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(12) # EUROPEAN PATENT SPECIFICATION

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(54) **SPIRAL SEPARATOR.**

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AU-B-3 717 578
AU-B-5 520 580
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Description

This invention relates to spiral separators. Spiral separators are used extensively for the wet gravity separation of solids according to their specific gravities. For examples, spiral separators are used in separation of various kinds of mineral sands from silica sands, and in cleaning crushed coal by the removal of ash or other impurities. An example of such a spiral separator is described in pending Australian patent application No. 55205/80 (AU—B—531345).

Separators of the kind under discussion have a helical trough or sluice which has an inner wall and an outer wall connected by a floor. In use, a pulp or slurry containing species to be separated is fed to the trough. The species in the slurry are sorted according to size and specific gravity with the largest and heaviest materials moving to one side of the stream and the finer and lighter materials being distributed in layers from the bed of the stream upwardly and from the inside of the curve outwardly and with water piling up on the outside of the bend. When the gravitational force is greater than the centrifugal force the largest and heaviest particles are concentrated in a band near the inner wall ("concentrate band") and the finer and lighter particles move towards the outer wall forming a band of depleted concentrate ("depleted band"). A splitter is arranged to remove the concentrate band via a take-off and the separation may be repeated on the depleted band.

While spirals of this general type have proved highly valuable, problems do arise in their operation in practice. Firstly, it has been observed that when the lighter and finer species (for example silica sand or other gangue) of the slurry has a very fine particle size, comparable with the particle size of the more dense material to be separated, some of the lighter species will move inwardly toward the inner wall of the spiral with the concentrate of the more dense particles even though there is a very great difference in their respective specific gravities. In separating a mineral concentrate from silica sand, the presence of the silica sand can be observed as a band or layer which at least partially overlies the concentrate. This overlying depleted band or layer adversely affects the yield and/or grade of the concentrate which can be recovered from the slurry.

Secondly, a recent trend has been to operate such spirals without the addition of wash water as the pulp flows down the spirals. It has been observed that, with spirals having a large pitch and/or floors with a relatively large inclination to the horizontal in the trough longitudinal direction, the water in the pulp rapidly moves outwardly towards the outer walls of the spiral under centrifugal action and the remaining concentrate and gangue in the pulp quickly become sluggish as they flow down the spirals.

According to the present invention in one aspect there is provided a spiral separator having a helical trough including an inner wall and an outer wall connected by a floor and having at least one take-off for a concentrate band separated from a depleted remainder, characterized in that said separator includes a deflector located on or adjacent to the inner wall and upstream of the take-off for diverting a band of depleted remainder, which in use of the separator at least partially overlies the concentrate band, in an outward direction relative to the concentrate band.

In a preferred embodiment a slurry deflector is situated inwardly of the depleted band. The shape of the deflector and the velocity of the slurry are selected so that a "bow wave" is produced which urges the overlying depleted band outwards. Preferably the deflection means serve to fan out the width of the concentrate band in addition to diverting the overlying depleted band outwards relative thereto, the widened concentrate band facilitating setting by an operator of take-off splitters to obtain optimum grade and/or yield of concentrate.

As herein used the terms "pulp" and "slurry" are interchangeable. An "outwardly" direction is a direction towards the outer wall of the trough and an "inwardly" direction is a direction towards the inner wall of the trough.

The number of turns, pitch and floor angle of the spirals may be selected to suit the particular concentrate to be concentrated and the spirals may be provided with an inner gutter provided between the column and the inner wall, to receive and convey the concentrate taken out of the pulp at the various take-offs in the spiral. The take-offs may be of any suitable type, for example the type disclosed in Australian Patent No. 522,914 having a transverse slot, or may include slots or discontinuities in the inner wall leading to the inner trough, and fixed or movable splitter blades may be provided to direct the concentrate through the take-offs. Preferably the deflection means are provided approximately 50—200 mm upstream of the take-offs and they may be provided on any or all of the turns of the spiral. However it is preferred that they are provided on every turn of the spiral to enable to the pulp to reach a deflection velocity before impinging on the deflection means. The "deflection velocity" is the velocity at which it is observed that for example the silica sand (or gangue) is deflected outwardly from the inner wall of the spiral by a "bow wave" created by the deflection means.

The deflector may be fixed in, on or adjacent the inner wall of the spiral or may be movable relative thereto and the deflector may be concealed in a recess formed in the inner wall to allow an unimpeded flow of the pulp down the spiral when not required. For the separation of high grade mineral, where no gangue or silica overlies the inner portion of mineral stream, the deflector may be spaced from the inner wall to allow the portion of the mineral flow to be unimpeded, the deflector operating to deflect the gangue or silica from the outer portion of the mineral flow. The deflector may comprise a blade,

finger or other formation which extends upwardly from the floor, or which has a slot or aperture adjacent the floor which allows the band of concentrate to flow unimpeded down the spiral but where the overlying band or layer of silica is deflected outwardly.

According to the present invention in a second aspect, there is provided a method for separating a first species from a second species having a specific gravity different from the first species comprising the steps of:

(a) feeding a slurry of the first and second species down the trough to a take off of a spiral separator having an inner wall and an outer wall connected by a floor whereby the slurry forms an inner band in which one of the species is concentrated and an outer band in which it is depleted, at least a portion of said depleted outer band overlying the concentrated inner band, characterized by

(b) diverting at least the inner part of the overlying depleted band outwardly relative to the underlying concentrate band by means of a deflector located on or adjacent to the inner wall upstream from the take off.

Two of the embodiments of the invention will now be described, by way of examples, with reference to the accompanying drawings, in which:

FIG. 1 is a plan view of one turn of a first embodiment of a separator spiral according to the invention,

FIGS. 2, 3, 4 and 5 are respective sectional side views taken respectively along lines 2—2, 3—3, 4—4 and 5—5 indicated on FIG. 1, and

FIG. 6 is a plan view showing part of one turn of a second embodiment according to the invention.

The spiral assembly has four similar spirals 12 provided around a substantially vertical central column 11, the upper ends of the spirals being connected to a common feed box containing a supply of pulp from which the concentrate is to be separated. For clarity of description only one spiral is shown in the drawings. In the present example the separator is used to separate a mineral concentrate from a silica sand.

Each spiral 12 has an outer wall 13 connected to a spiral floor 14 which is inclined to the horizontal. For approximately the first turn, the inner wall 15 is fixed to the column 11 and thereafter is spaced from the column by a gutter 16 which conveys the separated concentrate to a concentrate outlet (not shown) at the bottom of the spiral. For ease of manufacture, the spirals 12 are preferably formed of fibreglass.

At approximately the second turn of the spiral 12, as shown in FIGS. 1 and 3, a take-off 17, having a transverse slot 18 and movable splitter blade 19, of the type disclosed in Australian Patent No. 522,914, is provided to convey the concentrate separated from the pulp to the gutter 16, the steep angle of the gutter 16 to the horizontal ensuring that the concentrate will flow freely down the gutter 16.

A deflector 20, approximately 15—20 mm wide, is provided integrally with the inner wall 15 approximately 50—200 mm upstream of the take-off 17. As shown in FIG. 1, the nose of the deflector 20 is rounded to enable the concentrate 21a to flow around the deflector 20 with a relatively smooth flow. However, the deflector 20 creates a "bow wave" in the water containing the silica sand layer partially overlying the concentrate 21a and this "bow wave" diverts the silica outwardly, away from the inner wall, to leave a clean, albeit wider, band of concentrate 21a. (The width of the concentrate band may be increased to e.g. 25 mm downstream of the deflector 20, from a width of e.g. 15 mm upstream of the deflector 20).

The operator, by observing the concentrate band, can adjust the splitter blade 19 to take almost all the concentrate 21a. The wider band of concentrate, free of the silica sand, enables an initial cut of higher grade and yield to be taken than with a conventional spiral.

With reference to Figure 6, there is shown schematically a second embodiment in which a first deflector blade 30 is mounted by means of a pin 31 so that the angle of the blade 31 relative to the direction of flow of slurry is adjustable. Inner wall 15 is provided with a recess whereby blade 30 can be moved out of the stream when not in use. If desired, the height of the lower edge of blade 30 above the trough floor may be made adjustable. The concentrate band in Figure 6 lies radially inwards of line 32 it being understood that in practice the concentrate band and depleted band are not separated by a line. Flow lines 33 and 34 show a bow wave in the vicinity of blade 30.

A repulping assembly 21 is provided just downstream of take-off 17 as shown in Figure 1.

A second deflector 22 (Figures 1 and 4), which is crescent-shaped in plan, is formed by diverting the inner wall 15 of the spiral outwardly in a smooth curve and then returning it to its initial path to form a restricted width passage 23. The inner wall 15 is connected to a gutter outer wall 24 by a connecting panel 25.

A third deflector 26 (Figures 1 and 3) is provided integrally with the outer wall 13 just downstream of the take-off 17 and may be of similar width to first deflector 20. A roof section 27, having down-turned leading and trailing edges 28, covers the restricted passage 23.

In operation, concentrate is removed via take-off 17. Water moves to the outer wall 13 of the spiral under centrifugal force, while the unseparated remainder comprising tailings and any concentrate remaining in the pulp continue past the take-off 17 adjacent the inner wall 15. The water strikes or impinges against the third deflector 26 and is directed inwardly and upwardly against the roof section 27. Simultaneously, the tailings and remaining concentrate are moved outwardly by the second deflector 22, and so are caused to be remixed, or repulped, with the water. The leading or trailing edges 28 of the roof section direct any water striking the latter downwardly to assist in

this mixing process. (If preferred, the pitch of the spiral over a short section of the restricted passage 24 may be increased to accelerate the tailings and remaining concentrate to further assist in the mixing process. Downstream of the repulping assembly, the remaining concentrate begins to separate from the tailings and may be taken off into the gutter 16 by a second take-off 17 provided at e.g. the fourth turn, the tailings continuing to a middling and/or tailings outlet (or outlets) at the bottom of the spiral. (These outlets may be of the type disclosed in pending Application No. 55205/80).

To assist in taking off the remaining concentrate, a deflector similar to deflector 20, may be provided upstream of the second take-off. A further deflector, provided e.g. on the third turn of the spiral, may be required to retard the flow of the concentrate down the third and fourth turns of the spiral, otherwise the concentrate reaches a velocity which is such that the centrifugal force on the concentrate moves it outwardly into or over the tailings layer.

Because the spirals are compact, and do not require any additional wash water fittings, and because the repulping assembly ensures the flow of the pulp down the spirals, up to four spirals may be mounted on each column 11.

It will be readily apparent to the skilled addressee that deflectors 20, take-offs 17 and repulping assemblies 21 can be provided on any or all of the spiral turns. However, for effective operation, the pulp must preferably reach a "deflection velocity" where the "bow wave" effect is created to deflect the silica or other gangue, and so generally the first deflector 20 will be provided on the second turn and any subsequent similar deflectors or take-offs approximately every $1\frac{1}{2}$—$2\frac{1}{2}$ turns thereafter, with retarding deflectors (if necessary) to control the upper limit of the pulp velocity intermediate the take-offs. Experiments to date have shown best results have been obtained using spirals with five or six turns, the first deflector 20 and take-off 17 being provided on the second turn, a retarding deflector on the third turn, and a second deflector 20 and take-off 17 on the fourth turn and a repulping assembly 21 on the second turn.

Where high grade mineral is being separated from the pulp, it can be observed that the gangue or silica only overlies the outer portion of the concentrate. To disturb the concentrate flow as little as possible, the first deflector 20 (and subsequent deflectors) may be spaced inwardly from the inner wall to provide an undisturbed path for the inner portion of the concentrate. The outer portion is deflected, as hereinbefore described, but the mineral flows inwardly to fill the void downstream of the deflector as the gangue or silica is deflected outwardly to produce a clear stream of mineral concentrate downstream of the deflector. The deflector may be movable across the spiral to suit the particular mineral being separated from the pulp.

If preferred a vane shaped deflector may be used and this may be pivotally mounted.

The size, shape and position of the repulping assemblies will be dictated by the nature of the pulp to be separated and the pitch of the spirals. It will be readily apparent that the design of the repulping assembly will preferably ensure a good flow of the pulp down the spiral to enable high feed rates to be fed to the spirals, while ensuring adequate repulping of the water and tailings to ensure continuity of flow of same down the spirals, with as little disturbance of the partially separated concentrate as is possible. In certain applications, e.g. the separation of high grade mineral at lower feed rates, it may be preferred to allow a portion of the wash water to flow over the second deflector 26 to prevent excessive turbulence being generated in the repulping assemblies. In these applications the deflector may extend up only a portion of the height of the outer wall 13. Where the spirals are to be used to separate minerals of different grades and/or feed rates, the height of the deflector may be made adjustable. For example, the deflector may have a fixed lower portion formed integrally with the wall and an inner, telescopic portion, which may be raised or lowered to adjust the height operated by a suitable control stick, rod or bar.

The previously known methods of facilitating the flow of pulp down the spirals by the adding or injection of washwater involved supplementary plumbing means. The washwater is a constant source of operating and other problems such as algae growth in the distribution tubes and the need for adjustment of up to five taps per spiral start. The water has to be finely screened to remove extraneous trash and is costly to supply, and the distribution equipment is troublesome to maintain in good working order. The addition of the wash water to the pulp also creates bin overflow problems.

The present invention of repulping with the water contained in the initial feed is substantially costless and operator free.

Claims

1. A spiral separator having a helical trough (12) including an inner wall (15) and an outer wall (13) connected by a floor (14) and having at least one take-off (17) for a concentrate band separated from a depleted remainder, characterized in that said separator includes a deflector (20, 30) located on or adjacent to the inner wall (15) and upstream of the take-off (17) for diverting a band of depleted

remainder, which in use of the separator at least partially overlies the concentrate band, in an outward direction relative to the concentrate band.

2. A separator as claimed in claim 1, in which the deflector (20) is integral with the inner wall (15), and of a shape which at a deflection velocity of slurry produces a bow wave which urges the overlying depleted remainder in an outward direction.

3. A separator as claimed in claim 1, in which the deflector (20) comprises a vane (30) at or near the inner wall (15) and extending transverse the direction of slurry flow.

4. A separator as claimed in claim 3, in which the vane (30) is pivotally mounted.

5. A separator as claimed in claim 1, in which the deflector comprises a vane (30) for directing an upper strata of the slurry in an outward direction and having an underlying passage whereby to permit a relatively undeflected flow of a lower stratum.

6. A separator as claimed in claim 5, in that are provided for adjusting the height above the trough floor (14) of a lower edge of the vane (30).

7. A separator as claimed in any preceding claim, in which the deflector (20, 30) is situated between 50 and 200 millimeters upstream from a splitter (19) or take-ff (17).

8. A method for separating a first species from a second species having a specific gravity different from the first species comprising the steps of:

(a) feeding a slurry of the first and second species down the trough (12) to a take-off (17) of a spiral separator having an inner wall (15) and an outer wall (13) connected by a floor (14) whereby the slurry forms an inner band in which one of the species is concentrated and an outer band in which it is depleted, at least a portion of said depleted outer band overlying the concentrated inner band, characterized by

(b) diverting at least the inner part of the overlying depleted band outwardly relative to the underlying concentrate band by means of a deflector (20, 30) located on or adjacent to the inner wall (15) upstream from the take-off (17).

9. A method as claimed in claim 8, wherein the overlying layer is diverted by deflecting a flow of slurry in an outwards direction, said deflected flow urging the overlying depleted band outwardly relative to the underlying band of concentrate.

10. A method as claimed in claim 9, wherein the outward flow is a result of impingement of the slurry on a deflector (20, 30) situated inwardly of the depleted band at a sufficient slurry velocity to form a bow wave.

11. A method as claimed in claim 8, wherein the overlying depleted band is deflected outwardly relative to the underlying concentrate by means of a deflector blade (30) directing an upper stratum of the slurry stream outwardly and permitting a lower stratum of the slurry stream to pass substantially undeflected.

12. A method according to any one of claims 8 to 11, wherein the slurry at or adjacent the inner wall (15) is deflected in an outwards direction causing the inner concentrated band to fan out in width upstream from the splitter (19).

Patentansprüche

1. Spiraltrennvorrichtung mit einer helixförmigen Rinne (12) mit einer Innenwand (15) und einer Außenwand (13), die durch einen Boden (14) verbunden sind, und mit mindestens einer Entnahmeeinrichtung (17) für ein von einem abgereicherten Rückstand abgetrenntes Konzentratband, dadurch gekennzeichnet, daß die Trennvorrichtung eine Ablenkvorrichtung (20, 30) umfasst, die sich zum Ableiten eines Bandes von abgereichertem Rückstand an oder benachbart zu der Innenwand (15) und stromaufwärts von der Entnahmeeinrichtung (17) befindet, welches in Gebrauch der Trennvorrichtung mindestens teilweise das Konzentratband in einer Richtung auswärts relativ zum Konzentratband überlagert.

2. Trennvorrichtung nach Anspruch 1, in welcher die Ablenkvorrichtung (20) mit der Innenwand (15) ein Ganzes bildet und derart gestaltet ist, daß bei einer Ablenkgeschwindigkeit des Schlamms eine Bugwelle gebildet wird, welche den überlagernden abgereicherten Rückstand in Richtung nach außen drängt.

3. Trennvorrichtung nach Anspruch 1, in welcher die Ablenkvorrichtung (20) einen Flügel (30) an der oder nahe der Innenwand (15) und sich quer zur Richtung des Schlammflusses erstreckend umfaßt.

4. Trennvorrichtung nach Anspruch 3, in welcher der Flügel (30) schwenkbar gelagert ist.

5. Trennvorrichtung nach Anspruch 1, in welcher die Ablenkvorrichtung einen Flügel (30) umfaßt, die eine obere Schicht des Schlamms in eine äußere Richtung lenkt und einen darunterliegenden Durchlaß hat, so daß ein relativ nicht abgelenkter Fluß der unteren Schicht ermöglicht wird.

6. Trennvorrichtung nach Anspruch 5, in der Mittel zum Einstellen der Höhe der unteren Kante des Flügels (30) über dem Rinnenboden (14) vorgesehen sind.

7. Trennvorrichtung nach einem der vorangegangenen Ansprüche, in welcher sich die Ablenkvorrichtung (20, 30) zwischen 50 und 200 mm stromaufwärts von einem Spalter (19) oder der Entnahmeeinrichtung (17) befindet.

8. Verfahren zur Trennung einer ersten Sorte von einer zweiten Sorte, die ein von der ersten Sorte verschiedenes spezifisches Gewicht hat, das die folgenden Stufen umfaßt:

a) Einbringen eines Schlamms der ersten und zweiten Sorte abwärts der Rinne (12) zu einer Entnahmeeinrichtung (17) einer Spiraltrennvorrichtung, die eine Innenwand (15) und eine Außenwand (13) hat, die durch einen Boden (14) verbunden sind, wodurch der Schlamm ein inneres Band bildet, in dem die eine Sorte konzentriert ist, und ein äußeres Band, in der sie abgereichert ist, wobei mindestens ein Teil des abgereichter-

ten äußeren Bandes das konzentrierte innere Band überlagert, gekennzeichnet durch

b) das Ableiten von zumindest dem inneren Bereich des überlagernden abgereicherten Bandes nach außen relativ zu dem darunterliegenden Konzentratband mittels einer Ablenkvorrichtung (20, 30), die sich an oder benachbart zu der Innenwand (15) stromaufwärts von der Entnahmeeinrichtung (17) befindet.

9. Verfahren nach Anspruch 8, bei dem die überlagernde Schicht durch Ablenken eines Schlammstroms in eine äußere Richtung abgeleitet wird, wobei der abgelenkte Strom das überlagernde abgereicherte Band nach außen relativ zu dem darunterliegenden Konzentratband drängt.

10. Verfahren nach Anspruch 9, in dem der äußere Strom das Ergebnis des Aufpralls des Schlamms auf eine Ablenkvorrichtung (20, 30) ist, die sich innerhalb des abgereicherten Bandes bei einer Schlammfließgeschwindigkeit befindet, die zur Bildung einer Bugwelle ausreicht.

11. Verfahren nach Anspruch 8, in dem das überlagernde abgereicherte Band nach außen relativ zu dem darunterliegenden Konzentrat mittels eines Ablenkblattes (30) abgelenkt wird, das eine obere Schicht des Schlammstroms nach außen lenkt und es einer unteren Schicht des Schlammstroms ermöglicht, im wesentlichen ohne Ablenkung zu passieren.

12. Verfahren nach einem der Ansprüche 8 bis 11, bei dem der Schlamm an der oder benachbart zur Innenwand (15) in eine Richtung nach außen abgelenkt wird, wodurch das innere Konzentratband veranlaßt, wird, sich weit stromaufwärts des Spalters (19) aufzufächern.

Revendications

1. Séparateur en spirale comportant un canal hélicoïdal (12) comprenant une paroi intérieure (15) et une paroi extérieure (13) reliées par un fond (14) et comportant au moins une prise (17) pour une bande de concentré séparée d'un résidu appauvri, caractérisé en ce que ledit séparateur comprend un déflecteur (20, 30) situé sur la paroi intérieure (15) ou au voisinage immédiat de celle-ci et en amont de la prise (17) pour détourner une bande de résidu appauvri qui, au cours de l'utilisation du séparateur, recouvre au moins partiellement la bande de concentré, vers l'extérieur par rapport à la bande de concentré.

2. Séparateur selon la revendication 1, dans lequel le déflecteur (20) fait corps avec la paroi intérieure (15) et a une forme qui, à une vitesse de déviation de la boue, produit une ondulation en arc qui tend à diriger le résidu appauvri surjacent vers l'extérieur.

3. Séparateur selon la revendication 1, dans lequel le déflecteur (20) comprend une ailette (30) sur la paroi intérieure (15) ou près de celle-ci, laquelle est dirigée transversalement par rapport à la direction d'écoulement de la boue.

4. Séparateur selon la revendication 3, dans lequel l'ailette (30) est montée de façon à pouvoir pivoter.

5. Séparateur selon la revendication 1, dans lequel le déflecteur comprend une ailette (30) pour diriger une couche supérieure de la boue vers l'extérieur et comportant un passage sous-jacent, de façon à permettre un écoulement relativement non dévié d'une couche inférieure.

6. Séparateur selon la revendication 5, dans lequel on prévoit des moyens pour ajuster la hauteur au-dessus du fond (14) du canal d'un bord inférieur de l'ailette (30).

7. Séparateur selon l'une quelconque des revendications précédentes, dans lequel le déflecteur (20, 30) est situé 50 et 200 millimètres en amont d'un diviseur (19) ou de la prise (17).

8. Procédé pour séparer une matière d'une première nature d'une matière d'une seconde nature présentant une densité différente de la première matière, comprenant les étapes suivantes:

a) on fait descendre une boue de la première matière et de la seconde le long du canal (12) d'un séparateur spirale vers une prise (17) de celui-ci, ledit canal comportant une paroi intérieure (15) et une paroi extérieure (13) reliées par un fond (14), de telle façon que la boue forme une bande intérieure dans laquelle l'une des matières est concentrée et une bande extérieure dans laquelle elle est appauvrie, au moins une portion de ladite bande extérieure appauvrie recouvrant la bande intérieure concentrée, caractérisé en ce que

b) on détourne au moins la partie intérieure de la bande appauvrie surjacente vers l'extérieur par rapport à la bande concentrée sous-jacente au moyen d'un déflecteur (20, 30) situé sur la paroi intérieure (15) ou au voisinage immédiat de celle-ci, en amont de la prise (17).

9. Procédé selon la revendication 8, dans lequel on détourne la couche surjacente en déviant un courant de boue vers l'extérieur, ledit écoulement dévié tendant à diriger la bande appauvrie surjacente vers l'extérieur par rapport à la bande concentrée sous-jacente.

10. Procédé selon la revendication 9, dans lequel l'écoulement vers l'extérieur résulte de l'impact de la boue sur un déflecteur (20, 30) situé à l'intérieur de la bande appauvrie à une vitesse suffisante de la boue pour former une ondulation en arc.

11. Procédé selon la revendication 8, dans lequel la bande appauvrie surjacente est déviée vers l'extérieur par rapport au concentré sous-jacent au moyen d'une ailette déflectrice (30) dirigeant une couche supérieure du courant de boue vers l'extérieur et permettant à une couche inférieure du courant de boue de passer pratiquement sans déviation.

12. Procédé selon l'une quelconque des revendications 8 à 11, dans lequel la boue est, sur la paroi intérieure (15) ou au voisinage immédiat de celle-ci, déviée vers l'extérieur, ce qui provoque un étalement de la bande intérieure concentrée en largeur en amont du diviseur (19).

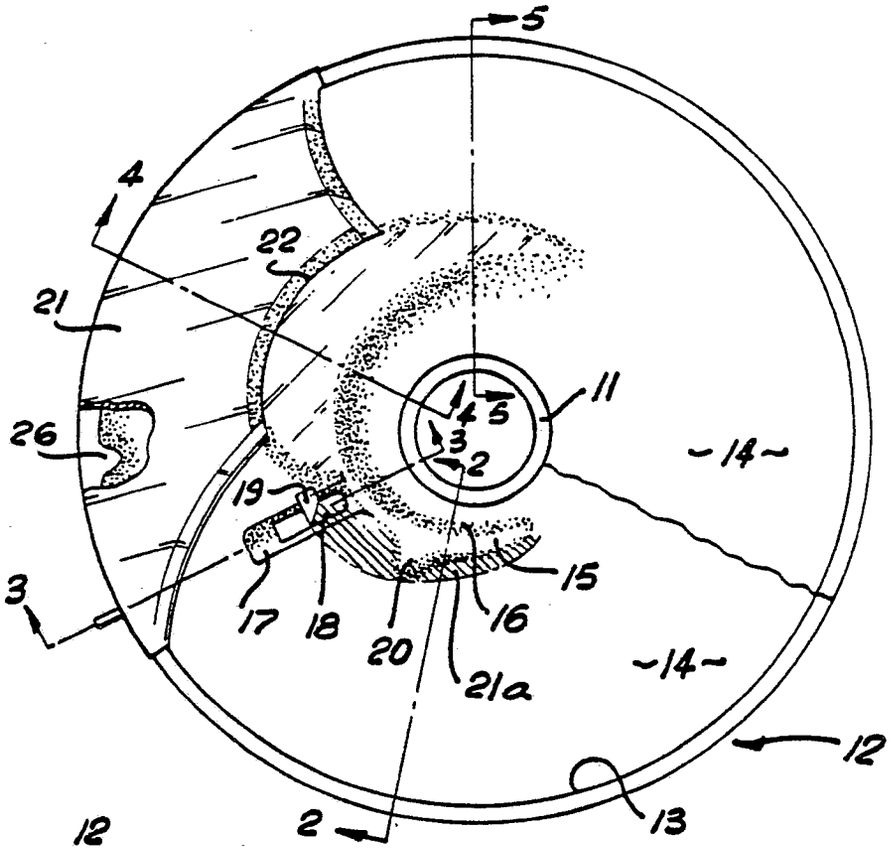

FIG.1

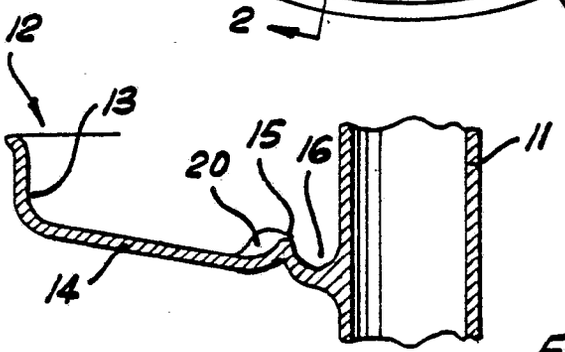

FIG.2

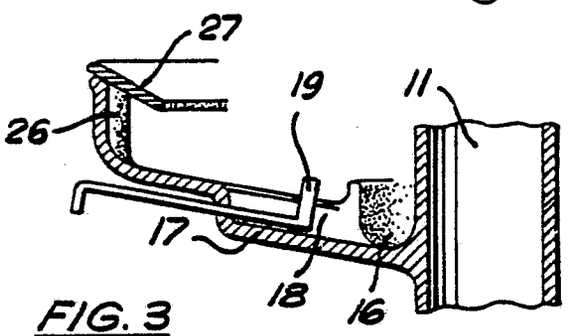

FIG.3

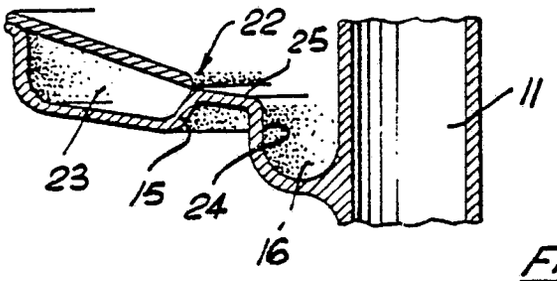

FIG. 4

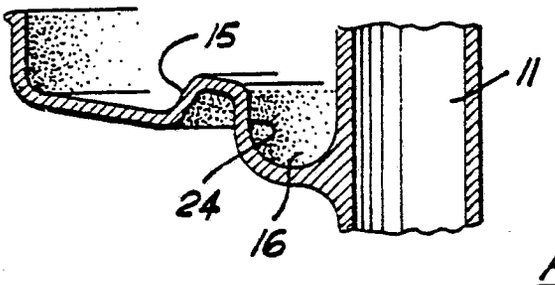

FIG. 5

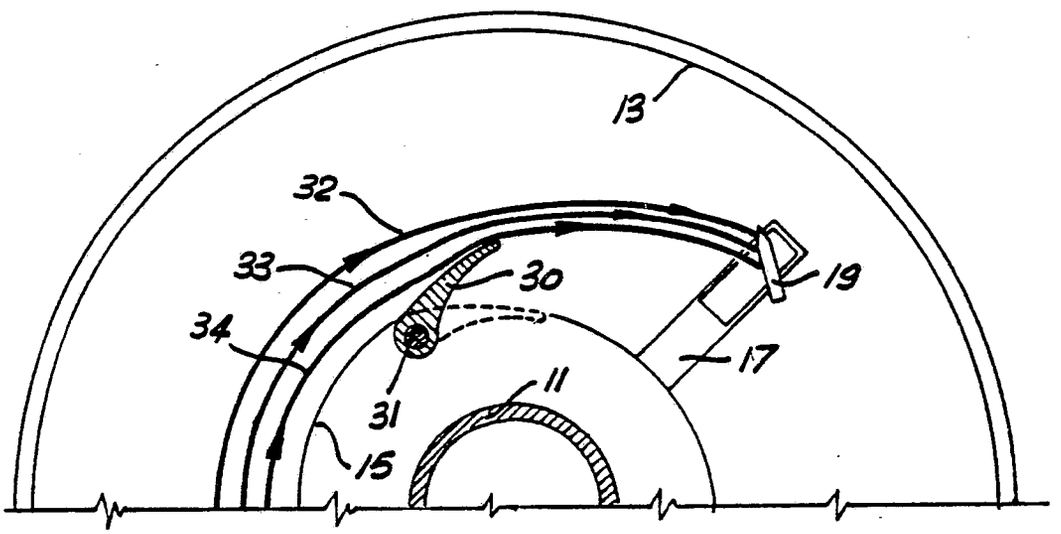

FIG. 6