

Oct. 27, 1953

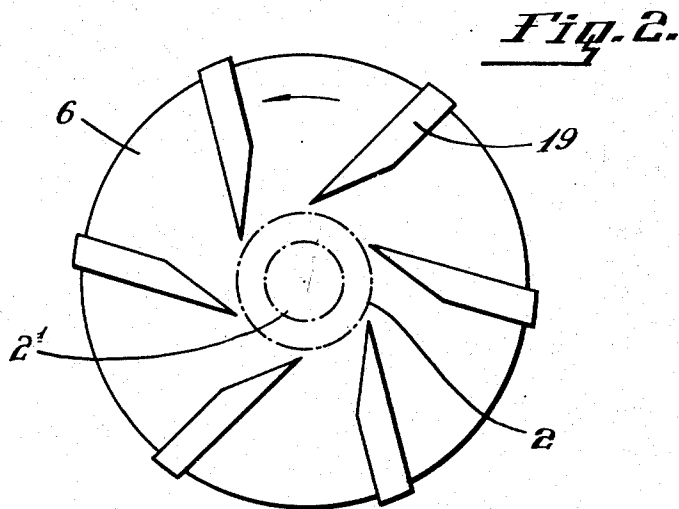
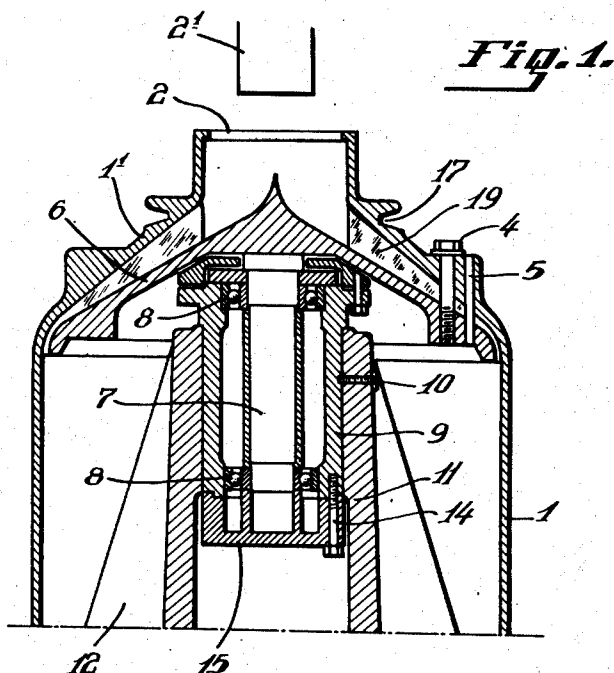
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CENTRIFUGAL APPARATUS FOR MIXING GASES AND LIQUIDS

Filed Oct. 4, 1950

4 Sheets-Sheet 1



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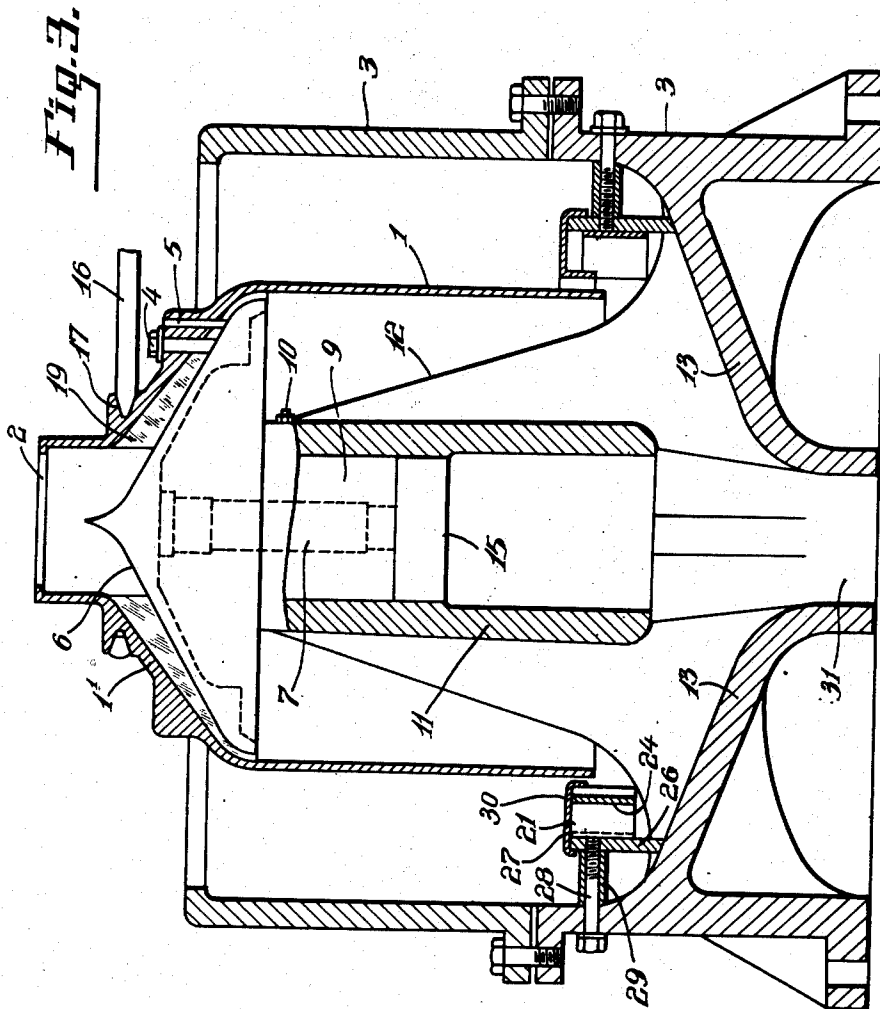
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4 Sheets-Sheet 2



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Fig. 4.

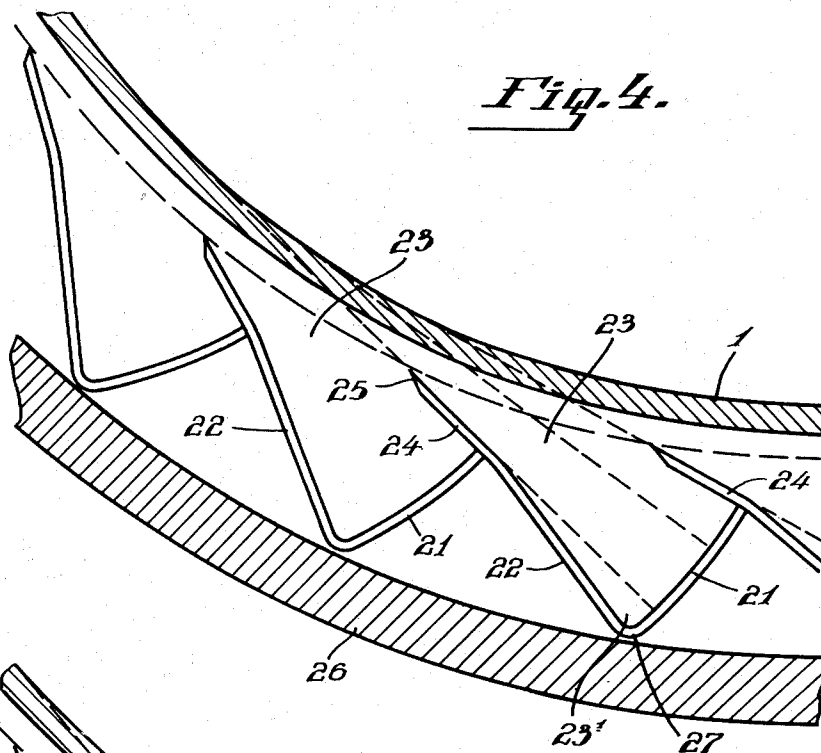
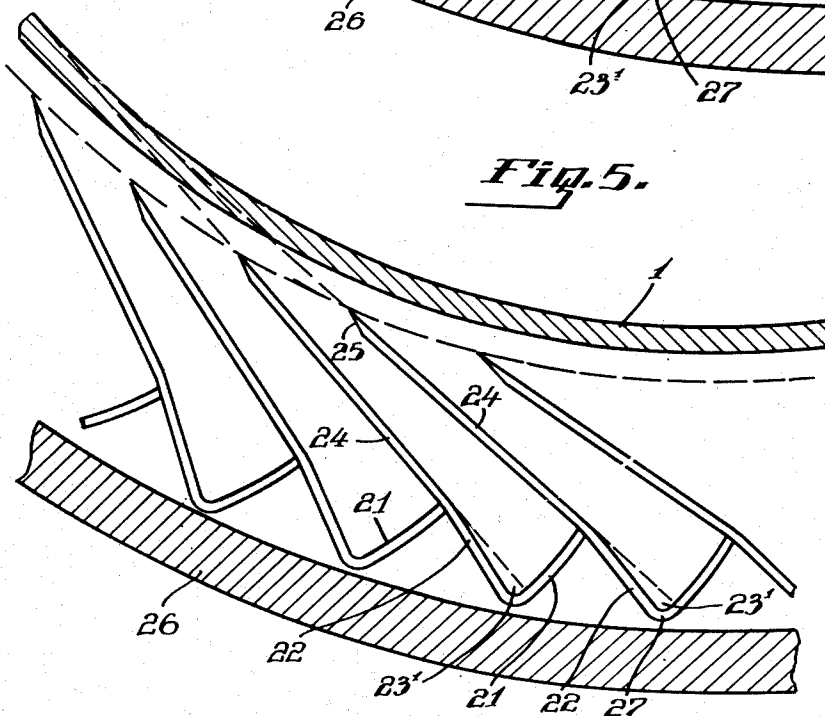


Fig. 5.



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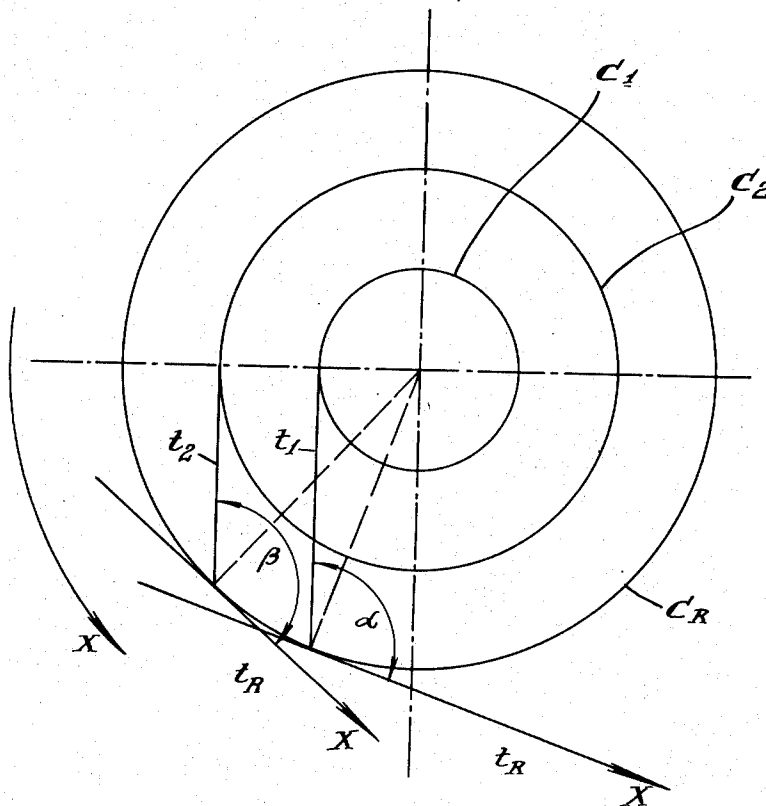
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4 Sheets-Sheet 4

Fig. 6.



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UNITED STATES PATENT OFFICE

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CENTRIFUGAL APPARATUS FOR MIXING
GASES AND LIQUIDS

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5 Claims. (Cl. 261-84)

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My present invention relates to a centrifuging apparatus comprising a rotary vat or cylinder capable of carrying along a liquid or a mixture of liquids simultaneously with air, a gas or a mixture of gases in order to let them subsequently escape in the form of a sheet or of very thin jets directed against a receiving wall.

In the United States patent application No. 142,866 of February 7, 1950, there has been described and claimed a process for the separation of one or more constituents in suspension in a mother liquor, and more particularly of micellae or other particles which may flocculate within a liquid phase.

One of the objects aimed at by the present invention is to provide a machine which is capable of carrying out this process in commercial practice, but which could likewise be utilized with respect to other applications.

The invention is based on the discovery that in the case of a centrifuging apparatus, the liquid leaving the rotary vat or cylinder, reaches the receiving wall with a kinetic energy which is composed of two components, one of which is perpendicular to said wall and the other is tangential to the latter at the same point considered.

It is to be noted that the trajectory of the liquid, which is tangential to the discharge circle, increases in proportion to the increase of the diameter of discharge of the liquid from the vat if the radial distance between the receiving wall and the discharge circle of the liquid is kept constant. Since the path of the liquid increases, its spreading increases, too, and consequently at the moment of impact against the receiving wall the kinetic energy of the liquid diminishes, and does so the more since one has to take additionally into account the friction of the liquid in the air or in the ambient gases.

In other words, when the trajectory grows, the unit mass of liquid as well as the velocity of the liquid diminish; hence a decrease in the kinetic energy which has been imparted initially on the liquid.

In order to preserve to the liquid or to the liquid-gas mixture at the moment of impact the maximum of kinetic energy acquired owing to the rotation of the vat or cylinder, it is necessary to place the circle on which the liquid or the mixture of gas and liquid from the vat is received as near as possible to it.

Now then it will be noted that the angle α or β (Figure 6) included between the trajectory (t_1 or t_2) of the liquid or of the mixture of liquid and gas emerging from the vat at any point of

the discharge circle C_1 or C_2 and the tangent t_R to the receiving circle C_R at the corresponding theoretical point of impact increases the more, the more the circle of discharge from the vat approaches the circles of the impact C_R (angle β being larger than angle α) so as to become theoretically eventually equal to 180° , for which angle the two tangents are in alignment with one another. In order to place the angles in question hereinabove correctly, one considers those of the angles as positive which are included between the trajectories (t_1 or t_2) of the liquid and the tangent t_R to the receiving circle C_R in the portion of the latter, the sense of which corresponds to the sense of rotation of the vat or cylinder.

At the theoretical point of impact this kinetic energy can be resolved into two components: one perpendicular to the receiving circle, and the other tangential at the same point of the circle. These two components are perpendicular to one another.

The component in the direction of the tangent to the receiving circle determines naturally a spiral movement of rotation of the liquid on the receiving circle whereas the other component corresponds to the desired kinetic energy of impact.

It need not be demonstrated that this impact would be a maximum if the receiving wall were perpendicular to the trajectory of emergence of the liquid and if the spreading of the said liquid were reduced to zero: provided, that the velocity of the liquid at the moment of its reception were equal to that which it had acquired at the moment of its leaving the vat (apart from the resistance to its displacement in the medium).

These conditions cannot be fulfilled if the receiving circle is constituted by a circular crown concentric to the circle of emergence of the liquid, whatever be the distance provided between said circular crown of reception and the circle of discharge of the liquid from the vat.

Therefore in order to attain outputs of commercial value, it is necessary to arrange it so that the impact takes place in conditions as perfect as possible.

To this effect a series of impact surfaces designed to receive the sheet of liquid emerging from the vat or cylinder in rotation is arranged according to the invention at the level of the discharge edge of the vat or of the cylinder and completely surrounding the same. These surfaces are disposed perpendicular or substantially perpendicular to the trajectories which are

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followed by the liquid or mixture of liquid and gas emerging tangentially from the vat or cylinder in rotation.

Moreover, these annularly arranged impact surfaces are placed as near as possible to the vat or cylinder in order to obviate any appreciable loss of the kinetic energy initially imported to the liquid.

In order that the invention may be well understood, an apparatus constructed in accordance with the invention will now be described by way of example but not of limitation.

Figure 1 is a view in vertical section showing the rotary vat and its driving device. This embodiment is purely by way of example, for a similar apparatus could be easily conceived which would have a bell, the opening of which would be turned for example upward.

Figure 2 is a plan view of a detail representing the top portion of a mushroom fixed to the vat.

Figure 3 is a view in vertical section representing the assembly of the apparatus.

Figure 4 represents a plan view of the impact device receiving the liquid at its exit from the vat.

Figure 5 relates to a modification of this device in which the number of receiving buckets has been increased, which number varies according to the applications.

Figure 6 is a diagram showing the trajectories of the liquid or mixture emerging from the vat at respective points of discharge.

An apparatus constructed according to the invention comprises a rotary vat or cylinder which functions to carry along the liquid, and to disperse it, and which in this embodiment is supplied with raw liquid from the top by means of an entrance orifice 2 from a fixed piece 2'. This supply could alternatively be effected in a different way. This element 1 is arranged at the interior of a fixed envelope 3 (Figure 3), which forms the base and, in the embodiment represented, is assumed to be cylindrical. It can nevertheless have any other appropriate shape.

The upper portion of the rotary cylinder is made in the shape of a bell 1', and below said bell there is fixed, for example by means of screw bolts 4 and of dowels 5 (Figure 1), a mushroom 6 which carries a piece of a shaft 7 extending vertically downwards and rotating in ball bearings or others 8 in a sleeve 9 which is made integral, for example by means of screw bolts 10, with a tubular support 11 connected with the inclined bottom 13 of the envelope 3 by ribs 12 (Figures 1 and 3).

On the sleeve 9 is attached downwardly, for example by screw bolts 14, a piece 15 forming the support for the bearings of the shaft 7.

The vat 1 can be driven directly, but alternatively it can be driven, according to this embodiment, by means of a belt 16 running in a groove 17 formed in the bell 1' (Figures 1 and 3).

On the upper face of the mushroom 6 and between said mushroom and the bell of the vat, there is provided an appropriate number of vanes 19 (Figures 1, 2, and 3) which serve as stays between the mushroom 6 and the bell 1' of the cylinder 1 and which serves for carrying along the liquid towards the periphery of the cylinder 1 and for sucking in simultaneously air or a gas which acquires likewise the angular velocity of the vat.

As will be readily understood, the liquid introduced at 2 falls on to the mushroom 6, and is carried along owing to the fact that the assembly 1-6-7 and 19 is in rotation.

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On the other hand, the vanes 19 are constructed in such a manner that when the liquid has left them, the liquid turns at the velocity of the inner wall of the vat and then spreads out over the inner cylindrical portion of the vat from where it eventually escapes in a thin and uniform sheet.

The liquid emerges at the lower portion of this cylinder, and forms by centrifugal action a practically horizontal sheet or layer which is projected outwards.

An essential feature of the apparatus consists in that the sheet of liquid that emerges from the cylinder 1 is received on a series of impact surfaces 21 (Figure 4) which are disposed perpendicularly or almost perpendicularly to the tangential trajectory the liquid takes after its emergence from the cylinder 1.

An important condition is that the surfaces be sufficiently close to the cylinder in order to prevent a subsequent loss of the kinetic energy imparted to the liquid.

From the point of view of construction, the surfaces 21 are usually connected with one another by connecting surfaces 22 which prevent any splashing towards the exterior.

These surfaces 21 and 22 cooperate also with one another in forming buckets 23 each of which receives part of the liquid, and which possess preferably a third face 24 which is disposed parallel or almost parallel to the tangential trajectory of the liquid and which prevents any splashing towards the vat.

These surfaces 24 terminate in general in a chamfer 25 intended to prevent a subsequent impact from already occurring at the edges of these surfaces 24 which would cause part of the liquid to rebound onto the vat. The buckets formed by the surfaces 21 and 22 abut at 27 on a crown 26 which is disposed, substantially edge-wise, concentrically to the cylinder 1 (Figures 3 and 4).

It is, however, important that this abutment be arranged, as shown in the drawing (Figure 4), outside the trajectory of the jet of liquid received in the bucket and that thus a neutral zone 23' is formed which does not receive any liquid. Thus it is made certain that the whole sheet of liquid meets the surface 21 in directions which are perpendicular or almost perpendicular to this surface.

The crown 26 is, in this embodiment, represented as fixed to the structure by means of screw bolts 28 (Figure 3) which traverse the wall of the envelope 3 in a horizontal direction and extend through sleeves 29; but any other manner of fixation may alternatively be employed.

A flat ring 30 is moreover provided which comes into contact with the upper edges of the crown 26 and of the pieces 21-22-24 which compose the assembly of the impact device.

In this manner any projection of the liquid upward is obviated.

The mixture of liquid and air, after having hit the surfaces 21, escapes downwardly, meets the bottom 13, and is discharged by the exit orifice 31.

Figure 5 relates to a modification of the embodiment in which the number of buckets 23 has been increased. It will be seen that in this case the length of the surfaces 24 has to be increased in a corresponding manner.

Numerous modifications of construction can be applied with respect to what has been described hereinabove and represented in the drawings.

Thus notably the impact device could be limited to a series of surfaces 21 fixed in an appropriate manner in the position shown, and an apparatus constructed in this manner would evidently not fall outside the scope of the invention.

The apparatus forming the subject of the invention finds its application notably with a view of carrying into practice the process described and claimed in the United States patent application Ser. No. 142,866 filed February 7, 1950, and relating to the separation of one or several constituents in suspension in a liquid, which process is characterised in that the micellae or particles which may flocculate within a liquid phase are placed into such conditions as are suitable for fixing air, a gas or a mixture of gases and thus to acquire eventually a buoyancy force sufficient for causing a rapid separation of the micellae or other particles, and for causing a concentration on the surface of the liquid, or a sedimentation, of a constituent of a density initially equal to a higher value than that of the liquid, while the latter becomes gradually clear.

When the apparatus described is used for this purpose, the liquid to be treated and containing the constituents to be separated is introduced at 2 at the same time as the air or other gas which is sucked in by the vanes 19; the liquid and the air, which leave the vat 1, escape in the form of laminations or jets which are sufficiently thin to ensure an intimate contact of the air or of the gas with the particles, and to secure the fixation of the air or of the gas to the micellae. The excess of this air or of this gas escapes eventually with the liquid, taking part, as explained in the prior United States patent application, in the formation of the sedimentation.

It is, however, well understood that the ambit of protection of the present patent is by no means limited to this application, and that the same apparatus finds use with a view of treating liquids or mixtures of liquids by this kind of centrifuging.

It can be particularly employed to effect, by the means described, the mixing of several liquids or of one or several liquids with one or several gases.

What I claim is:

1. Centrifugal apparatus for dispersing and mixing a gas and a liquid, including a cylinder and means for rotating the same, means for admitting a liquid into said cylinder, means for spreading the liquid along the inner periphery of the cylinder whereby the liquid escapes as a sheet in a tangential trajectory from the lower cylinder edge, means for sucking air into said cylinder, means for mixing said air with said

liquid and a series of impact surfaces positioned along the lower portion of the cylinder and extending substantially perpendicular to said trajectory, said trajectory being followed by both air and liquid, said impact surfaces being positioned sufficiently close to the lower edge of the cylinder, so as to obviate a subsequent loss of the kinetic energy of the mixture, and also being located in a staggered relation so to be substantially perpendicular to the trajectory followed by the sheet of air and liquid and are located sufficiently close to the lower edge of the cylinder, so as to obviate a subsequent loss of the kinetic energy of the mixture, connecting surfaces and also including means for connecting with one another the impact surfaces, whereby to prevent the splashing of the mixture towards the exterior, and said connecting surfaces together with the impact surfaces forming buckets, each of which receives a part of the mixture.

2. Centrifugal apparatus according to claim 1, in which each bucket includes a third face arranged substantially parallel to the trajectory of the mixture, so as to prevent any splashing towards the cylinder.

3. Centrifugal apparatus according to claim 1, also including a crown which is disposed substantially edge-wise and concentrically to said cylinder, and on which said buckets abut.

4. Centrifugal apparatus according to claim 3, in which said buckets abut said crown in regions where each active impact surface is connected to a corresponding connecting surface.

5. Centrifugal apparatus according to claim 4, in which the connection between an impact surface and a connecting surface takes place towards the exterior in a region situated outside the trajectory of the sheet received in the bucket, whereby the whole sheet may always meet the impact surface at an angle of impact which is substantially perpendicular to it.

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