

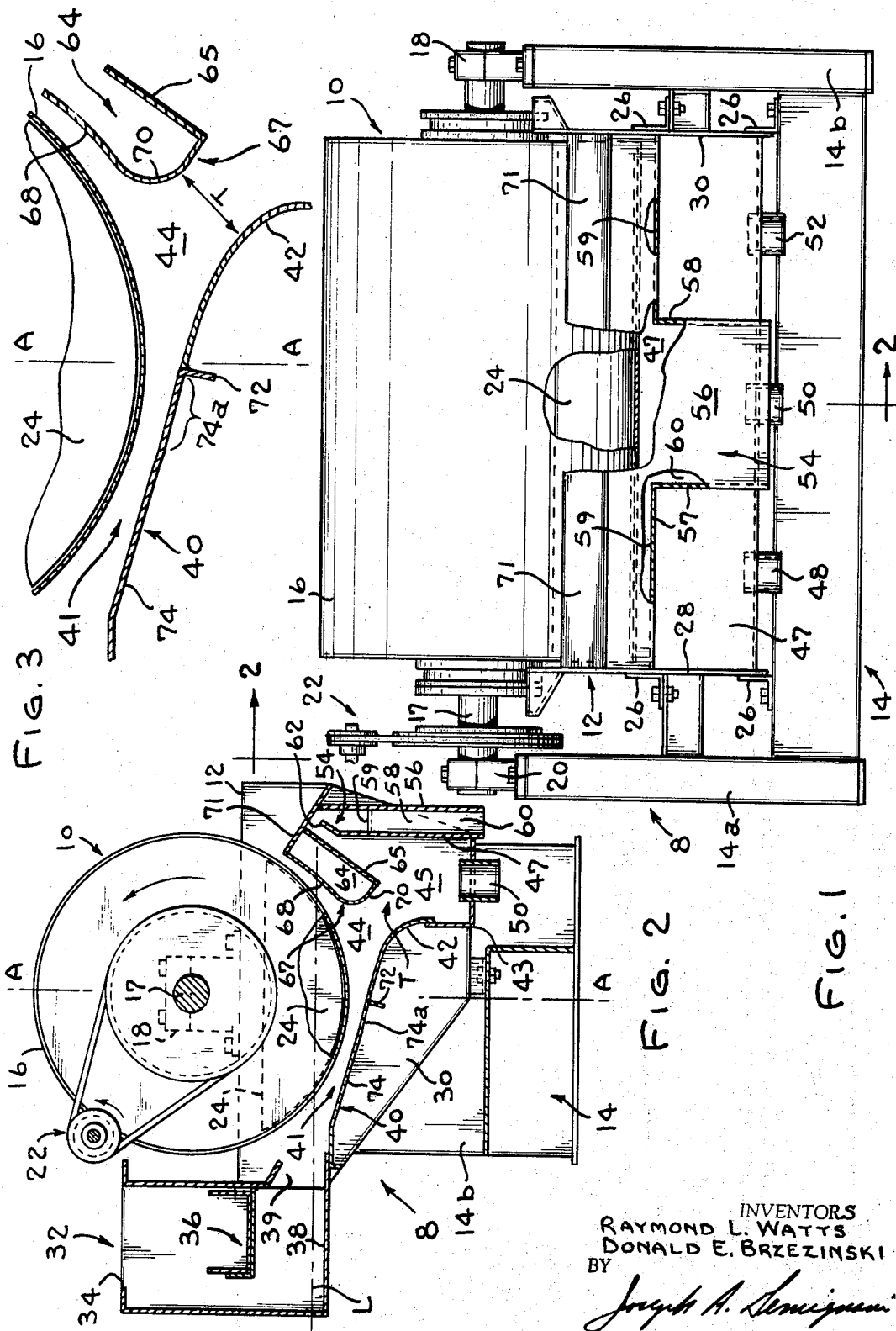
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MAGNETIC DRUM SEPARATOR AND TANK THEREFOR

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MAGNETIC DRUM SEPARATOR AND TANK THEREFOR

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ABSTRACT OF THE DISCLOSURE

This disclosure relates to a magnetic drum type separator wherein the tank wall holding the liquid media in the magnetic field is constructed to minimize turbulence. The tank wall has a generally straight portion extending up to the vertical centerline of the drum and has an extension beyond the vertical centerline, or the point at which magnetics adhering to the drum change direction relative to the liquid medium, which is generally arcuate and slopes downwardly and away from the drum.

This invention relates to magnetic separators and, more particularly, to an improved tank design for a drum type magnetic separator.

A typical application of drum type separators is in the recovery of magnetite used in a form of coal processing and, to assist in a better understanding, this invention will be discussed in such an environment. In such an application coal is pulverized and a mixture of coal and rock results. Magnetite is added to this mixture in the required proportion to produce a coal-magnetite association which, although being heavier than the coal, is lighter than rock. In a manner well known in the art the resulting mixture, containing the coal-magnetite association, is floated in a separator wherein the rock sinks and the coal-magnetite association floats, for example, onto a separating screen. After this separation of the rock from the coal-magnetite association the magnetite is removed from the coal by washing with water. The wash water, containing magnetite, is retained and passed through a magnetic separator to recover the magnetite. This invention is concerned with a separator of the type used to recover the magnetite used in such a process and has as a general object the improvement of the separation achieved in a separator of this type. At this point it should be mentioned that although discussed in connection with a magnetite recovery process, this invention is not limited to any specific separating operation but is applicable to separating operations generally.

Generally, past efforts at improving separation have been concentrated in the area of improving the magnetic circuit of the separator. Observation and study of such separators has indicated that tank design is an additional and significant factor in determining the effectiveness of the separation achieved and, moreover, it has been discovered that separation can be improved by taking an approach which is directly contrary to heretofore commonly accepted procedures used to achieve effective separation. Heretofore, a common practice has been to strive for agitation of the media being processed with the thought being that agitation exposes more of the magnetic portions of the media to the magnetic field in a condition more suitable for separation. In contrast, a specific object of this invention is to minimize turbulence and agitation of the media as it is exposed to the magnetic separating field.

More particularly and with reference to a drum type separator to which this invention has particular application, a drum rotates through a portion of a liquid media contained in a separator tank and a fixed magnetic circuit is associated with the portion of the drum passing through

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the media. The magnetic portions contained in the liquid media are attracted to the drum and carried over a separator plate after which it leaves the influence of the magnetic field and falls back in the direction of the tank but is caught by the separator plate and directed out of the tank. The non-magnetic portion of the media does not follow the drum but runs off through suitable drains. In accordance with this invention the tank is provided with a configuration which reduces turbulence at the point of physical separation of the magnetic and non-magnetic portions of the media being processed. More particularly, at this point of separation the tank configuration is such that it forms, in cooperation with the rotating drum, a nozzle-like area at the point of physical separation which has the effect on the flowing media of reducing its flow rate and provides a smooth transition of the media into and through the point of physical separation. This not only reduces turbulence for more effective separation but it has been observed that it affords an additional advantage in that the tank configuration which achieves the nozzle-type effect also increases the arc through which the media is confined adjacent the rotation drum for exposure to the magnetic field to thereby further enhance separation. It will be appreciated that the physical separation discussed above and throughout this description is intended to refer to the point at which the magnetic portions leave the non-magnetic portions and follow the drum while the non-magnetic portions are drained off, as opposed to the separation which occurs as the magnetic and non-magnetic portions flow jointly past the magnetic circuit.

By minimizing turbulence the flow of the media to the point of physical separation approaches, as near as possible, laminar flow, for example as the media approaches the point of separation it contains distinct layers of water and water-magnetite, and it has been observed that achieving laminar flow of the media, as opposed to agitation of the media, provides more effective separation.

In furtherance of the achievement of laminar type flow, this invention, in its more specific aspects, also contemplates providing a smooth path for flow of media into the physical separator area formed by the tank and drum. Specifically, the wall along which the media flows to the nozzle area at which magnetic and non-magnetic portions of the media are physically separated is substantially straight, or parallel to a tangent to the drum, throughout substantially its entire extension as opposed to conforming to the drum curvature. This achieves a non-turbulent laminar type of flow up to the physical separation area. Moreover, this permits the above mentioned wall to be arranged at a shallow angle to the horizontal which reduces the head on the liquid media as it flows past the magnetic circuit and contributes generally to the achievement of laminar flow.

Accordingly, a more specific object of this invention is to improve separation by achieving laminar type flow of a media through the separator.

Another specific object of this invention is to increase the arc through which the media is controlled and confined within the influence of the magnetic field of a drum type separator.

Other objects and advantages will be pointed out in, or be apparent from, the specification and claims, as will obvious modifications of the embodiment shown in the drawings, in which:

FIG. 1 is a front elevation of a drum type separator incorporating a tank constructed in accordance with this invention;

FIG. 2 is a sectional view taken generally along line 2—2 of FIG. 1; and

FIG. 3 is an enlarged sectional view of the nozzle forming portions of the tank wall and drum.

With particular reference to the drawings, heavy media separator 8 includes rotatable drum assembly 10 supported on tank 12 which is in turn supported from frame 14. Drum assembly 10 includes an outer cylindrical drum shell 16 connected to shaft 17 which is supported at its opposite ends in bearing assemblies 18 and 20 connected to upstanding legs 14a and 14b of the frame. A suitable power source (not shown) rotates drum 16 through drive assembly 22 which is connected to shaft 17. Magnetic circuit assembly 24, of any well-known construction, is positioned within and is fixed with respect to drum 16 and cooperates with the drum to effect a separation of magnetic particles from a media passing through the tank in a manner to be described more completely hereinafter.

Tank 12 includes end walls 28 and 30 and these end walls carry brackets 26 which are suitably connected to frame 14 to mount the tank on the frame. The material to be processed, e.g. the magnetite containing water discussed above, is introduced into tank 12 through an inlet including feed box assembly 32. The media is fed through opening 34 in the feed box assembly into trough assembly 36 and spills over the trough assembly onto lower floor 38 of the feed box. The feed box assembly communicates with the tank 12 through opening 39 and bottom wall 38 of the feed box extends into the tank where it connects to bottom tank wall 40. Bottom wall 40 slopes downwardly and away from wall 38 into the tank and, with drum 16, defines flow passage 41 in which the media is confined within the influence of the magnetic field of magnet assembly 24. At a point substantially coincident with the vertical centerline A—A of drum 16, which is the point at which the direction of travel of drum 16 with respect to the liquid media changes, the bottom wall merges into a generally elliptical portion 42 which curves downwardly and away from the drum. Portion 42 is joined to L-shaped plate 43 which provides the bottom-most wall of a liquid media receiving chamber 45. Elliptical portion 42 and drum 16 cooperate to form a nozzle-like area 44 at the point of physical separation, namely the point at which the magnetic portion of the media being processed are physically separated from the remainder or non-magnetic portion of the media. Area 44 has a nozzle-like effect on the flowing fluid to reduce its rate of flow and provide a smooth transition of the media through the physical separation area with a minimum of turbulence.

The non-magnetic portion of the media being processed flows into chamber 45, which is defined by end plates 28 and 30, elliptical portion 42, L-shaped plate 43 and vertical wall 47, and passes from the chamber through conduits 48, 50 and 52 for removal as desired. Conduits 48, 50 and 52 provide restricted orifices through which the non-magnetic portion of the media flows from the tank and with proper selection of the flow rate of the media liquid can be made to back up in chamber 45 to maintain liquid media in contact with the drum. To limit the liquid media to a desired working level in the tank a secondary run off in the form of overflow assembly 54 is provided. More particularly, T-shaped plate 56 is connected to and held in spaced relationship from plate 47 by L-shaped brackets 57 and 58 forming horizontal trough 59 extending the length of tank 12 and vertical run off passage 60. Vertical plate 47 terminates in angular tip 62 which defines a weir which in turn determines the limit on the liquid level in the tank as indicated by dotted line L in FIG. 2.

Baffle 64 is spaced from elliptical portion 42 and forms a throat T therewith and also cooperates in defining the point at which the non-magnetic portions are physically separated from the magnetic portions adhered to drum 16. Baffle 64 extends the length of tank 12 and is spaced vertically above the elliptical portion 42 so as not to interfere with flow over the elliptical portion and cause turbulence. Structurally, the baffle includes planer plate 65 attached to an L-shaped plate 67. L-shaped plate 67 includes convex portion 68 which conforms generally to the configuration of drum 16 and arcuate portion 70

which connects convex portion 68 to planer plate 65. Portion 68 can be made to conform generally to the drum without any adverse effect on the separation process since it is positioned at a point where separation has virtually already been completed. Both L-shaped member 67 and plate 65 are connected to end plates 28 and 30 and separator plate 71 which is also connected to and extends between the end plates. Plate 65 and portion 68 are spaced apart a preselected distance to separate the liquid in chamber 45 from the magnetic field as will be described more particularly hereinafter.

Plate 71 is arranged to catch the magnetic portions of the media being processed as they leave the influence of the magnetic field of circuit 24 and separate from drum 16 and is also effective to direct the magnetic portions out of the tank.

The configuration of bottom wall 40 and its association with drum 16 will be specifically described with particular reference to FIG. 3. As illustrated, bottom wall 40 is made up of two separate sections, elliptical portion 42 forming one section and being welded to turned end 72 of a substantially straight portion 74 which forms the other section. Preferably, portion 74 extends parallel to a tangent to drum 16, rather than extending on an arc which conforms generally to the curvature of the drum, and it is disposed at a relatively shallow angle to the horizontal. For example an angle of approximately 15° has given satisfactory results whereas, in comparison, a typical prior art arrangement presented the media to the drum at approximately a 25° angle. This shallow angle provides a relatively gradual transition from bottom wall 38 of the feed box assembly to bottom wall 40 of the tank and reduces the head on the liquid as it flows through passage 41 which, together with portion 74 of the bottom wall being straight, provides a smooth flow of the liquid media through passage 41 and into nozzle area 44 where physical separation takes place. This smooth flow provides, as near as possible, laminar flow of the liquid media through passage 41 for optimum separation.

Although satisfactory results are obtained with a section 74 which is straight along its entire length, it has been found that separation and flow characteristics can be further optimized by forming the terminal portion 74a of member 74 at a slight angle to the remainder of portion 74 so that the terminal end follows and conforms somewhat to the configuration and path of travel of drum 16. This specific configuration of member 74 insures smooth laminar flow of the media up to the vertical centerline of the drum and begins the nozzle area at the point at which the magnetic particles change direction with respect to the media within the tank. In other words, the non-magnetic portions do not encounter a marked change in direction or begin to flow away from the magnetic portions until the magnetic portions themselves undergo a change in direction. This arrangement insures both a smooth, non-turbulent flow into the area of physical separation and provides maximum confinement of the media in the magnetic field.

In operation, the media to be processed is admitted into feed box 32 and flows from the feed box onto bottom wall 40 and into passage 41. The media flows smoothly into the passage and as it is exposed to the magnetic field of assembly 24 the magnetic particles are attracted toward the drum 16 whereas the non-magnetic portions remain adjacent bottom wall 40 thereby tending to assume a laminar type of flow. The straight line, shallow angle of bottom wall portion 74 offers a minimum of resistance and disturbance to flow so that the flow is virtually uninterrupted by the configuration of the bottom wall and can assume laminar characteristics. As the media flows past the vertical centerline of the drum it flows into enlarged area 44 which has a nozzle-type effect on the fluid in that it reduces the speed of the media and, furthermore, reduces turbulence at that point

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of physical separation of the magnetic and non-magnetic portions to a minimum. The magnetic portions adhering to the drum remain undisturbed and under the influence of the magnetic field follow drum 16 upwardly whereas the non-magnetic portions follow elliptical portion 42 downwardly into chamber 45. The non-magnetic portion of the liquid drains from the tank through conduits 48, 50 and 52 into a suitable receptacle where they can be disposed of or recirculated through separator 8. As discussed above the restricted orifices provided by conduits 48, 50 and 52 are insufficient to handle the flow of media into the tank and the liquid backs up into the tank and chamber 45 with overflow assembly 54 maintaining a maximum liquid working level in the tank. The thickness of baffle 64, i.e. the distance between plate 65 and 67, is desired since it spaces any magnetic portions which may remain entrained with the non-magnetic liquid from the magnetic circuit a sufficient distance to place these particles outside of the magnetic field so that they can fall back into chamber 45 and pass out with the non-magnetic liquid. As the magnetic portions travel upwardly past baffle assembly 64 they eventually leave the influence of the magnetic field of assembly 24 and separate from the drum. This separation occurs above separator plate 71 which is positioned in the area of the termination of the magnetic circuit and catches the magnetic portions as they fall and directs them out of the tank to a suitable receptacle (not shown) for accumulation and removal.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

We claim:

1. A magnetic drum separator comprising, in combination,

a tank,

a drum,

means supporting said drum for rotation relative to said tank,

a magnetic circuit adjacent said drum to generate a magnetic field over an arcuate portion of said drum,

a tank wall disposed in opposed relation to a portion of said arcuate drum portion and including a first

portion having a generally straight extension up to the vertical centerline of the drum and generally

parallel to a tangent to said drum and a generally arcuate portion extending from the vertical centerline of said drum generally downwardly and away

from said drum, said tank wall spaced from said drum a predetermined distance to cooperate there-

with in defining a passage to confine a liquid media in said magnetic field,

means for admitting a liquid media into said passage,

and means communicating with said arcuate portion of said drum and defining means for receiving liquid

media from said tank wall whereby magnetic portions of said liquid media are attracted to and travel

with said drum for separation from said non-magnetic portions of said liquid media which pass into

said liquid media receiving means.

2. A magnetic drum separator comprising, in combination,

a drum,

means supporting said drum for rotation,

a magnetic circuit supported adjacent to and limited generally to an arcuate portion of said drum,

tank wall means arranged in opposed relation with a portion of said arcuate portion of said drum and extending at an angle to the horizontal to and beyond

the vertical centerline of said drum, said wall means spaced from said drum but disposed in the magnetic

field of said magnetic circuit to define, with said

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drum, a passage for confining a liquid media within the magnetic field said tank wall including a portion extending from said centerline generally downwardly and away from said drum with said portion being curved on a radius located below said portion to form a gradually downwardly curved lip,

said portion and at least 10 degrees of the surface of said drum forming a divergent nozzle type contour

to effect a physical separation of the magnetic and non-magnetic portions of said liquid media while

controlling the flow of said liquid media and through said point of physical separation to increase its exposure to said magnetic field and reduce the amount

of turbulence at the point of physical separation,

and means spaced vertically above said tank wall adjacent the termination of said magnetic circuit and said drum to receive said magnetic portions as they

leave the influence of the magnetic field of said magnetic circuit and separate from said drum.

3. The magnetic separator of claim 2 wherein a major portion of the length of said wall means disposed upstream of said point of physical separation with respect to the direction of drum rotation extends parallel to a

tangent to said drum.

4. A magnetic drum separator comprising, in combination,

a tank,

a drum,

means supporting said drum for rotation relative to said tank,

inlet means for admitting liquid media into said tank,

a magnetic circuit supported in fixed relation adjacent the portion of said drum passing through said tank

to provide an attractive magnetic field over said drum portion to attract magnetic portions of said

liquid media to said drum,

means within said tank defining a chamber for receipt of said liquid media,

means defining a tank wall communicating with said inlet means and said chamber to receive said liquid

media from said inlet means and provide means for conveying said liquid media to said chamber, said

tank wall being spaced from said drum but disposed in the magnetic field of said magnetic circuit

to define, with said drum, a passage for confining said liquid media within the magnetic field of said

magnetic circuit and in contact with said drum so that the magnetic portions of said liquid media are

attracted to and carried by said drum away from said chamber while the non-magnetic portions of

said liquid media pass into said chamber,

said tank wall including an arcuate portion extending from said vertical centerline downwardly and away

from said drum into said chamber to thereby define, with said drum, a nozzle-like area at the point of

physical separation of said magnetic portions from said non-magnetic portions so that said tank wall

and drum extend along divergent paths with respect to each other from substantially said vertical centerline and physical separation occurs with a minimum

of turbulence,

and said tank wall including a generally straight portion extending from said inlet means and merging

with said arcuate portion with the end of said straight portion merging with said arcuate portion

including a straight portion disposed at an angle to the remainder of said straight portion and extending

parallel to a tangent to said drum from a point substantially aligned with the point at which magnetic

portions adhered to said drum change direction with respect to said first straight portion.

5. A magnetic drum separator comprising, in combination,

a tank,

a drum,

means supporting said drum for rotation relative to said tank,
 inlet means for admitting liquid media into said tank,
 a magnetic circuit supported in fixed relation adjacent the portion of said drum passing through said tank to provide an attractive magnetic field over said drum portion to attract magnetic portions of said liquid media to said drum,
 means within said tank defining a chamber for receipt of said liquid media,
 means defining a tank wall communicating with said inlet means and said chamber to receive said liquid media from said inlet means and provide means for conveying said liquid media to said chamber, said tank wall being spaced from said drum but disposed in the magnetic field of said magnetic circuit to define, with said drum, a passage for confining said liquid media within the magnetic field of said magnetic circuit and in contact with said drum so that the magnetic portions of said liquid media are attracted to and carried by said drum away from said chamber while the non-magnetic portions of said liquid media pass into said chamber,
 said tank wall including an arcuate portion extending from said vertical centerline downwardly and away from said drum into said chamber to thereby define, with said drum, a nozzle-like area at the point of physical separation of said magnetic portions from said non-magnetic portions so that said tank wall and drum extend along divergent paths with respect to each other from substantially said vertical centerline and physical separation occurs with a minimum of turbulence,
 and said tank wall also including a generally straight portion disposed at a shallow angle to the horizontal so that said media approaches said point of physical separation with a minimum of turbulence.
 6. A magnetic separator comprising, in combination, a tank,
 a drum,
 means supporting said drum for rotation with respect to said tank,
 inlet means for admitting a liquid media to said tank,
 means defining means for draining said liquid media from said tank and cooperating with said inlet means to maintain a predetermined level of liquid media in said tank sufficient to extend over a portion of said drum so that a portion of said drum rotates through said liquid media,
 a magnetic circuit supported in fixed relation within said drum and extending adjacent the portion of said drum rotating through said liquid media to provide an attractive magnetic field over said tank portion to attract magnetic portions of said liquid media to said drum for rotation therewith,
 means defining a liquid media flow path from said inlet means into said tank and including a tank wall com-

municating with said inlet means and spaced from said drum a predetermined distance to define, with said drum, a passage confining said liquid media within said magnetic field, said tank wall extending beyond the vertical centerline of said drum to define a controlled flow path for said liquid media through the point at which physical separation of said magnetic and non-magnetic portions occurs,
 said tank wall including an arcuate portion extending vertically downward and away from said drum toward said first drain to thereby define, with said drum, a nozzle-like area at said point of physical separation so that said physical separation occurs with a minimum of turbulence and also including a generally straight portion extending from said inlet means to the vertical centerline of said drum so that said media approaches said point of physical separation with a minimum of turbulence.
 separating means spaced vertically above said point of physical separation and positioned adjacent said drum to receive said magnetic portions from said drum as they leave the influence of said magnetic field and separate from said drum,
 said drain means including means defining a first drain disposed vertically below said point of physical separation and an overflow including a second drain and a weir disposed between said first and second drains, said weir extending to a point spaced vertically above said point of physical separation and the lowermost point of said drum to cooperate with said inlet means and said first drain in defining the level of liquid media in said tank,
 and baffle means spaced from said tank wall in the direction of rotation of said drum and extending co-extensively with a portion of said drum toward said separating means and between said drum and said weir, said baffle means having a portion facing said drum and disposed in said magnetic field and having an extension transversely of said path of rotation to provide a second portion facing away from said drum and disposed out of said magnetic field.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,360,126

December 26, 1967

Raymond L. Watts et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 2, after "field" insert -- of said magnetic circuit, --.

Signed and sealed this 14th day of January 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents