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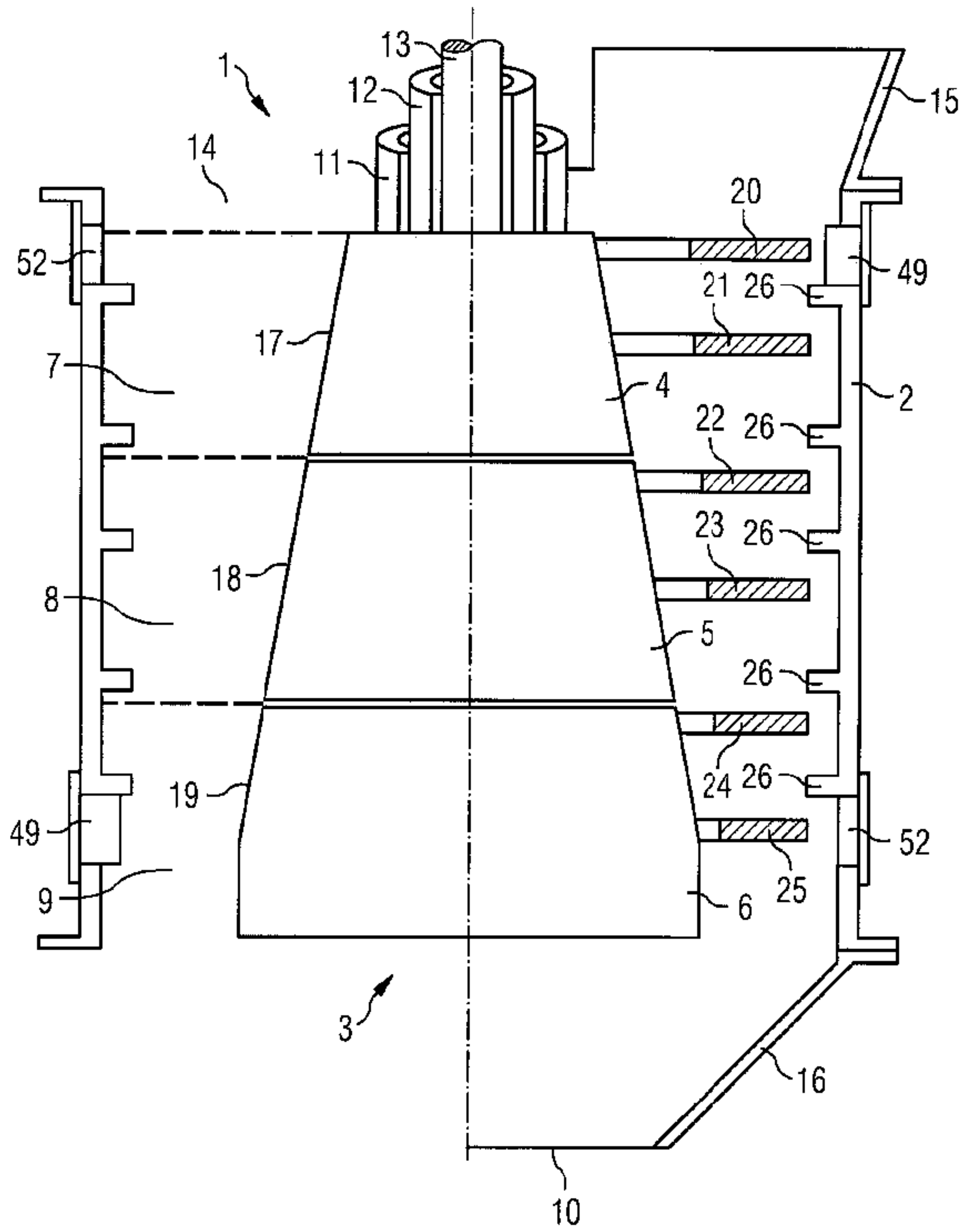
(54) **Titre : DISPOSITIF DE DESAGREGATION MECANIQUE DE CONGLOMERATS COMPOSES DE MATERIAUX DE DENSITE ET/OU DE CONSISTANCE DIFFERENTE**

(54) **Title: DEVICE FOR MECHANICAL SEPARATION OF CONGLOMERATES FROM MATERIALS OF DIFFERENT DENSITIES AND/OR CONSISTENCIES**



(57) **Abrégé/Abstract:**
The invention relates to a device for mechanically breaking up conglomerates of materials with differing density and/or consistency, which has a breaking-up chamber with a feed opening (14) at a first end and an outlet opening (10) at a second end, wherein the

(57) **Abrégé(suite)/Abstract(continued):**
breaking-up chamber has at least two portions (7, 8, 9) which follow one another in the axial direction and are surrounded by a breaking-up chamber wall (2) in the form of a cylinder or shell of a truncated cone, wherein in each of the portions (7, 8, 9) there is respectively arranged at least one rotor (4, 5, 6) with a rotor shell (17, 18, 19) and beating tools (10, 21, 22, 23, 24, 25) extending radially from the rotor shell (17, 18, 19) into the breaking-up chamber, wherein the rotor shells (17, 18, 19) of the rotors (4, 5, 6) in the portions (7, 8, 9) following one another from the first end to the second end have a radius that increases towards the second end, and a difference between the radius of the respective rotor shell (4, 5, 6) and a radius of the breaking-up chamber wall (2) decreases from the first end to the second end, and wherein the rotors (4, 5, 6) can be driven such that a direction of rotation of the rotor (6) in the portion (9) proximate to the second end is opposite to a direction of rotation of the rotor (5) in the portion (8) lying ahead thereof in the direction of the first end, and such that rotational speeds of the rotors (4, 5, 6) increase in the portions (7, 8, 9) from the first end to the second end.

ABSTRACT

The invention relates to a device for mechanically breaking up conglomerates of materials with differing density and/or consistency, which has a breaking-up chamber with a feed opening (14) at a first end and an outlet opening (10) at a second end, wherein the breaking-up chamber has at least two portions (7, 8, 9) which follow one another in the axial direction and are surrounded by a breaking-up chamber wall (2) in the form of a cylinder or shell of a truncated cone, wherein in each of the portions (7, 8, 9) there is respectively arranged at least one rotor (4, 5, 6) with a rotor shell (17, 18, 19) and beating tools (10, 21, 22, 23, 24, 25) extending radially from the rotor shell (17, 18, 19) into the breaking-up chamber, wherein the rotor shells (17, 18, 19) of the rotors (4, 5, 6) in the portions (7, 8, 9) following one another from the first end to the second end have a radius that increases towards the second end, and a difference between the radius of the respective rotor shell (4, 5, 6) and a radius of the breaking-up chamber wall (2) decreases from the first end to the second end, and wherein the rotors (4, 5, 6) can be driven such that a direction of rotation of the rotor (6) in the portion (9) proximate to the second end is opposite to a direction of rotation of the rotor (5) in the portion (8) lying ahead thereof in the direction of the first end, and such that rotational speeds of the rotors (4, 5, 6) increase in the portions (7, 8, 9) from the first end to the second end.

DEVICE FOR MECHANICAL SEPARATION OF CONGLOMERATES FROM MATERIALS OF DIFFERENT DENSITIES AND/OR CONSISTENCIES

Field of the Invention

The invention relates to a device for mechanically disintegrating conglomerates of materials of different densities and/or consistencies. Such a device may for instance be used in waste reclamation. Slags from metal production and other slags and ashes of thermal waste reclamation usually contain iron and other metals. These can be heavily scaled or incorporated in their native form in mineral slags. These metals can be recovered efficiently from the respective conglomerates if these metals are released or separated from their composites or scale formations such that they can be subsequently segregated from the material flow by magnets or non-ferrous metal separators.

Background

According to prior art, such slags are fragmentized with hammer mills or impact mills and are subsequently fed into magnetic and non-ferrous metal separators for the actual separation. With hammer and impact mills, the disintegration and reclamation of metals with a particle size of more than 20 mm is possible as well as relatively efficient. For the disintegration of smaller metal particles with these mills, it would be necessary to provide very small gap separations, such as less than 20 mm, which would then result in a significant increase in grind crushing at the expense of impact crushing. As a consequence, soft non-ferrous metals would be comminuted to such an extent that they could no longer be separated by means of a non-ferrous metal separator. For this reason, the reclamation of small metal particles which are present in slags in their native form, using the above-mentioned agglomerate breakers from prior art, is possible only to a limited extent.

Therefore, the invention is based on the object to suggest a device for mechanically breaking up material conglomerates of different densities and/or consistencies enabling mechanical breaking-up or separation also of small and smallest metal particles incorporated in slags in their native form. Moreover, the device to be proposed should also be suitable to disintegrate other conglomerates of materials of different densities and/or consistencies.

This problem is solved according to the invention by a device comprising the features of the main claim. Beneficial designs and further developments of the invention result from the features of the dependent claims.

Summary of the Invention

In a first aspect, this document discloses a device for mechanical separation of material conglomerates from materials with different density and/or consistency, comprising: a separating chamber with a feed side; and, a discharge side, where said separating chamber is surrounded by a cylindrical separating chamber wall and has at least two consecutive sections in the axial direction, in each of which at least one rotor has impact tools which extend radially into the separating chamber, wherein the rotors have, in the consecutive sections from the feed side to the discharge side, a rotor casing, the radius of which increases towards the discharge side, wherein the difference between the radius of the rotor casing and the radius of the separating chamber wall decreases from the feed side towards the discharge side, the directions of rotation of the rotor in the section facing the discharge side and the rotor of the section which lies ahead in the direction of the material flow are counter-rotating, and the rotational velocity of the rotors in the sections from the feed side towards the discharge side of the separating chamber, increases.

In a second aspect, this document discloses a separating chamber with a feed opening on a first end and a discharge opening on a second end. The separating chamber is surrounded by a cylindrical or truncated cone-shaped separation chamber wall which is typically oriented vertically, with the feed end positioned on top and the discharge end at the bottom. With such a vertical arrangement, material can be fed gravimetrically from above.

In the direction of a cylinder axis defined by the cylindrical shape of the separation chamber wall, the separation chamber comprises at least two, preferably three consecutive sections. In each of the three sections, at least one rotor each with a rotor casing and impact tools is arranged, which impact tools extend radially from the rotor casing into the separating chamber at least during the operation of the device. If e. g. chains are used as impact tools, these chains of course extend into the separation chamber radially only if the corresponding rotor is turning at sufficient speed. For the purpose of the claims, such impact tools as well are to be designated as impact tools extending radially from the rotor casing into the separating chamber. With the impact tools, it is possible—possibly in connection with baffle plates arranged on the separation chamber wall to be described later—to break up conglomerates in a manner still to be described later.

The rotors have in their successive sections a rotor casing the radius of which increases towards the second end of the separation chamber, wherein a difference between the radius of the respective rotor casing and a radius of the separation chamber decreases from the first end towards the second end. Accordingly, the rotor casings of the rotors have more or less the shape of a cone in the successive sections, the radius of which cone increases from the first end towards the second end. In this manner it can be achieved that the material conglomerates supplied through the feed opening are positioned further towards the outside in the radial direction as they increasingly advance into the separating chamber, where the velocity of the impact tools is correspondingly higher than in the areas further inside. The mentioned cone can have a continuously increasing diameter towards the second end or a diameter increasing in steps, such as in the form of a cascade. The radius of the separating chamber wall can either stay the same or can increase from the feed opening towards the discharge opening, which will also result in that the velocities of the particles moving through the separating chamber increase with increasing distance completed in the separating chamber. It is also possible that the radius of the separating chamber wall decreases from the first end towards the second end. If the radius of the separating chamber wall increases towards the second end typically arranged at the bottom, then the radius may change either continuously or in steps. In any case, the radius of the respective rotor casing and the radius of the separating chamber wall will for this purpose be adjusted such that the difference between these two radii decreases in the axial direction from the first end towards the second end. This will achieve that the volume of the separating chamber becomes smaller with the increasing axial advance of the material through the separating chamber, which results in increasing particle density and thus in increasing reciprocal impacts and the impacts of the particles against the impact tools or baffle plates. In addition to that, the direction of rotation of the rotors in the respective adjacent sections is preferably counter-rotational. In this manner it is achieved that the particles which are accelerated by the impact tools in one of the sections will impact head-on against the counter-rotating impact tools in the next section. The impact velocities thus are the sum of the particle velocity and the velocity of the impact tools. This will achieve extremely high impact velocities of the metal particles on the impact tools and/or baffle plates on the separating chamber wall, which results in crushing the conglomerates, insofar as there are materials of different densities and/or consistencies, such as of different elasticities, inside. In addition, the rotational velocities of the rotors in the different sections from the first end towards the second of the separating chamber preferably increase. Also in this manner it can be achieved that the impact velocities increase in the range of increasing particle density in the direction towards the second end of the separating chamber, because also the rotational velocities of the rotors there and therefore the velocities of the impact tools increase.

The combination of the technical features explained above thus results in that on the one hand, the velocity of the conglomerates fed through the feed opening into the separating chamber increases greatly towards the discharge opening, and at the same time the particle density increases. This can result in that the conglomerates in the last section before the discharge opening of the separating chamber impact against baffle plates or impact tools with velocities e. g. in excess of 200 m/s. In this manner, a bursting of the material conglomerates can be achieved without that these are being pulverized as with conventional hammer mills or impact mills. So in particular metal particles contained in the conglomerates can be released without undesirably reducing the particles themselves in size.

The proposed device therefore permits the separation of metals, for instance iron or non-ferrous metals, from slags or scale formations in a manner which is not possible using the conventional hammer mills or impact mills. In this process, the proposed device utilizes a design which achieves maximization of the impact energy of the conglomerates to be disintegrated on the impact tools and/or the baffle plates, without the metal parts themselves being fragmented. It is consequently possible to disintegrate and separate even the smallest metal particles in slags still in an economically reasonable manner. With the invention therefore extremely high impact velocities of conglomerates to be separated can be achieved, which results in breaking up the conglomerates with only a small pulverizing effect.

It is preferable that the rotor in each section has its own drive which can be operated or controlled independently of the drive or drives of the at least one other section. In this manner, the rotational speeds of the rotors can be adapted to different conglomerates to be separated.

The rotor casing is preferably designed like a truncated cone. This results in that the conglomerates and metal particles are transferred into the areas of the separating chamber which are further towards the outside, without substantially reducing their rate of fall. The rotor casings of the rotors in the successive sections of the separating chamber will then preferably form a truncated cone in which the diameters of the immediately successive truncated cones in the ends facing each other is preferably the same in each ease so that the rotor casings of the different rotors together form the shape of a cone or truncated cone. In this manner, a transfer of the supplied metal particles and material conglomerates can occur in the entire separating chamber into the radially outer areas, without significantly reducing the material throughput in the axial direction of the separating chamber. It is also possible, however, to realize an increase in the diameter of the rotor casing or rotor casings in stages, wherein then in each section preferably one or several axial areas with a constant diameter of the rotor casing are developed, wherein the rotor casing has subsequent stages of areas with larger diameters. This version has the disadvantage that the material throughput through the separating chamber in axial direction is impeded more.

In preferable embodiments, the impact tools are held in receptacles provided on the rotor so that they can be replaced easily. Also with a view to easy replaceability, the rotor casings are preferably designed in the same manner from several replaceable rotor casing elements mounted on the rotor. During the transfer of the material particles from the conglomerate through the rotor casings into the radially outer area of the separating chamber, the rotor casings are subjected to a certain amount of wear due to the many impacts, so that merely replacing individual damaged rotor casing elements is significantly more cost-effective than having to replace the entire rotor.

By way of example, the proposed device is subsequently described based on a separating chamber with three sections. The device can also be realised with only two sections or also four or more sections and would function basically in the same manner. A first section of the separating chamber facing the first end or feed opening will hereafter be named the pre-treatment chamber. A second section follows this pre-treatment chamber in the direction towards the second end, which will be named acceleration chamber. A remaining third section, which is facing the second end or discharge opening, will be named the high-velocity impact chamber.

In an advantageous development of the invention, two or more axially offset receptacles for the impact tools are provided in the first and/or second and/or third section of the separating chamber. In this manner, it is possible to adjust the number of impact tools per section of the separating chamber over wide ranges, which in the first two sections entails an improvement in the acceleration of the particles and the conglomerates and in the third section an increase in the probability of a controlled collision of the conglomerate or of the particles on an impact tool. At least in the second section, the rotor casing may have lifting bars, which extend axially and radially into the separating chamber. These lifting bars carry along material particles which move along further inside in the area of the rotor casing and accelerate them in areas of the separating chamber which are radially further outside, so that these particles can be broken up more effectively by the impact tools of the high-velocity impact chamber. This feature is useful for the fundamental idea of the invention, according to which the kinetic energy of all particles in the separating chamber, as far as poccible, is to be increased to such an extent that an impact of the particles or conglomerates on the impact tools or baffle plates is achieved with velocities which are in the range of approximately 200 m/s. It turns out that by such impact velocities, the crushing and controlled disintegration of the conglomerates can be achieved very reliably without fragmenting the metal components themselves. In this process, however, the velocities of the impact tools at those ends which move the fastest should not exceed the velocity of sound.

In order to increase the number of collisions of particles or conglomerates in the separating chamber, baffle plates can be arranged on the separating chamber wall, which extend axially and radially to the inside. In this manner, particles accelerated by the impact tools can impact against these baffle plates and can then break up.

When the described device is operated as intended, the result is a material flow of the conglomerate or particles from the feed opening towards the discharge opening or from the first end towards the second end. In preferred embodiments of the described device, more impact tools are arranged in a section of the separating chamber that follows in the feed direction of the material flow than in the section arranged before it. This has the advantage that a larger number of collisions of particles and impact tools is shifted towards a section in which the impact tools have a higher velocity. It can thus be possible that the number of impact tools in the pre-treatment chamber is even lower, for example, since the object of the pre-treatment chamber is to convey the particles of the conglomerate radially towards the outside, so that they can get into the sphere of action of the impact tools of the subsequent acceleration chamber. Therefore, more impact tools should be arranged in the acceleration chamber. Moreover, in the pre-treatment chamber, lifting bars can in addition be developed on the rotor casing to realize an effective transport of the particles into the area which is radially further on the outside.

In the acceleration chamber, which follows the pre-treatment chamber in the direction of the material flow, preferably clearly more impact tools are provided than in the pre-treatment chamber. These impact tools are utilized to accelerate the particles which are present with higher density near the second end, towards the outside and towards the second end, i. e. typically downwards in the direction of the high-velocity impact chamber. The rotor casing of the rotor in the acceleration chamber can also be provided with lifting bars which can also serve to transfer the particles into areas positioned further on the outside. There they are greatly accelerated by the more numerous impact tools in the acceleration chamber while moving in the direction towards the high-velocity impact chamber at the same time.

Most of the impact tools are preferably provided the third section, i.e. in the high-velocity impact chamber. The purpose of these impact tools is to crush the particles with a high degree of probability in this section of the separating chamber, which particles are present in the high-velocity impact chamber in an increased particle density due to the increasing radius of the rotor casing. The rotational velocity of the impact tools and of the corresponding rotor is preferably the highest in the high-velocity impact chamber. It can be selected such that the velocity of the impact tools there in the outside areas is over 200 m/s, but preferably less than 300 m/s, i.e. below the velocity of sound. Both the increasing number of impact tools and the increasing rotational speed in the successive sections towards the second end in conjunction with the counter-rotating directions of rotation therefore result in a maximisation of the impact energies in particular in the transition zones from one section to the next.

This produces a particularly effective mechanical disintegration of the conglomerates. After the discharge from the separating chamber through the discharge opening, the conglomerates which have been disintegrated into their individual constituents can be separated from each other in the currently known manner, such as in conventional segregation chambers or separation chambers, as e. g. in cyclones, magnetic separators, or eddy current separators. It may be provided that the rotational speed of the rotor in one of the sections has a ratio of between 1:1 and 5:1, preferably a ratio of between 2:1 and 4:1 with regard to the rotational speed of the rotor in the section arranged before it in the direction towards the first end. It turns out that both the impact velocity and the probability of an impact of a metal particle or of a particle containing metal on an impact tool can be maximised. The rotational speed of the rotor in the last section facing the second section are then to be preferably adjusted such that the absolute velocity of outside edges of the impact tools there is between 100 m/s and 300 m/s, preferably between 130 m/s and 200 m/s, or between 200 m/s and 300 m/s.

The ratio of the radius of the rotor casing to the radius of the separating chamber wall in the first section is preferably between 0.15 and 0.5. In the second section, the radius of the rotor casing preferably has a ratio of between 0.34 and 0.65 with regard to the radius of the separation chamber wall. In the third section, the corresponding ratio is preferably between 0.55 and 0.85. Such ratios of the rotor casing radii and the separating chamber wall achieve a particularly effectively controlled transfer of the particles into the area that lies radially further outside, in conjunction with a beneficial increase of the particle density towards the second end. At the same time, the flow of particles will not be too heavily affected by the expansion of the rotor casing, even if the radius of the separating chamber wall does not increase at the same rate as the radius of the rotor casings. This ultimately results in an increase of the particle density and an increase in the impact energy, since in the areas lying further outside, the velocity of the impact tools is higher than in the areas which are further inside.

In typical cases, the diameter of the rotor casings in the separating chamber can increase from the top to the bottom from 500 mm or 600 mm to 1400 mm or 1500 mm, for example. It may be provided that at the same time, the diameter of the separating chamber wall increases from approximately 1200 mm or 1300 mm at the top to approximately 1900 mm at the bottom, or that it remains constant in a range between 1700 mm and 1900 mm. In any case, the distance between the respective rotor casing and the separating chamber wall decreases from the first end towards the second end. It can possibly be sufficient if this decrease exists at least on the average over a certain axial distance of the separating chamber. It is safe, however, if the distance between the rotor casing and the separating chamber wall increases locally towards the discharge opening of the separating chamber in individual cases, e. g. in the area of a cascaded expansion step of the separating chamber wall, or if the separating chamber wall comprises one or more possibly beneficial protrusions. Possible rotational speeds of the rotors in the described example comprising three sections can be e. g. 500 RPM or 600 RPM for the rotor in the first section, 900 RPM or 1000 RPM for the rotor in the second section, and 1400 RPM or 1500 RPM for the rotor in the third section. It is provided that the rotor in the third section rotates in the opposite direction of the rotors in the first and the second section, while the rotors in the first and in the second section rotate in the same direction. In this way, velocities of the impact tools in the outside areas of the third section, i. e. in the high-velocity impact chamber, of more than 140 m/s can be realised. Due to the counter-acceleration of the particles in the pre-treatment chamber and the acceleration chamber, impact speeds of more than 200 m/s can be realized.

In this manner, the impact velocity and therefore the impact energy of the metal particles or of the particles of the conglomerate containing metal can be controlled and maximized within the reasonable, physically possible limits when impacting on the impact tools and/or baffle plates.

The impact tools can be formed e. g. by chains and/or baffle plates or comprise chains and/or baffle plates. Such impact tools are actually known e. g. from publication DE 10 2005 046 207 A1.

The device preferably has a feed hopper on the first end of the separation chamber and/or a discharge hopper on the second end of the separation chamber. By means of the discharge hopper, the mechanically disintegrated material can be directed onto a conveyor belt or a separator device, for example.

The described device is obviously not limited to breaking up metal particles in slags. It can rather be used for breaking up all other types of material conglomerates consisting of materials of different densities and/or elasticities.

In typical embodiments of the described device, the separating chamber wall and/or the impact tools and/or the rotor casings preferably consist of hard, impact-resistant materials such as metal or ceramic-metal composite materials.

It may also be provided that in one or several or all sections of the separating chamber, not only one rotor, but two or more rotors are provided in an axial sequence. Moreover, the number of sections may vary and there may be in particular two, three, four, or five or even more sections.

It can possibly be beneficial if the separating chamber wall has several annular peripheral protrusions pointing inwards to divert material which drops down along the separating chamber wall back into the direction of the interior of the separating chamber so that this material is again in reach of the impact tools. In this manner, the dropping material will he brought back into the sphere of action of the impact tools and therefore be effectively provided for crushing.

Brief Description of the Drawings

An exemplary embodiment of the invention is described in the following based on the Figures 1 to 6. In these drawings,

Fig. 1 shows a partial longitudinal section of a device for disintegrating conglomerates of material of different densities and/or consistencies in an embodiment of the invention with three rotors;

Fig. 2 shows a longitudinal section of a detail of the device according to Fig. 1;

Fig. 3 shows a cross section of another detail of this device with a suspension of an impact tool;

Fig. 4 shows a top view of the same suspension;

Fig. 5 shows a section drawing of another detail of the device according to Fig. 1; and

Fig. 6 shows a schematic diagram of a disintegration of a conglomerate that can be realised by this device.

Detailed Description

Fig. 1 shows a partial longitudinal section of a device 1 for mechanical separation of conglomerates from materials of different densities and/or consistencies. Device 1 comprises a separating chamber with a cylindrical separating chamber wall 2 which is arranged vertically and which has a uniform diameter. Said diameter can however also increase from the top to the bottom, for example. A rotor arrangement 3 is centrally arranged within the separating chamber wall 2. The rotor arrangement comprises three rotors 4, 5, and 6, arranged one on top of the other, which can be driven separately.

Between the rotors 4, 5, and 6 and the sections arranged at the corresponding level of the cylindrical separating chamber wall 2, a first section 7, a second section 8, and a third section 9 of the separating chamber are formed. The top first section 7 of the separating chamber is a pre-treatment chamber, the centrally arranged second section 8 is an acceleration chamber, and the third, bottom section 9 before the discharge opening 10 is a high-velocity impact chamber.

The rotors 4, 5, and 6 can each be separately driven by one of three associated coaxially guided shafts 11, 12, 13. Each of the shafts 11, 12, 13 is connected with a drive (not shown here) arranged at an upper end of the device. On its top end, the separating chamber forms a feed opening 14 with a feed hopper 15 for the conglomerate to be separated which is to be fed as bulk material.

At the bottom end of the separating chamber formed by the sections 7, 8, 9, there is a discharge hopper 16, which serves to transfer the crushed and mechanically disintegrated bulk material to a belt conveyor, for example.

Each of the rotors 4, 5, 6 has a truncated cone-shaped rotor casing 17, 18, 19. The rotor casings 17, 18, 19 are arranged concentrically to the associated rotor 4, 5, 6 and have a diameter which increases from top to bottom, so that the rotor arrangement 3 or the shape formed by the three rotor casings 17, 18, 19, to be precise, has the overall shape of a truncated cone. In the following, the individual rotors and sections are numbered from the top to the bottom in the direction of material flow. The first rotor 4 has two rows of impact tools 20, 21 which are axially offset relative to one another across the circumference, and which are connected with the first rotor 4 in a manner which will be described later in greater detail. In the same manner, the second rotor 5 has a third and fourth row of impact tools 22, 23 which are likewise offset relative to one another in axial direction. Finally, also the third rotor 6 has two rows of impact tools 24, 25 which are axially offset relative to one another. These impact tools 20, 21, 22, 23, 24, 25 are chains and/or metal rods, which have a hard metal impact edge on their outer end and on their front side in the direction of rotation.

The diameter of the rotor casings 17, 18, 19 of the rotor arrangement 3 increases continuously like a truncated cone from the top to the bottom. The diameter of the separating chamber wall 2, on the other hand, is constant in the present exemplary embodiment.

On an inner side, the separating chamber wall 2 has several annular peripheral protrusions 26 which are axially offset relative to one another. These protrusions 26 serve to divert particles, which drop down along the separating chamber wall, towards the inside, i. e. in the direction of the rotor 4, 5, or 6, and therefore provide them for effective mechanical crushing. These protrusions 26 can (in a manner not shown here) be beveled from outside on the top to the inside on the bottom. Thereby, an improved guiding effect can be achieved. If, different from the case shown here, the radius of the separating chamber wall 2 increases from top to bottom, no annular protrusions 26 are necessary.

The inside diameter of the separating chamber wall 2 can be 1800 mm, for example, while the inside diameter of the annular peripheral protrusions 26 is smaller and can be 1700 mm, for example. The diameter of a first rotor casing 17 at the top end can be 700 mm, for example, while the bottom diameter of the third bottom rotor casing 19 can be 1300 mm, for example. Accordingly, the gap between the separating chamber wall 2 and the rotor casing 17, 18, 19 decreases from the top end towards the bottom end from 550 mm to 250 mm.

The fact that the distance between the rotor casings 17, 18, 19 and the corresponding section of the separating chamber wall 2 decreases from top to bottom and is radially displaced towards the outside, is a significant aspect of the device 1 shown in FIG. 1. This supports an effective disintegration of the fed conglomerates. The consequence is that on the one hand, the volume of the separating chamber 2 is reduced towards the bottom for each distance, as a result of which the density of the material in the separating chamber increases. In addition, the fed material is transferred to a radial area of the separating chamber of device 1 which is further outside, where the velocity of the impact tools 20, 21, 22, 23, 24, 25 is higher.

The first two rotors 4 and 5 are driven such that they rotate in the same direction, while the third rotor 6 rotates in opposite direction. The material accelerated by the impact tools 22, 23 of the second rotor 5 impacts on the counter-rotating impact tools 24, 25 of the third rotor 6. As a result, the velocity of the accelerated particles of the fed conglomerate as well as the velocity of the impact tools 24, 25 add up. This can produce impact speeds of the particles on the impact tools 24, 25 of more than 200 m/s which results in a relatively certain disintegration of material composites consisting of materials of different densities and/or consistencies.

In the present exemplary embodiment, the three rotors 4, 5, 6 are driven from the top via concentrically arranged shafts 11, 12, 13 by means of drives. Alternatively, the shafts 11, 12, 13 can also extend downwards and be driven from the bottom. It is likewise possible to arrange the drives themselves within the rotor casings 17, 18, 19 assigned to the rotors 4, 5, 6, so that extending the drive shafts out of the separating chamber is no longer necessary.

Instead of the three axial consecutive sections 4, 5, 6 provided in the present embodiment according to Fig. 1, also two or four and more sections may be provided. Likewise, the provision of a feed hopper 15 and of a discharge hopper 16 is optional. Furthermore, it may be provided that the diameters of the rotor casings 17, 18, 19 and possibly of the separating chamber wall 2 do not increase continuously as shown here, but in steps.

Fig. 2 shows an example of a detail of the top first rotor 4 of device 1 according to Fig. 1. The first rotor comprises three disc receptacles 27, 28, 29 which are connected in a torque-proof manner to the assigned shaft 11 (not shown here) and which rotate together with the shaft. The upper disc receptacle 27 has a smaller outside diameter than the disc receptacles 28 and 29 located below it. Cutouts 30 are provided in the outer periphery of the top two disc receptacles 27, 28, in which the first links 31 of impact chains are inserted, each of which links is held there by one bolt 32. For this purpose, pockets 33 are provided in the disc receptacles 27, 28. This is shown in Fig. 4 based on the example of disc receptacle 28 and one of the impact tools 21. The above-mentioned impact chains form part of the corresponding impact tool 20 or 21.

All disc receptacles 27, 28, 29 of the rotor 4 have vertical bores into which bolts 34, 35 can be inserted. Between each two disc receptacles 27, 28 and 28, 29, rotor casing elements 36, 37 are arranged, which also have vertical bores 38, which are oriented in-line with the bores of the disc receptacles 27, 28, 29. Limit stops 39, 40, 31 facing the rotor casing elements 36, 37 are developed on the bottom side of the upper disc receptacle 27 and on the upper side of the disc receptacle 28 arranged under it as well as on the bottom side of this disc receptacle 28. Positioned on these limit stops is the side of horizontal support walls of the rotor casing elements 36, 37 facing the shaft 11. In this manner, the rotor casing elements 36, 37 are centred and held and supported in the correct position in relation to the rotor 4. The rotor casing elements 36, 37 are then fixed on the rotor 4 in the supported position by means of bolts 34, 35. If the rotor casing elements 36, 37 have to he replaced, this can easily be done by removing the bolts 34, 35 and by replacing the corresponding rotor casing elements 36, 37.

The rotor casing element 37 positioned further below has a lifting bar 42 which extends radially and axially from a truncated cone-shaped exterior surface of the rotor casing element 37 to the outside. The lifting bar 42 is provided for the purpose of accelerating the particles which get into the area of the rotor casing 17 radially towards the outside, in order to transfer them there into the area where the impact tools 20, 21, 22, 23, 24, 25 have higher velocities. These lifting bars 42 are particularly provided also on the corresponding rotor casing elements of the second rotor 5. In addition, the lower rotor casing element 37 has an outside edge 43 which overlaps with the lowest disc receptacle 29 of rotor 4 and is supported against the disc receptacle 29 and thus helps to fix the respective rotor casing element 37 on the rotor 4 in its position in a similar manner as the limit stops 39, 40, 41, which rotor casing element is then fixed by the bolts 35.

Fig. 2 furthermore shows a disc receptacle 44 of the second rotor 5. Because of the larger diameter of this second rotor 5 in comparison with the diameter of the first rotor 4, the receptacle 45 for the corresponding impact tools 22 and the bore for the corresponding bolt 46 are radially offset further towards the outside.

Based on the example of disc receptacle 28, Figs. 3 and 4 show the connection between the disc receptacles 27, 28, 44 and the impact tools 20, 21, 22, 23, 24, 25 which are developed as impact chains. Each of the impact tools 20, 21, 22, 23, 24, 25 comprises a first chain link 31 facing the corresponding rotor 4, 5 or 6, into which link a vertical bolt 32 is welded. The first chain link 31 is engaged by a second, semi-open chain link 47, into which another part of the impact tool 20, 21, 22, 23, 24, 25 made of a highly resistant steel is welded. Several (e.g. up to eight) milled-out pockets 33, distributed around the perimeter, are located in the disc receptacles 27, 28, 29, into which pockets the impact tools will be hooked with their bolts 32. Fig. 3 in addition shows one of the annular peripheral protrusions 26 of the separating chamber wall 2, which protrusion is positioned opposite of the impact tool 21. These protrusions 26 can also be bevelled on a top end in order to improve their ability to direct falling particles into the area of the impact tools 21, 22, 23, 24, 25. Fig. 4 also shows two of the bores 48 for the bolts 34 and 35.

Fig. 5 shows a detail of the device 1 according to Fig. 1, which clarifies how an impact element 49 is attached in the separating chamber wall 2. The impact element 49 has an impact surface 50 which serves as the impact surface for the material accelerated by the impact tools 20, thereby making it possible to disintegrate the material conglomerates there. The conglomerates are obviously also disintegrated on the impact tools 20 and the other impact tools 21, 22, 23, 24, 25 themselves. The rotational direction of the rotor 4 with the impact tool 20 is indicated by an arrow in Fig. 5.

On the separating chamber wall 2, "teeth" protruding into the separating chamber with the rotors 4, 5, 6 are formed by the impact elements 49, in that the latter extend axially and radially towards the inside of the separating chamber. The impact elements 49 are inserted into pockets 51 provided for this purpose, which pockets are distributed around the periphery of the separating chamber wall 2. Accordingly, e. g. four or eight or significantly more pockets 51 with impact elements 49 can he distributed around the perimeter. The impact elements 49 can be inserted into these pockets 51 from the outside and then be bolted to the outside of the separating chamber wall 2. The side of the impact element 49 facing the direction of rotation and protruding into the separating chamber 2 forms the mentioned impact surface 50. If a smooth cylindrical separating chamber wall 2 without any such impact surfaces 50 is desired, placeholders 52 can be inserted into these pockets 51. The placeholders 52 have the same thickness as the separating wall chamber 2 including a wear lining 53 of the separating chamber wall 2. Therefore, the placeholders 52 align with the inside of the separating chamber wall, which results in a continuous smooth cylindrical inside 54 of the separating chamber wall 2. The impact elements 49, on the other hand, project into the separating chamber. Fig. 6 illustrates schematically the operating method of the device 1 with the separating device according to the present invention. Conglomerates 55 which consist of metal particles 56 and slag residues 57 are accelerated by the impact tools 20, 21, 22, 23 of the device 1. As a result, they achieve a velocity v_2. In the next section 9 of the separating chamber, they impact against the impact tools 24, 25 which rotate with high speed in the opposite direction. Upon the impact, the velocity v_2 of the conglomerates 55 and the velocity v_1 of the impact tools 24, 25 add up, which results in a definite breaking-up of the conglomerates, which are thereby separated into their individual components, i. e. into metal particles 56 and slag residues 57. It is thus possible to achieve impact speeds of 200 m/s and more in the described manner. The energy released in this process with a high probability results in a disintegration even of firmly caked conglomerates.

Of course also variations of the described exemplary embodiment are possible. For instance, the number and the distribution of the impact tools 20, 21, 22, 23, 24, 25 can deviate front the illustrated example. It is possible to use different impact tools instead, in particular chains and baffle plates. A lot more impact tools than in the first section 7 may be distributed around the perimeter in the rows of the impact tools 23, 24 in the third section 9 of the separating chamber. This results in an increased probability of collisions in the area of the third section 9, i. e. in the high-velocity impact chamber. It may be provided that a sector of the separating chamber wall 2 can be opened so that it can be used for access to the separating chamber 2 to perform maintenance work, for example. The replacement of parts subject to wear and tear, in particular the replacement of the wear lining 53, of the impact tools 20, 21, 22, 23, 24, 25 or of the rotor casing elements 36, 37—the rotor casings 18, 19 of the other rotors 5, 6 of course have correspondingly designed rotor casing elements—is therefore simplified.

What is claimed is:

1. A device for mechanical separation of material conglomerates from materials with different density and/or consistency, comprising: a separating chamber with a feed side; and, a discharge side, where said separating chamber is surrounded by a cylindrical separating chamber wall and has at least two consecutive sections in the axial direction, in each of which at least one rotor has impact tools which extend radially into the separating chamber, wherein the rotors have, in the consecutive sections from the feed side to the discharge side, a rotor casing, the radius of which increases towards the discharge side, wherein the difference between the radius of the rotor casing and the radius of the separating chamber wall decreases from the feed side towards the discharge side, the directions of rotation of the rotor in the section facing the discharge side and the rotor of the section which lies ahead in the direction of the material flow are counter-rotating, and the rotational velocity of the rotors in the sections from the feed side towards the discharge side of the separating chamber, increases.

2. The device according to claim 1, wherein the rotor of each section of the separating chamber has its own drive, which can be driven and/or controlled independently of the rotors of the other sections.

3. The device according to claim 1, wherein the rotor casing is designed like a truncated cone.

4. The device according to claim 3, wherein the rotor casings of the rotors form a truncated cone in the consecutive sections of the separating chamber.

5. The device according to claim 2, wherein the axis of the separating chamber is perpendicular and with the feed side aligned to the top.

6. The device according to claim 1, wherein the impact tools are held in holders formed on the rotor, wherein the rotor is adapted to be replaceable.

7. The device according to claim 6, wherein, in at least one section of the separating chamber, two axially offset holders for the impact tools are provided.

8. The device according to claim 1, wherein the rotor casing is formed from several rotor casing elements held on the rotor, wherein the rotor is adapted to be replaceable.

9. The device according to claim 1, wherein the rotor casing has lifting bars at least in the second to last section in the direction of the material feed device, which extend into the separating chamber axially and radially.

10. The device according to claim 1, wherein, in at least one section of the separating chamber, impact surfaces are arranged which extend from the separating chamber wall towards the inside axially and radially.

11. The device according to claim 1, wherein in one section of the separating chamber, following in the feed direction of the material, has more impact tools than in the section of the separating chamber which is arranged before.

12. The device according to claim 1, wherein the ratio of the rotational speeds of the rotor between one section of the separating chamber and the section of the separating chamber arranged before in the direction of throughput of the material to be treated is between 1.5 and 5.

13. The device according to claim 11, wherein the rotational speed of the rotor in the last section of the separating chamber facing the outlet side is selected such that the absolute velocity of the outside edges of the impact tools is between 100 and 300 m/s.

14. The device according to claim 1, further comprising one feed hopper above the separating chamber and/or one discharge hopper below the separating chamber.

15. The device according to claim 8, wherein the ratio of the radii of the rotor casing to the separating chamber wall in the direction of the material feed on the feed side is between 0.25 and 0.6, and is between 0.5 and 0.8 on the discharge side.

16. The device according to claim 1, wherein the impact tools are formed by chains.

17. The device according to claim 1, wherein the diameter of the separating chamber wall increases from the feed side towards the discharge side.

18. The device of claim 12, wherein the ratio of the rotational speeds of the rotor between one section of the separating chamber and the section of the separating chamber arranged before in the direction of throughput of the material to be treated is between 2 and 4.

19. The device of claim 13, wherein the rotational speed of the rotor in the last section of the separating chamber facing the outlet side is selected such that the absolute velocity of the outside edges of the impact tools is between 130 and 200 m/s.

20. The device according to claim 1, wherein the impact tools are formed by baffles.

FIG 1

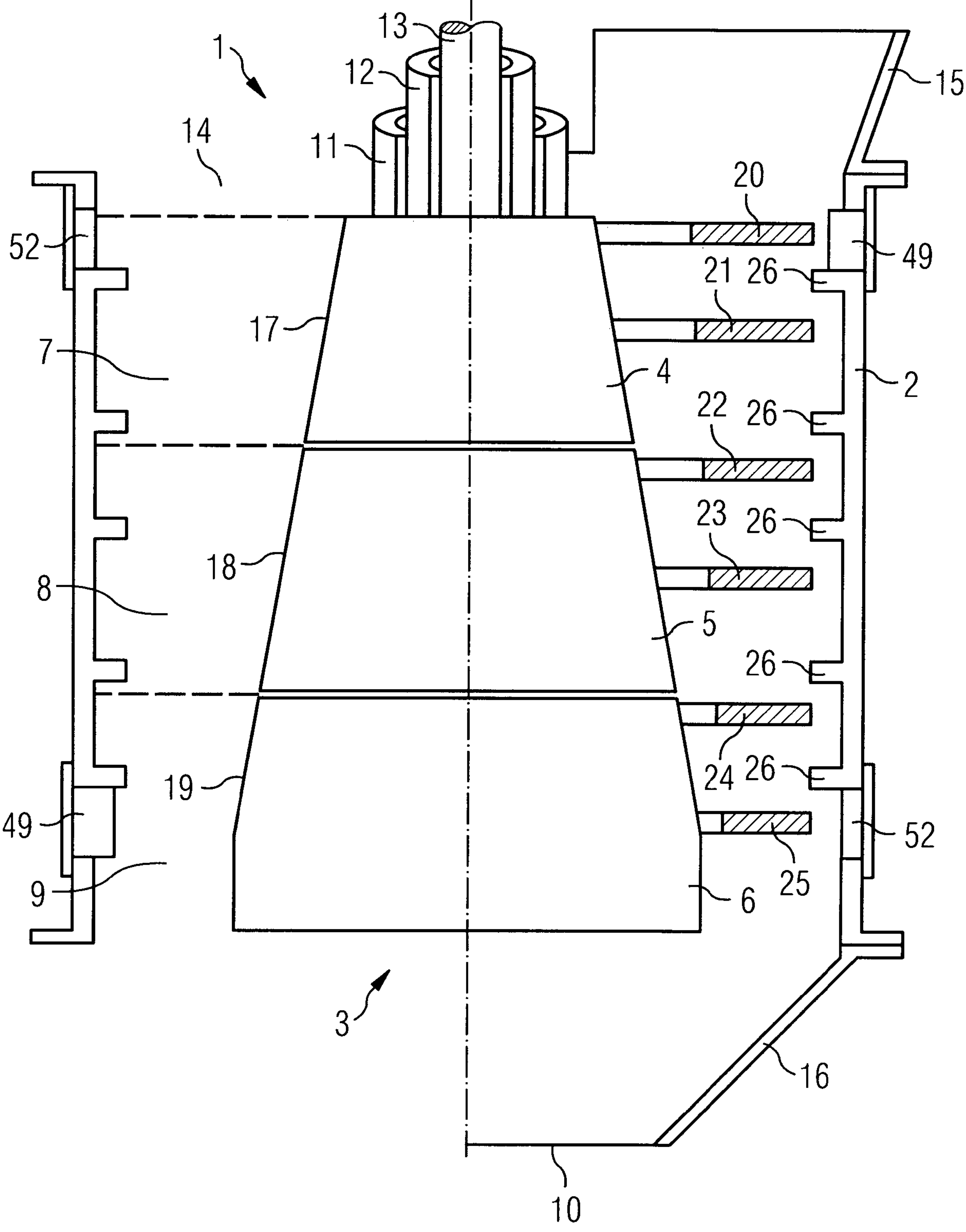


FIG 2

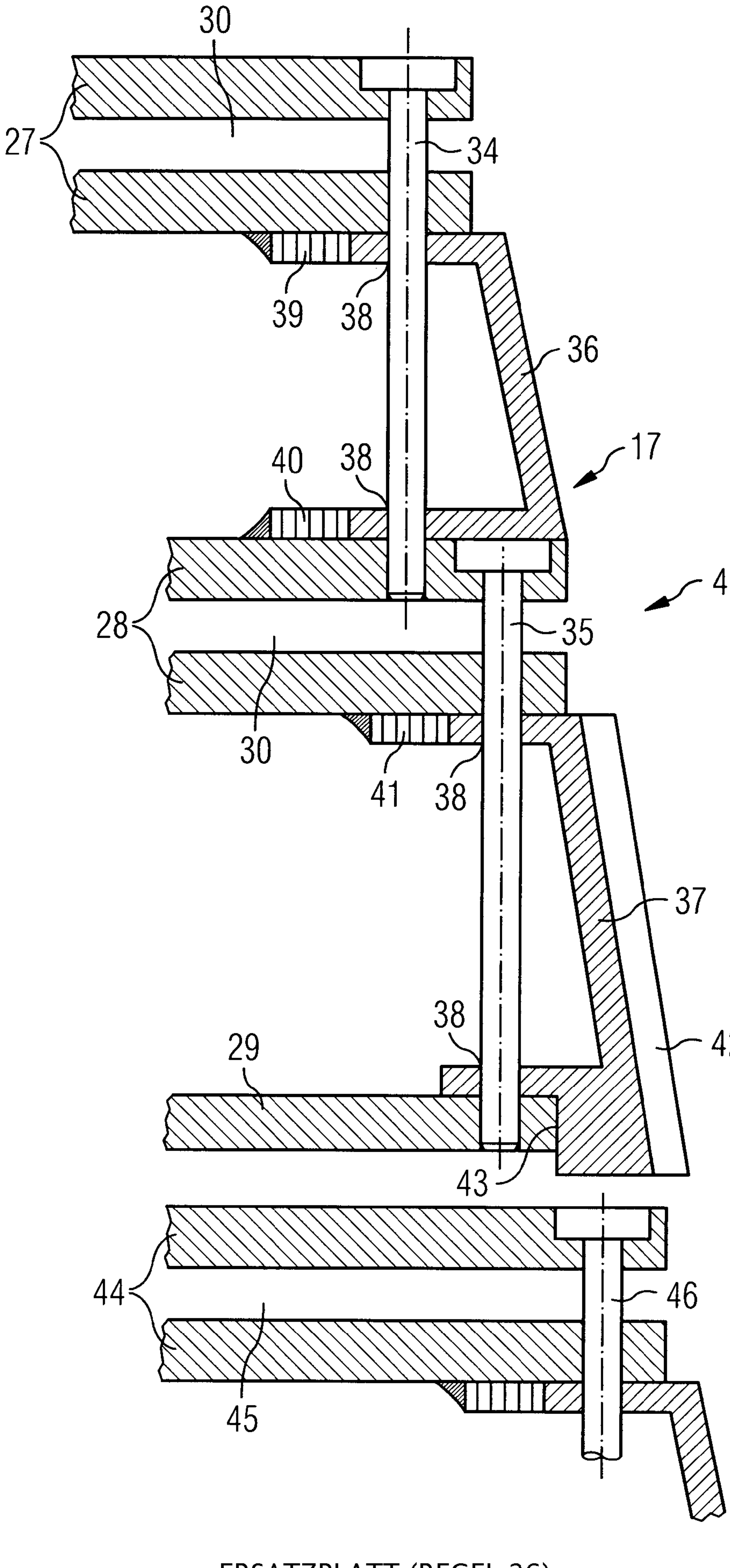


FIG 3

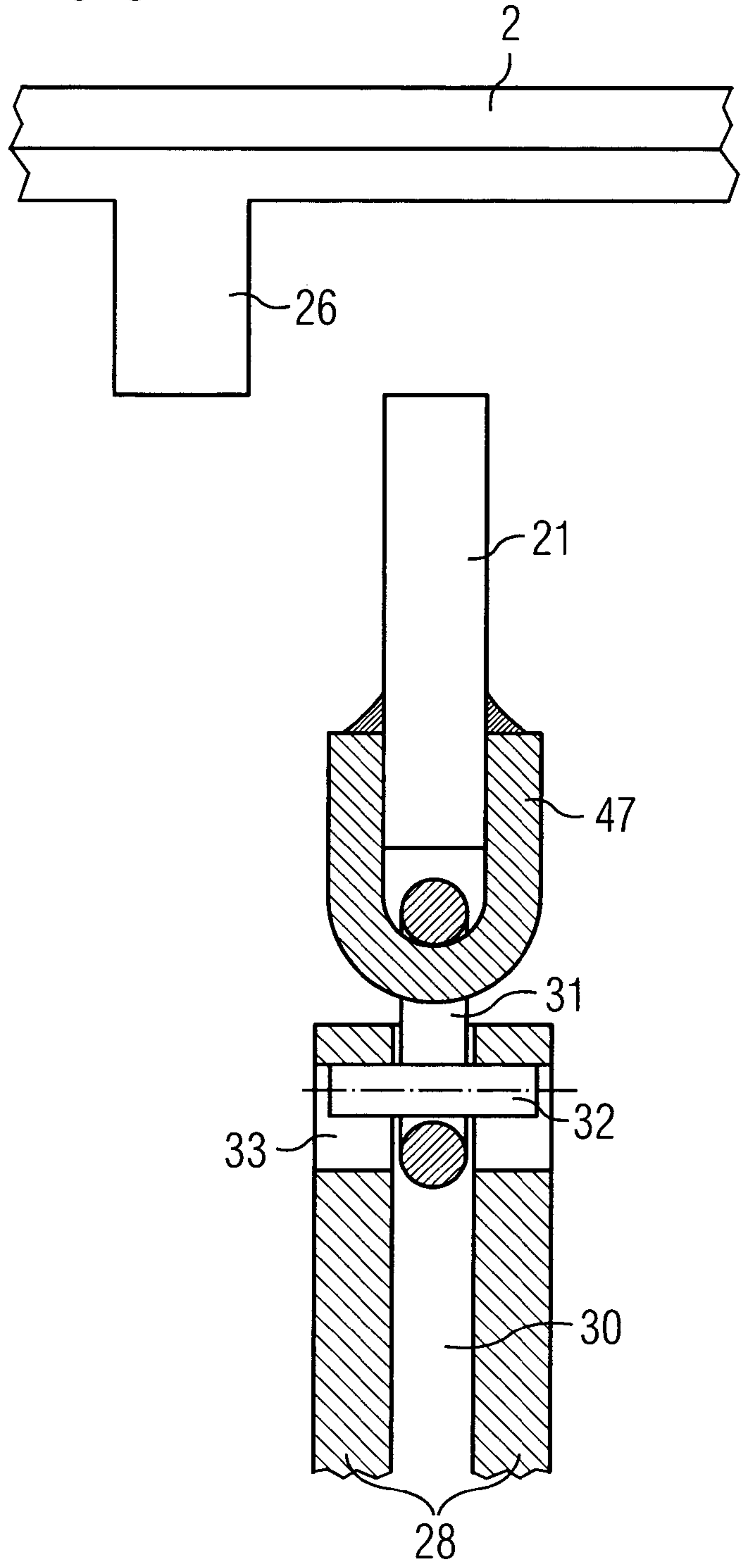


FIG 4

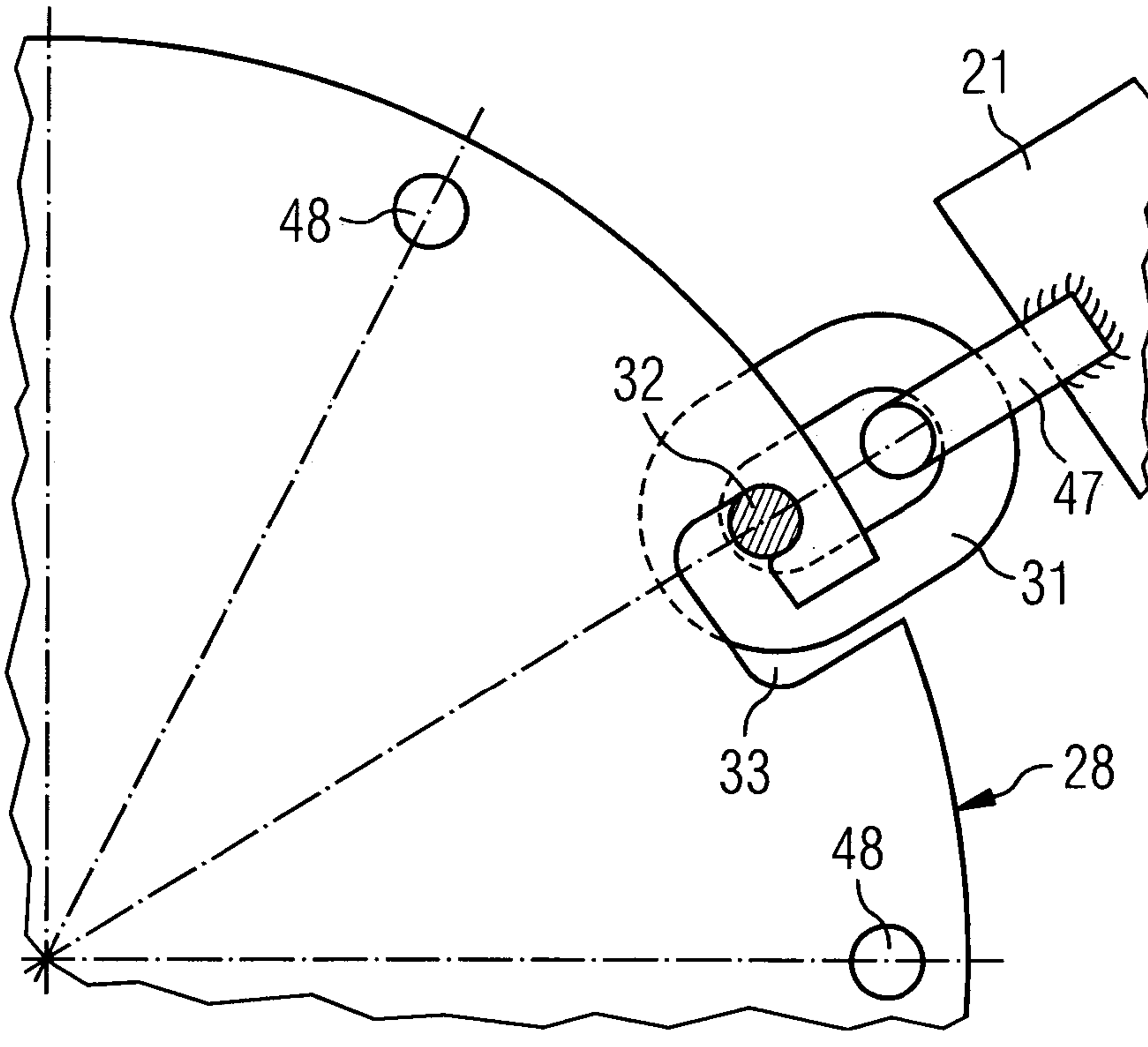


FIG 5

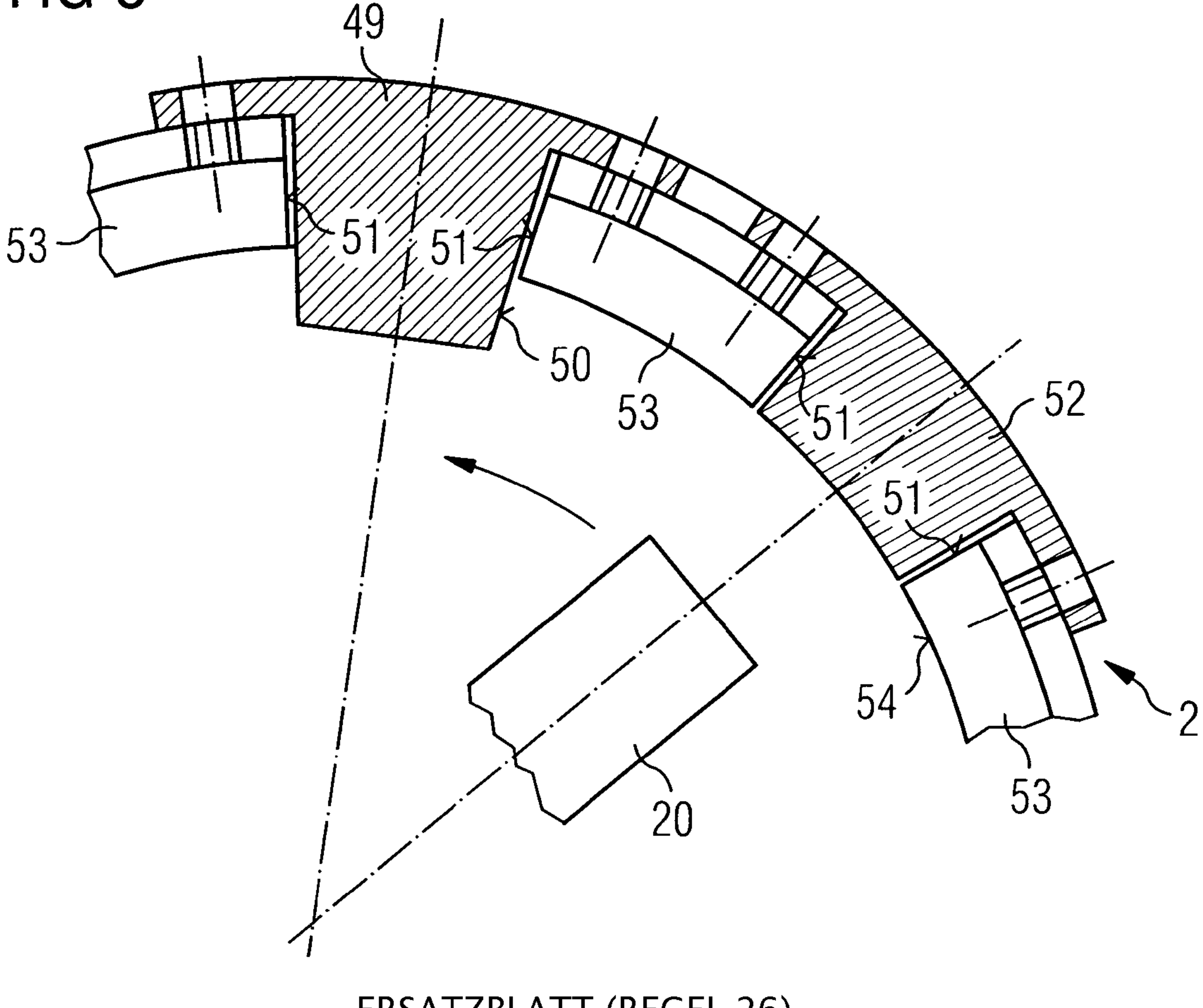
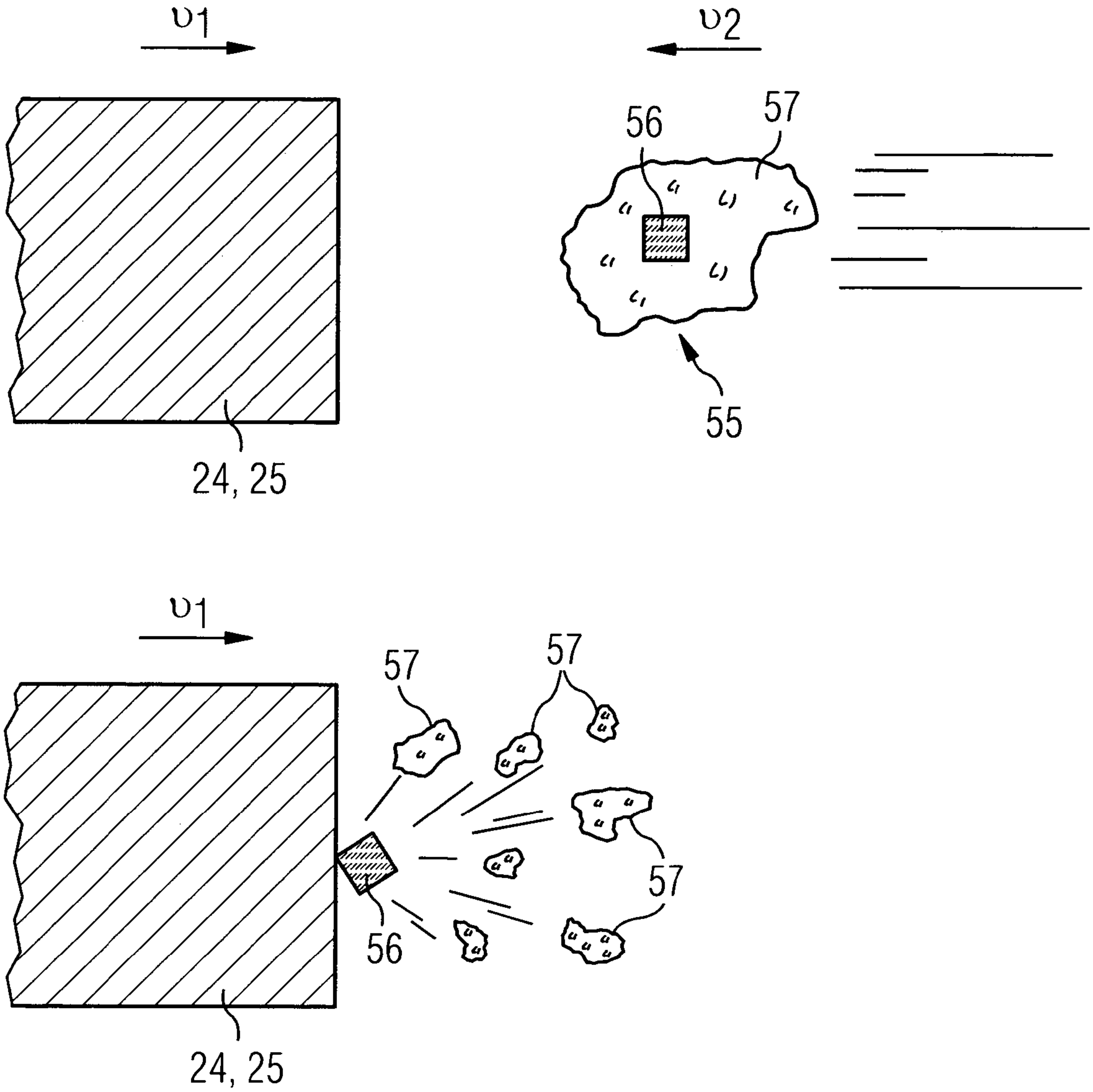
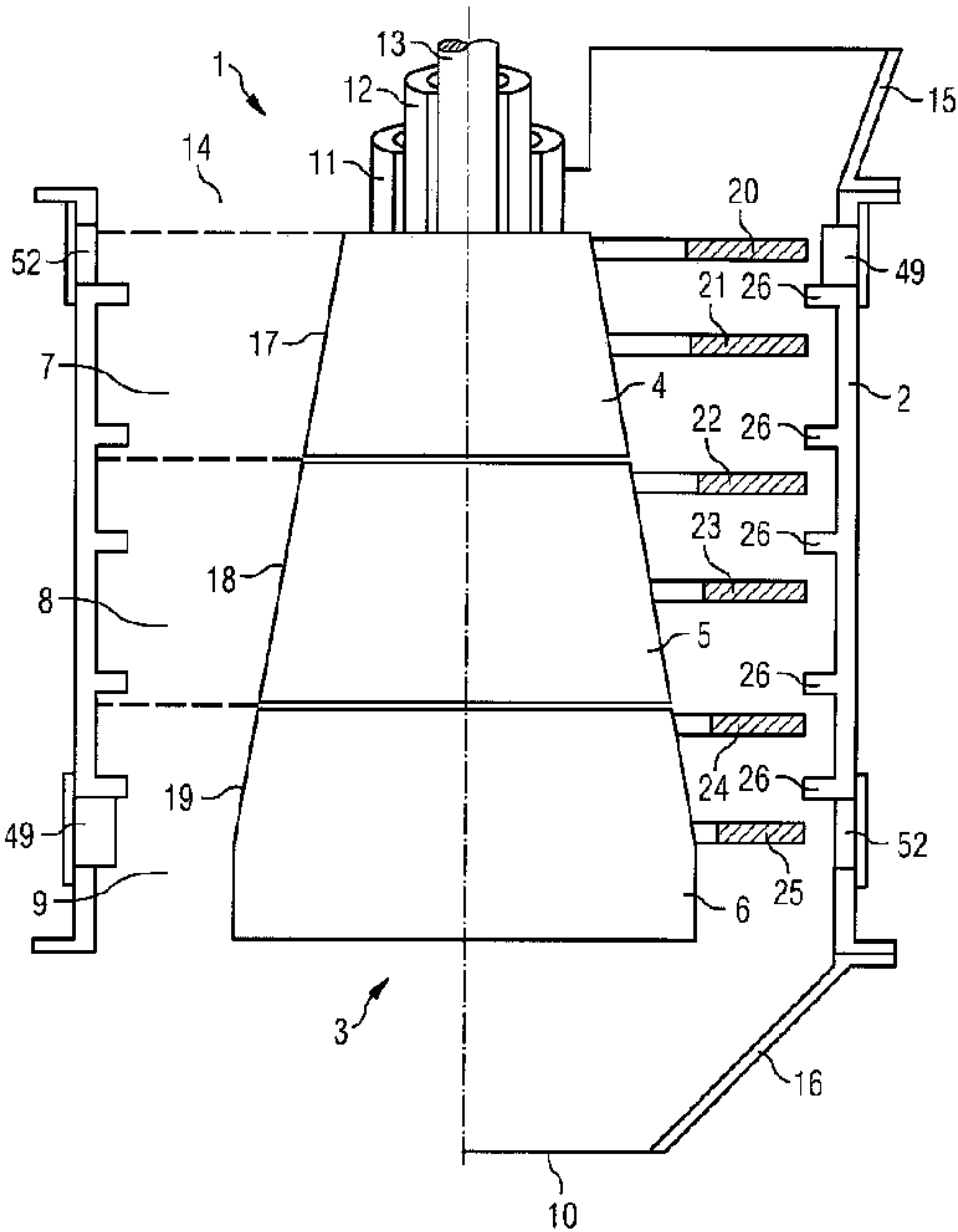


FIG 6





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