Oct. 27, 1964 K. E. VOGEL 3,154,295

VORTEX SEAL

Filed Oct. 1, 1963 2 Sheets-Sheet 1

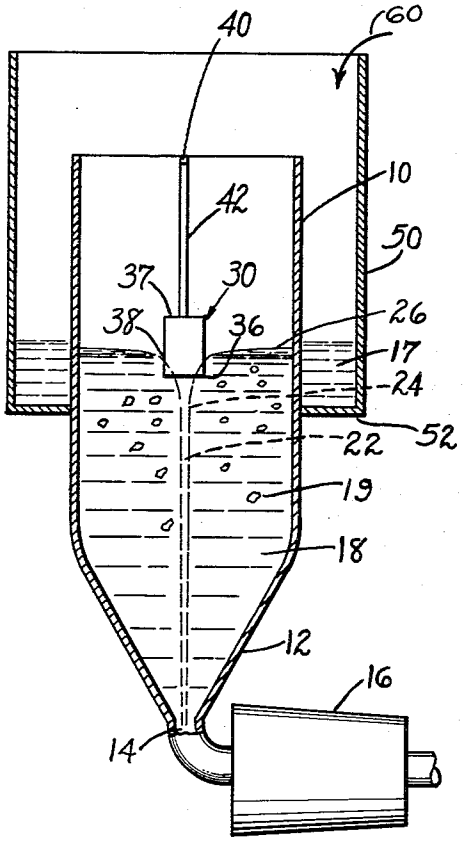


Fig. 1.

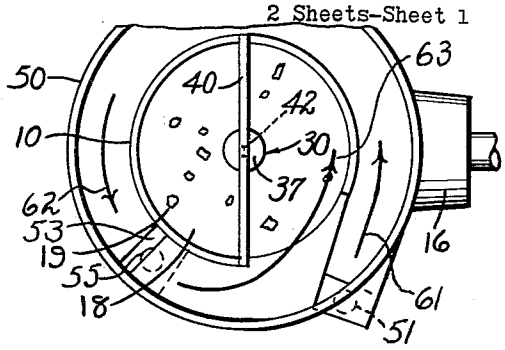


Fig. 2.

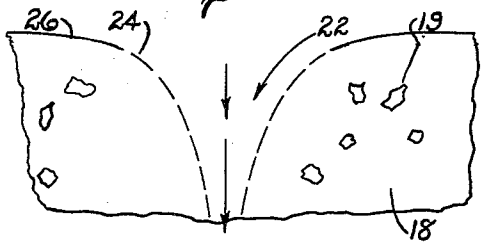


Fig. 3.

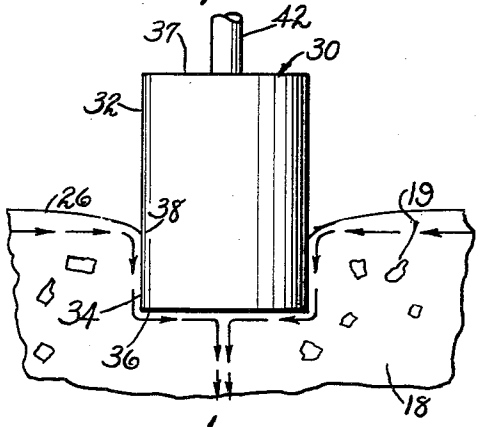


Fig. 4.

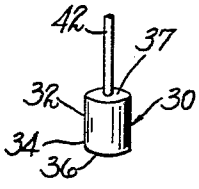


Fig. 5.

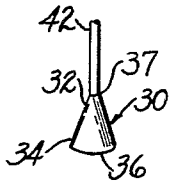


Fig. 6.

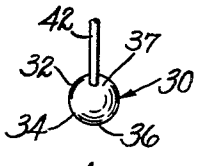


Fig. 7.

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VORTEX SEAL

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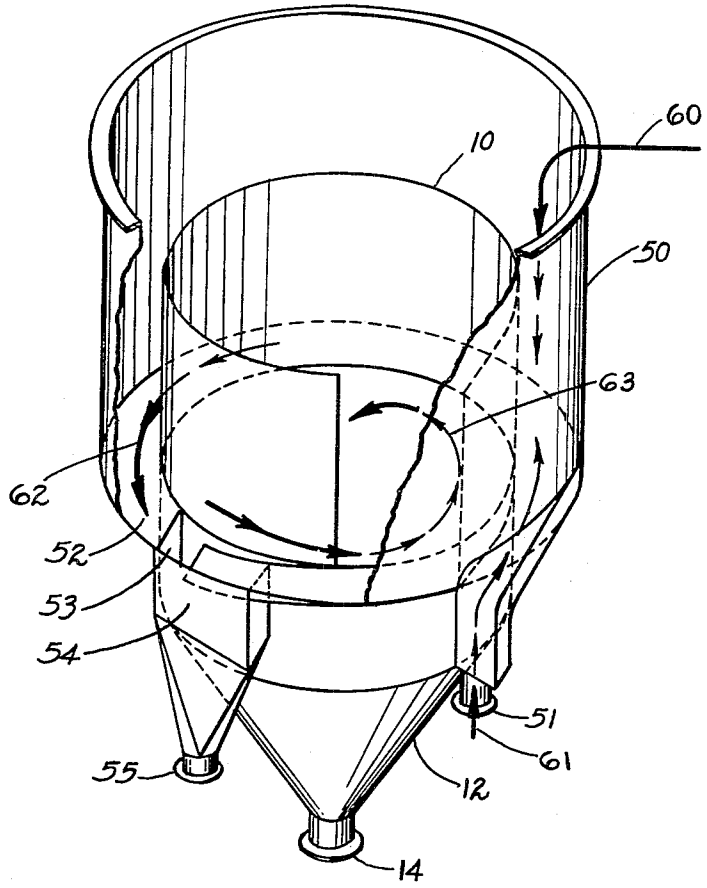


Fig. 8.

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VORTEX SEAL

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19 Claims. (Cl. 259—36)

This invention relates to a chamber for mixing materials in which a vortex is formed and to means for sealing the vortex from the atmosphere. More particularly this invention relates to means for preventing the ingestion of air by a pump which is fed from such a chamber.

In continuous pulping operations in the paper making industry wood chips are mixed with liquor prior to their reduction to pulp. In some instances this mixing takes place in a tall cylindrical mixing chamber having a conical bottom and having an outlet, axially disposed in the bottom, which leads to a pump and thence to a digester. As chips and liquor are continuously added to the chamber near the top thereof and are continuously withdrawn through the outlet at the bottom thereof, a vortex forms along the axis of the chamber. The vortex has two undesirable effects however: (1) it hinders vital wetting of the chips which tend to float on the vortex surface; and (2) it results in the ingestion of air into the pump and thence into the digester where it has a deleterious effect on the cooking process.

The problem of air ingestion is particularly acute where the pump is one similar to that described in the patent to J. P. Rich et al., Patent No. 2,908,226, dated October 13, 1959, for such a pump will pump air as well as liquor and the air will certainly be transferred into the digester.

On the other hand, it is important that any seal for a vortex in such a chamber not impede the free flow of chips and also that it not result in a buildup about the seal of chips which might break off periodically to plug the outlet and the pump.

Thus, it is a prime object of the invention to provide, in such a mixing chamber, means for sealing a vortex from the surrounding atmosphere.

It is another object of this invention to provide vortex sealing means which will aid the vital wetting process.

And it is a further object of this invention to provide vortex sealing means which will neither hinder the flow of material in the chamber nor result in a buildup of solids about the sealing means.

To accomplish these and other objects of the present invention, in a chamber in which such a vortex is formed, a seal body having air impervious walls is provided. The seal body is of circular cross-section and is positioned within the chamber with its axis along the vortex axis. The seal body is positioned in the vortex, the bottom thereof being spaced from the chamber bottom. The upper portion of the seal body is either positioned above the vortex surface or has a configuration with no horizontally extending flat portion. The lower portion of the seal body is positioned at least as low as the uppermost portion of the vortex surface. On one portion of the seal body is a vortex contacting portion having a diameter equal to the maximum diameter of the vortex at the point to which said portion is suspended. Also provided are means for suspending the seal body within the chamber.

These and other objects, features and advantages of the present invention will be apparent to those skilled in the art from the following detailed description thereof together with the accompanying drawings wherein:

FIG. 1 is a partially diagrammatic side elevation partly in section of a mixing chamber embodying a preferred embodiment of the present invention;

FIG. 2 is a plan view of the chamber shown in FIG. 1;

FIG. 3 is an enlarged view of a portion of FIG. 1 showing the vortex surface as it appears unsealed;

FIG. 4 is a view similar to FIG. 3 showing a sealed vortex;

FIGS. 5, 6 and 7 are each isometric views of alternate preferred embodiments of an element of the invention disclosed in FIG. 1; and

FIG. 8 is an enlarged detail isometric view, partly in section, of a preferred form of the mixing chamber shown in FIG. 1.

Having reference now to the drawings and more particularly to FIGS. 1, 2 and 8 thereof, a mixing chamber is provided which has a cylindrical wall **10**.

Preferably, liquid **17**, **18** is fed tangentially to the cylindrical wall **10** from a tramp metal separation trough formed about the mixing chamber by a cylindrical wall **50** and an annular wall **52**. The trough is fed through inlet **51** in the base thereof and the liquid **17** therein then follows a path **61**, **62**, **63** into the mixing chamber. Preferably, the trough has a trap, FIG. 8, for removing deleterious solids, such as metallic and mineral matter, comprising an opening **53** in the annular wall **52** and an associated area **54** for collecting the trapped material. The trap has an outlet **55** which is normally provided with a valve (not shown) for periodically removing the trapped material.

The bottom **12** of the mixing chamber preferably comprises an inverted frustro-conical section leading to an axially disposed discharge outlet **14**. The discharge **14** in turn leads to a pump **16** which may be a pump of the type described in the Rich patent, supra, and which in turn feeds a digester (not shown). As the liquid **18** is fed into the mixing chamber and pumped therethrough a vortex **22** is formed therein having a vortex surface **24** extending outwardly at the upper portion of the mixing chamber to the cylindrical wall **10** thereof as shown in FIGS. 1 and 3 partially in broken and partially in solid lines.

To seal the vortex which ordinarily would form in such a chamber, a seal body **30** which has a circular cross-section and which has air impervious walls, is suspended in the chamber with its axis being positioned along the axis of the vortex. While a hollow body of cylindrical shape (FIG. 5) is preferred, the seal body may be of any geometric shape having a circular cross-section such as a cone, FIG. 6, or a sphere, FIG. 7, and may be hollow or solid as desired so long as the side wall and the top **37** and bottom **36** wall surfaces are air impervious. The side wall surfaces of the seal body may be visualized as comprising upper **32** and lower **34** side wall surfaces, the upper side wall surface being positioned above the vortex surface **24** but preferably at least partially below the uppermost portion **26** of said vortex surface. The lower side wall surface is positioned at least at the uppermost portion of the vortex surface and

preferably therebelow. The bottom **36** of the seal body is spaced from the discharge outlet **14**.

On the lower side wall surface **24** of the seal body is a vortex contacting portion **38** the diameter of which is equal to the greatest diameter of the vortex **22** at the point in the chamber at which the vortex contacting portion is positioned. Preferably, the lower wall surface **34** extends below the vortex contacting portion **38** and at some point therebelow has a diameter which is in the range of 120–200% as large as the diameter of the vortex at that point. Thus, if the vortex diameter should for any reason widen at the vortex contacting portion, usually due to a lowering of the liquid level in the chamber, there will still be a sealing portion on the seal body **30**.

In the case of a sphere, FIG. 7, or a cone having its apex at the top, FIG. 6, wherein the top thereof does not present any horizontally extending flat surface, it is possible, although not deemed preferable, to place substantially the entire body below the vortex surface. In this event the top **37** or upper wall surface **32** may or may not be wholly submerged, but in any event, for present descriptive purposes, becomes the vortex contacting portion **38**.

Means are also provided to suspend the seal body in the chamber. This may, as shown in FIGS. 1 and 2, be a very simple arrangement comprising a cross-support **40** resting on the top of the chamber having a supporting rod **42** extending therefrom to the seal body. Or such means may be any other suitable device such as a chain limiting the maximum depth to which the seal body can extend. This latter arrangement has the advantage of permitting the seal body to follow the vortex if it is unstable and shift position and is particularly useful with a spherical seal body which has flotation characteristics.

In operation the seal body is suspended in the chamber as shown in FIGS. 1 and 2. The liquid **17** is then continuously fed into the separation trough through inlet **51**, mixed with wood chips **19**, fed into the trough at **60**, and circulated over the trap **53**, **54**, where any deleterious metal or mineral material is removed. Preferably the flow rate is in the range of 1–6 feet per second to permit any deleterious material to be properly separated from the liquid, chip mixture. The mixture is then directed into the mixing chamber. A vortex **22** tends to form as mixing and pumping progress but the diameter of the vortex and the vortex contacting portion **38** of the seal body **30** being equal, the area beneath the seal body is sealed from the atmosphere and filled with liquid which prevents ingestion of air into the pump **16** and the digester (not shown) and which aids the chip wetting process. The flow of chips **19** adjacent surface of the vortex is not impeded as the current in the liquid **18**, see the arrows in FIG. 4, is substantially the same with the seal body as without it, see FIG. 3, the only difference being that the current follows the contour of the seal body. Finally, the buildup of chips around the seal body is avoided by having the upper side wall surface extend above the vortex surface, thus avoiding the presentation of any flat surface on which the chips could collect.

Where a cone or sphere is used and is placed substantially completely below the vortex surface, as aforementioned, the operation is identical, but in this case the buildup of chips on the top thereof is avoided by the configuration of the seal body at the top, the top having no horizontally extending flat surface.

It will be understood by those skilled in the art that many variations and modifications of the apparatus heretofore described may be made which are nevertheless fully within the spirit and scope of the invention, wherefore nothing heretofore said is intended to limit the scope of the appended claims.

What is claimed is:

1. In a chamber for mixing materials wherein a vortex is formed during the mixing process, said chamber having a bottom and side walls, a vortex seal for sealing said vortex from the atmosphere comprising:
   - a seal body and means for suspending said seal body within said chamber;
   - said seal body being of circular cross section and having upper and lower side wall surfaces and top and bottom wall surfaces, said wall surfaces being air impervious;
   - said seal body having its axis positioned along that of said vortex within said chamber and having its bottom spaced from the bottom of said chamber;
   - said upper wall surface being positioned in said chamber above the surface of said vortex and said lower wall surface being positioned at least as low as the uppermost portion of said vortex surface; and
   - said lower wall surface having a vortex contacting portion thereof which has a diameter equal to the maximum diameter of said vortex at the point in said chamber at which said vortex contacting portion is positioned.

2. The vortex seal claimed in claim 1 wherein said lower wall surface is positioned below the uppermost portion of said vortex.

3. The vortex seal claimed in claim 2 wherein said lower wall surface extends below said vortex contacting portion.

4. The vortex seal claimed in claim 3 wherein said lower wall surface at a point below said vortex contacting portion has a diameter in the range of 120–200% as large as that of said vortex at said point.

5. The vortex seal claimed in claim 4 wherein said seal body is cylindrical.

6. The vortex seal claimed in claim 4 wherein said seal body is conical.

7. The vortex seal claimed in claim 4 wherein said seal body is spherical.

8. The vortex seal claimed in claim 6 wherein the apex of said cone is at said top, wherein said side wall surfaces are positioned below said surface of said vortex, and wherein said vortex contacting portion is adjacent said top wall surface.

9. The vortex seal claimed in claim 7 wherein said side-wall surfaces are positioned below said surface of said vortex, and wherein said vortex contacting portion is adjacent said top wall surface.

10. A vortex sealed mixing chamber wherein a vortex is formed during the mixing process comprising:
   - a chamber having side and bottom walls; and
   - a seal body and means for suspending said seal body within said chamber;
   - said seal body being of circular cross section and having upper and lower side wall surfaces and top and bottom wall surfaces, said wall surfaces being air impervious;
   - said seal body having its axis positioned along that of said vortex within said chamber and having its bottom spaced from the bottom of said chamber;
   - said upper wall surface being positioned in said chamber above the surface of said vortex and said lower wall surface being positioned at least as low as the uppermost portion of said vortex surface; and
   - said lower wall surface having a vortex contacting portion thereof which has a diameter equal to the maximum diameter of said vortex at the point in said chamber at which said vortex contacting portion is positioned.

11. The mixing chamber claimed in claim 10 wherein said side walls of said chamber are cylindrical, wherein said bottom wall of said chamber is an inverted frustroconical section having a discharge opening disposed therein along the axis of said chamber, and wherein said axis of said seal body is also positioned along the axis of said chamber.

12. The mixing chamber claimed in claim 11 wherein

said lower wall surface is positioned below the uppermost portion of said vortex.

13. The mixing chamber claimed in claim 12 wherein said lower wall surface extends below said vortex contacting portion.

14. The mixing chamber claimed in claim 13 wherein said lower wall surface at a point below said vortex contacting portion has a diameter in the range of 120–200% as large as that of said vortex at said point.

15. The mixing chamber claimed in claim 14 wherein said seal body is cylindrical.

16. The mixing chamber claimed in claim 14 wherein said seal body is conical.

17. The mixing chamber claimed in claim 14 wherein said seal body is spherical.

18. The mixing chamber claimed in claim 16 wherein the apex of said cone is at said top, wherein said side wall surfaces are positioned below said surface of said vortex, and wherein said vortex contacting portion is adjacent said top wall surface.

19. The mixing chamber claimed in claim 17 wherein said side wall surfaces are positioned below said surface of said vortex, and wherein said vortex contacting portion is adjacent said top wall surface.

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