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AGITATION DEVICE

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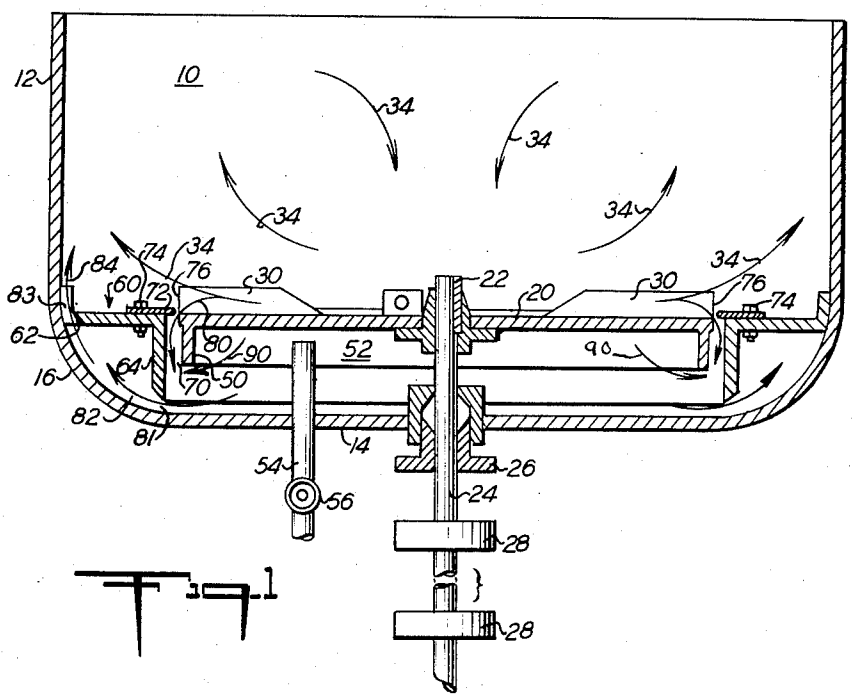

FIG. 1

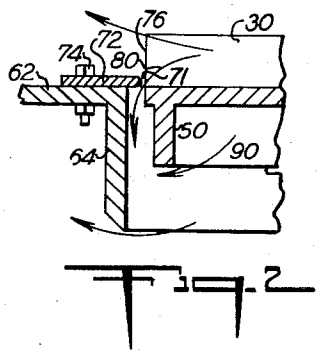

FIG. 2

FIG. 3

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AGITATION DEVICE

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This invention relates to apparatus for subjecting liquid-solid mixtures to an intense mechanical agitation. The apparatus is useful for many purposes as, for example, in the aid of mechano-chemical reactions, a typical use being in the paper industry as a pulper for converting a charge of liquid and cellulosic or other fibrous material into a pulp suitable for use in paper making.

The primary object of the invention is to reduce the power consumption demanded by such apparatus. In accordance with the preferred embodiment of my invention a rotor, submerged in a solids-liquid suspension, is formed on its under surface with a chamber for the reception of gas which is retained as a layer intervening between the under rotor surface and the surrounding liquid for relieving certain areas of the rotor surface of frictional contact with the surrounding liquid, in cooperation with passages for the conducting of liquid air mixtures in proximity to the rotor in a manner and for a purpose which will appear.

In the drawing:

Fig. 1 is a vertical section of my apparatus;

Fig. 2 is a detail vertical section of certain parts on enlarged scale, and

Fig. 3 is a plan view of the rotor showing a modification.

Referring to the drawing, the vessel **10** has side walls **12** and a bottom **14** meeting, in the embodiment illustrated, in the curved portion **16**. The vessel shown is vertically disposed and suitably supported.

Within the vessel, in its lower portion, is the rotor disc **20** horizontally disposed and secured as by key **22** to shaft **24** entering the vessel through stuffing box **26** to minimize leakage of the liquid contents of the vessel around the shaft. The shaft is suitably supported as by the bearings **28** and is power driven so that the rotor **20** rotates at a high rate of speed.

The upper surface of the disc is formed with a plurality of blades or vanes **30** which may extend radially, as indicated in Fig. 1, or they may be disposed at an angular inclination, as indicated at **30***a* in Fig. 3, or in any of the conventional ways employed, for example, in pulpers used in the pulp and paper industry. Fig. 3 also shows a second series of vanes **30***b* disposed toward the axis of the shaft, although this is a modification which may or may not be employed. The function of the vanes, as is well known, is to induce an intense mechanical agitation in the solids-liquid suspension in which the rotor is rotated at high speed, effecting a vortex-like circulation in the vessel as indicated by the arrows **34**.

In accordance with the preferred embodiment of my invention illustrated in the drawing, the rotor is formed with an annular depending flange **50**, preferably at or adjacent the periphery of the disc, forming a chamber **52** on the under surface of the disc. Into this chamber protrudes a pipe **54**, suitably valved as at **56**, to conduct air or gas under pressure into the chamber **52**.

The rotor **20** may be of the order of 6 feet or more in diameter in some installations. It is surrounded by a

fixed annular member **60** formed of a horizontal flange **62** and a vertical flange **64** integrally joined and merging with each other at right angles. The member **60** is mounted in stationary position in the vessel and its vertical flange **64** is spaced from the vertical flange **50** of the rotor to form a cylindrical annular chamber **70**. Superposed on the horizontal stationary flange **62** of the member **60** is a ring **72** of hardened material, replaceably mounted on the member **60** as by bolts **74** and extending horizontally inwardly into close proximity to the outer edges **76** of the vanes **30** with minimum operating clearance therefrom. The plane of the upper surface of the stationary horizontal flange **62** preferably lies in the plane of the upper surface of the rotor disc **20** so that the ring **72**, being superposed on the flange **62** has its lower surface in the plane of the upper surface of the rotor disc **20**. The inner edge of the ring **72** is beveled to afford a restricted annular opening **71** between the ring **72** and the outer periphery of the upper surface of the disc **20**. The arrow **80** shows flow of material therethrough in a manner to be described.

The vertical flange **64** of the member **60** extends downwardly below the plane of the bottom of the flange **50** into proximity with but spaced from the bottom **14** of the vessel to form a passage **81** therebetween. The arrow **82** indicates the flow of material through this passage.

The horizontal flange **62** of the member **60** protrudes into proximity with the side wall **12** of the vessel but is spaced therefrom to form a further annular passage **83**. Arrow **84** indicates flow of material therethrough.

With the apparatus constructed as above described its operation is as follows:

Conveniently the liquid component of the charge is first led into the vessel and the rotor is then started. This induces the vortex-like circulation which is indicated in the drawing by the several arrows designated **34**. The material to be pulped or otherwise treated mechanically is then charged into the vessel usually in chunks, bales or other large pieces. The proportion of solids to liquid is preferably such as to produce an ultimate suspension of high density.

Air or gas under pressure is admitted through the conduit **54** and fills the chamber **52** completely, after which the air or gas commences to flow outwardly around the lower edge of the rotating vertical flange **50**, as indicated by the arrows **90**. The gas flowing around the bottom of the flange **50** will flow into the annular chamber **70** but cannot escape vertically therefrom through opening **71** because it is met by the greater dynamic pressure of the liquid material being forced through opening **71** in the opposite direction as indicated by the arrow **80**. The gas escapes from the chamber **70** in the direction of low pressure following the direction of arrow **82** joining the flow of deflected liquid moving in the same direction and the liquid and gaseous mixture then flows out from beneath the horizontal flange **62** in the direction of the arrow **84**, through the passage **83**.

In operation the layer of gas interposed between the under surface of the rotor disc **20** and the surrounding liquid frees the disc of the friction that would otherwise be created between the lower surface of the disc and the surrounding liquid during the rotation of the disc. In practice I have found that the gas layer thus provided reduces substantially the power required to rotate the disc without in any way diminishing the effectiveness of the apparatus for vigorously agitating the material with which the vessel is charged.

The air entrapped in the chamber **70** is also effective to reduce the friction between the rotor and the surrounding liquid. The rotor vanes **30** throw the liquid, such as the pulp suspension, against the edge of the ring **72**. Some pulp will be deflected and pass with con-

siderable force through the narrow clearance space, following the path shown by arrow **80**. However, any liquid or pulp suspension which is forced against the outer surface of the rotating vertical flange **50** is thrown outwardly through the gas within the chamber **70** ultimately to flow to the bottom of the annular chamber **70** and thence outwardly with the gas through the course designated by arrows **82** and **84**. Thus a mixture of gas and liquid material will flow continuously in the direction of arrow **84** being eventually drawn into the general circulation of the vessel indicated by arrows **34**.

It is a feature of my invention that the apparatus is substantially relieved of the power demand heretofore imposed by friction between the liquid and those parts of the rotor surface which do no effective work in the intense agitation of the mix which the apparatus performs. As the result of my invention, a considerably greater proportion of the horsepower consumed is utilized in work done between the upper vaned surface of the disc and the liquid-solids suspension in contact therewith.

I claim:

1. In apparatus of the character described the combination of a vessel adapted to contain a charge of liquid material, a rotor impeller disc located in the lower portion of said vessel for submerged rotation in the liquid about a vertical axis, a shaft carrying said disc, means for driving the shaft to rotate the disc, a conduit leading into proximity to the under surface of the disc for conducting gas thereto, an annular flange extending downwardly from the under surface of the disc to form a chamber for the retention of a layer of gas contiguous to the under surface of the disc and between it and the surrounding liquid, a second annular flange surrounding the first annular flange concentrically therewith and stationarily mounted to form an annular chamber with the first flange adapted to receive gas overflowing from the first chamber around the lower extremity of the first flange, the second flange extending downwardly below the lower extremity of the first flange to restrain the escape of gas downwardly from the annular chamber and means for restraining the escape of gas upwardly from the annular chamber.

2. In apparatus of the character described the combination of a vessel adapted to contain a charge of liquid material, a rotor impeller disc located within the vessel for submerged rotation in the liquid and having vanes on its upper surface for mechanically agitating the liquid material within the vessel, means for rotating the impeller disc, a conduit leading into proximity to the undersurface of the disc for conducting gas thereto, a depending annular flange in proximity to the outer periphery of the disc to restrain the flow of gas out from under the disc, an annular chamber laterally surrounding the flange above the lower edge of the flange to receive and confine the gas escaping around the lower edge of the flange, passage means in the upper part of the chamber in communication with the interior of the vessel for conducting liquid downwardly into the chamber from the vessel, and passage means forming a communication between the lower portion of the chamber and the interior of the vessel adjacent its side walls for conducting a mixture of liquid and gas from the chamber into the interior of the vessel, whereby the rotational friction between the impeller disc and the surrounding liquid is reduced by the maintenance of a film of gas between the lower surface of the disc and the surrounding liquid and between the inner and outer surfaces of the flange and the surrounding liquid.

3. In a low power consumption agitator for subjecting liquid-solid mixtures to an intense mechanical agitation, the combination of a vessel adapted to contain a charge of the mixture to be agitated, an impeller located in the vessel for submersion in the liquid with which the vessel is charged, a series of vanes on the upper surface of the impeller to subject the mixture to an intense frictional agitation as the impeller is rotated, the lower surface of the impeller being devoid of vanes, power supply means for driving the impeller with a rotary motion with a force adaquate to drive the vanes through the mixture to effect such agitation, and means for minimizing the power consumed by friction from the said lower surface of the impeller during its rotation, said means comprising means for delivering gas in proximity to said lower surface, a substantially impervious wall for restraining escape of the gas so delivered to provide a constantly retained layer of gas between said lower surface and the surrounding liquid and means cooperating with said substantially impervious wall for inhibiting the escape of gas from the periphery of the impeller into the surrounding liquid.

4. In a low power consumption agitator for subjecting liquid-solid mixtures to an intense mechanical agitation, the combination of a vessel adapted to contain a charge of the mixture to be agitated, an impeller, in the form of a flat circular plate, located in the vessel for submersion in the liquid with which the vessel is charged, a series of vanes on the upper surface of the impeller to subject the mixture to an intense frictional agitation as the impeller is rotated, the lower surface of the impeller being devoid of vanes, power supply means for driving the impeller with a rotary motion with a force adequate to drive the vanes through the mixture to effect such agitation, means for delivering gas in proximity to said lower surface, and a substantially impervious annular flange depending substantially normally from said flat circular plate to restrain escape of the gas so delivered and to retain a layer of gas between said lower surface and the surrounding liquid to minimize the friction of rotational movement of said surface.

5. In a low power consumption agitator for subjecting liquid-solid mixtures to an intense mechanical agitation, the combination of a vessel adapted to contain a charge of the mixture to be agitated, an impeller in the form of a flat circular disc located in the vessel for submersion in the liquid with which the vessel is charged, a series of vanes on the upper surface of the impeller disc to subject the mixture to an intense frictional agitation as the impeller is rotated, the lower surface of the impeller disc being devoid of vanes, power supply means for driving the impeller with a rotary motion with a force adequate to drive the vanes through the mixture to effect such agitation, means for delivering gas in proximity to said lower surface, a substantially impervious annular flange depending substantially normally from said flat circular disc to restrain escape of the gas so delivered and to retain a layer of gas between said lower surface and the surrounding liquid to minimize the friction of rotational movement of said surface, a stationary annular ring surrounding the disc and projecting into close proximity to the said upper surface carrying the said vanes, and a second annular flange stationarily mounted and depending from said ring to form an annular chamber surrounding said first flange to minimize the friction of rotation of said first flange by retaining a supply of gas in contact with the outer surface of said first flange.

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