og 70° i forhold til vertikalen.

8. Indretning ifølge et af kravene 1 til 7, **kendetegnet ved, at** sigtegasindgangen (6) dannes af mindst en indgangsåbning, der er anbragt skråt oven over enhederne (8, 9).

9. Indretning ifølge et af kravene 1 til 8, **kendetegnet ved, at** sigtegasindgangen (6) alternativt eller yderligere dannes af flere åbninger, der er anbragt i skaktvæggen (21) af den statiske sigtes (2) sigtehus (4) og eventuelt kan indstilles, eller af et område af dette hus uden skaktvæg.

10. Indretning ifølge et af kravene 1 til 9, **kendetegnet ved, at** der i den statiske sigtes (2) sigtehus (3) er anbragt luftfordelingsindretninger, f.eks. hulplader, i strømningsretningen foran pral- og/eller føringsenhederne (8, 9).

11. Indretning ifølge et af kravene 1 til 10, **kendetegnet ved, at** tangentialeller spiraltilslutningen er orienteret i stavkurvens (12) drejeretning eller modsat stavkurvens drejeretning.

12. Indretning ifølge et af kravene 1 til 11, **kendetegnet ved, at** den dynamiske sigtes (3) sigtehus (11) har mindst en anden materialeindgang (19).

13. Indretning ifølge et af kravene 1 til 12, **kendetegnet ved, at** der er tilsluttet to eller flere statiske sigter (2) med hver deres sigtehus (4) på siden af den dynamiske sigte (3).

14. Indretning ifølge krav 13, **kendetegnet ved, at** de flere statiske sigter (2) er anbragt ækvidistant langs med omkredsen med en forskydning på 360°/n, hvor n svarer til antallet af de statiske sigter.

15. Indretning ifølge et af kravene 1 til 14, **kendetegnet ved, at** der i den dynamiske sigtes (3) sigtehus (11), f.eks. i dettes nedre hussektion (11 b), er anbragt yderligere pralenheder, som fortrinsvis er anbragt på indersiden af husvæggen.

16. Indretning ifølge et af kravene 1 til 15, **kendetegnet ved, at** den dynamiske sigtes (3) sigtehus (11) er forsynet med en eller flere yderligere lufttilførsler som bypass, f.eks. i dettes øvre hussektion (11a).

17. Formalingsanlæg, især kredsløbsformalingsanlæg eller flertrins-formalingsanlæg, til findeling af kornformet materiale med mindst en første findelingsindretning (22) og med mindst en sigteindretning (1) ifølge et af kravene 1 til 16,
hvor det materiale, der kommer ud af den første findelingsindretning (22), kommer ind i sigteindretningen via den første materialeindgang (5),
hvor grovmaterialet, der kommer ud af den statiske sigtes (2) grovmaterialeudgang (7), leveres til den første findelingsindretning (22), og
hvor gennemsnitsmaterialet, der kommer ud af den dynamiske sigte (3), leveres til den første findelingsindretning (22) eller en yderligere anden findelingsindretning (23).

18. Anlæg ifølge krav 17 med en anden findelingsindretning (23), hvor gennemsnitsmaterialet, der kommer ud af den dynamiske sigte (3), leveres fuldstændigt eller delvist til den anden findelingsindretning (23), og
hvor det materiale, der kommer ud af den anden findelingsindretning (23), leveres til den dynamiske sigte (3) eller en separat, anden sigteindretning, via

den anden materialeindgang (19).

19. Anlæg ifølge krav 17 eller 18, **kendetegnet ved, at** den første findelingsindretning (22) er udformet som valsepresse og/eller den anden findelingsindretning (23) er udformet som kuglemølle.

Fig.1

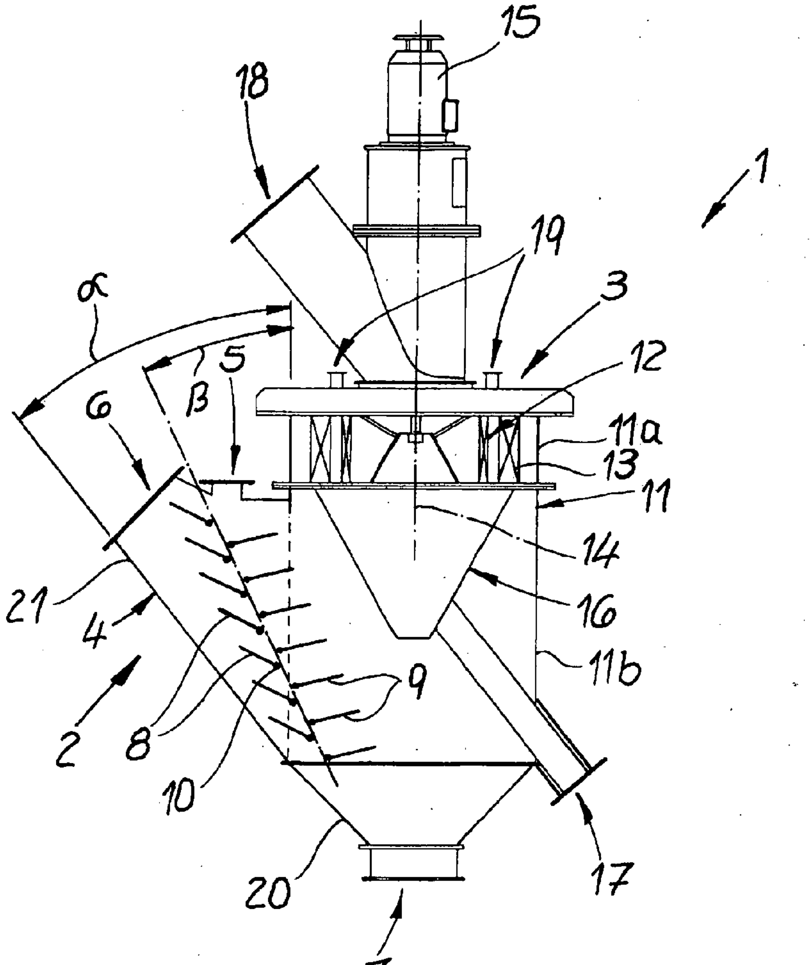

Fig.2

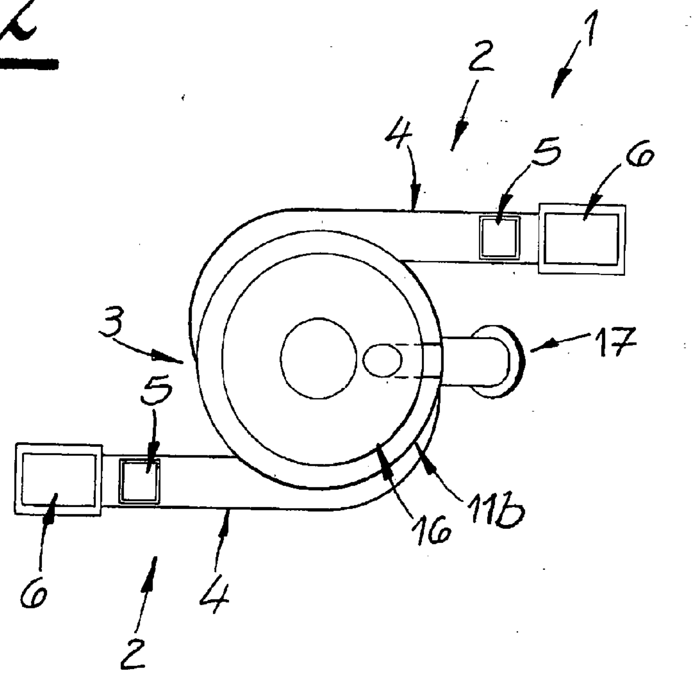

Fig.3

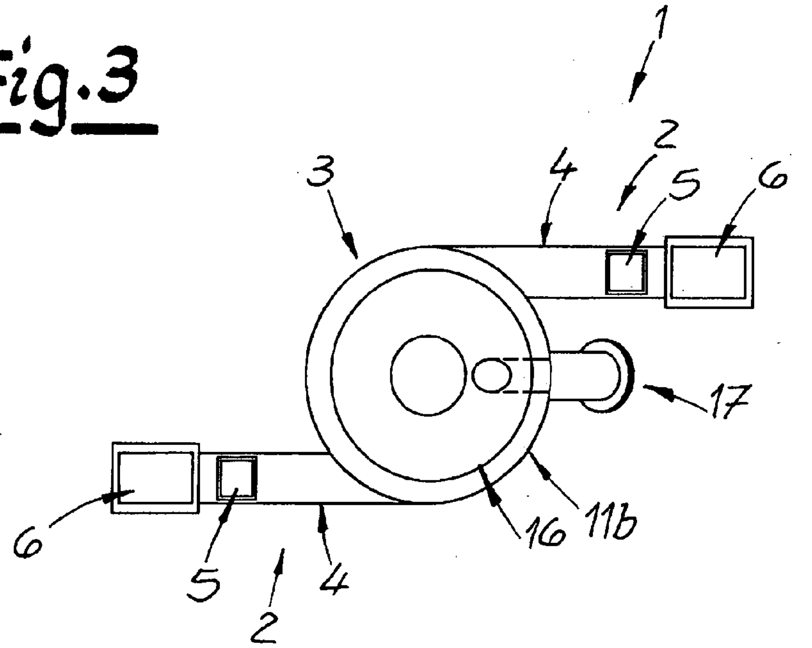

Fig. 4

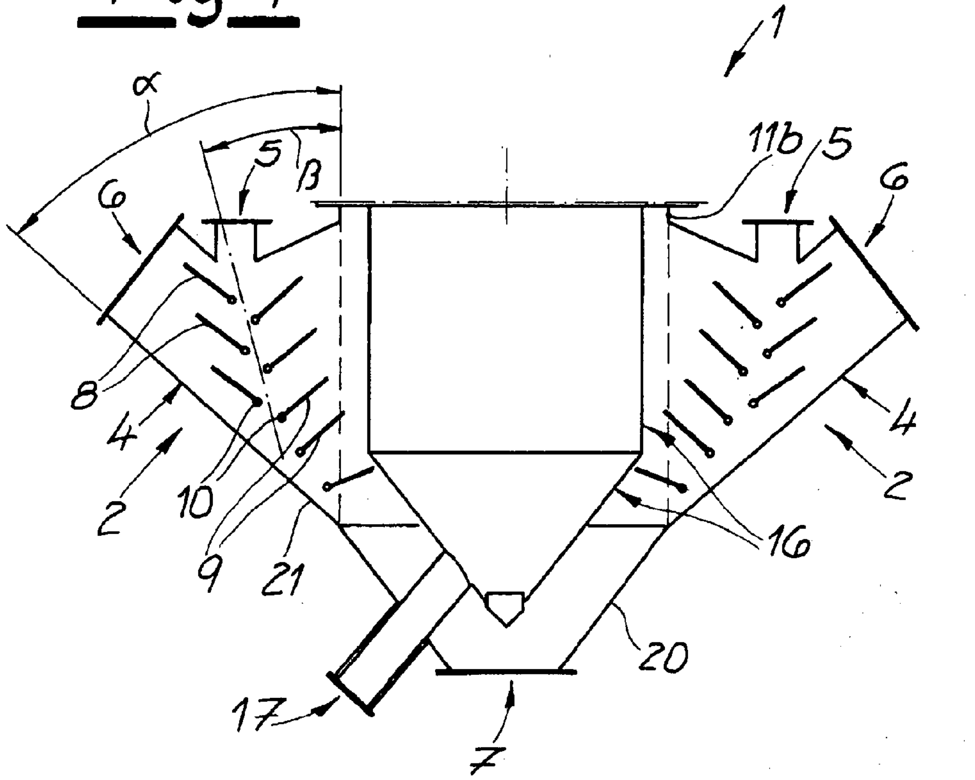

Fig. 5

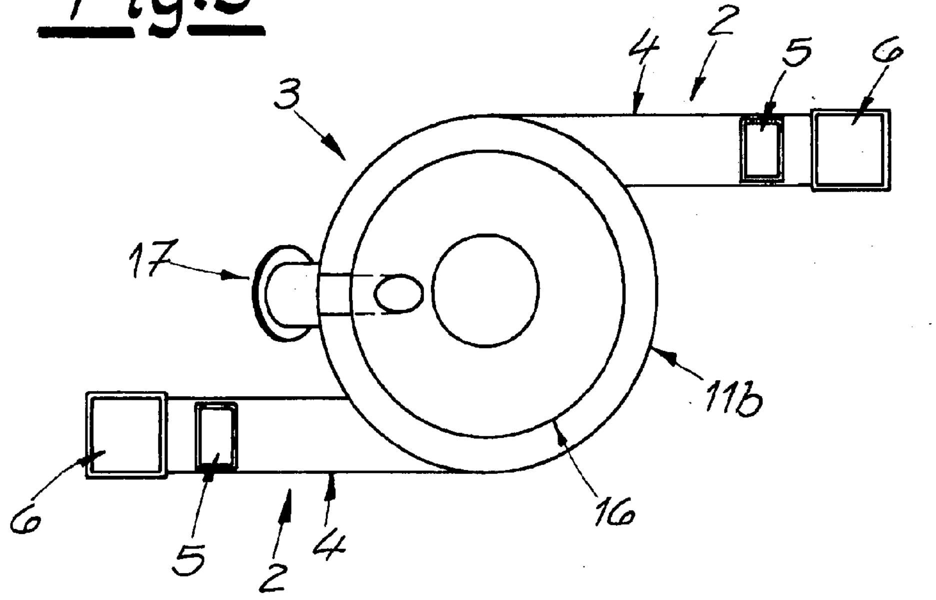

Fig. 6