March 30, 1965 R. C. GOODWIN ETAL 3,175,689

LINK SUSPENDED CENTRIFUGAL

Filed Oct. 14, 1960 3 Sheets-Sheet 1

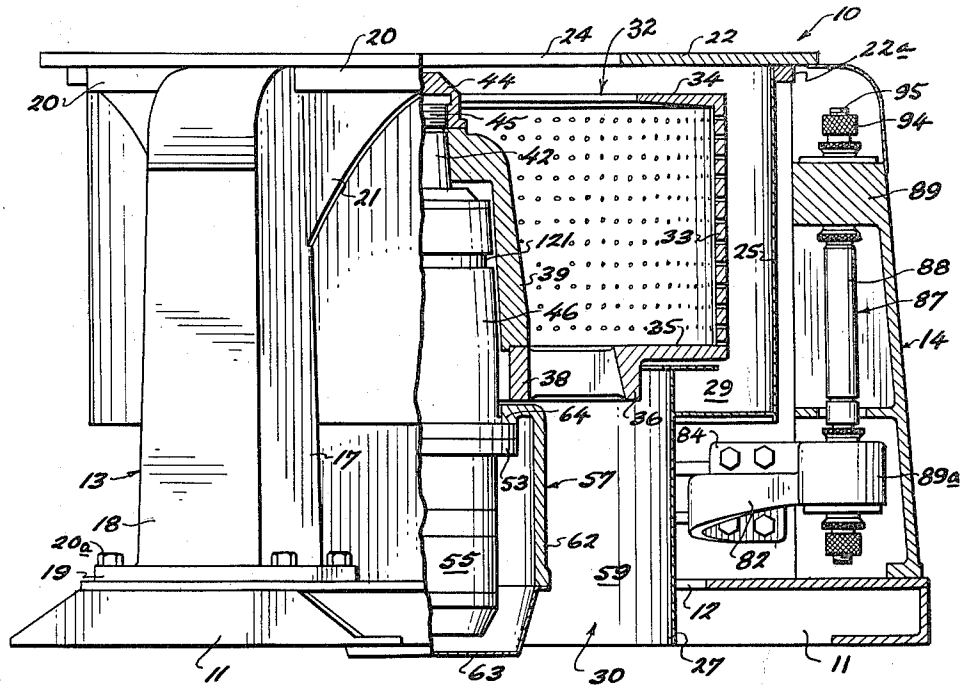


Fig. 1

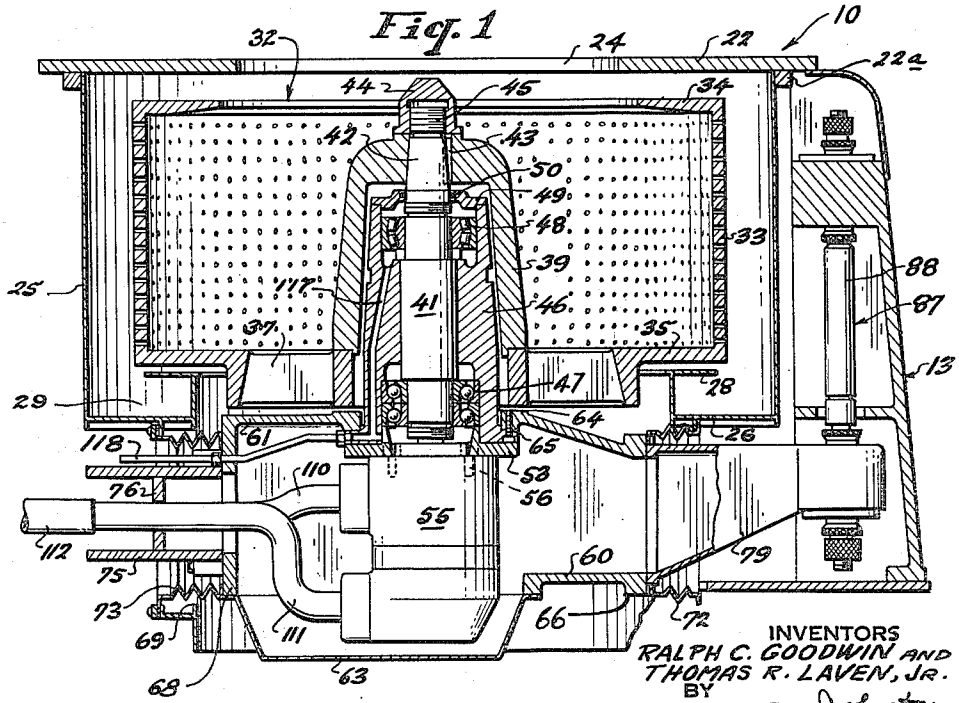


Fig. 3

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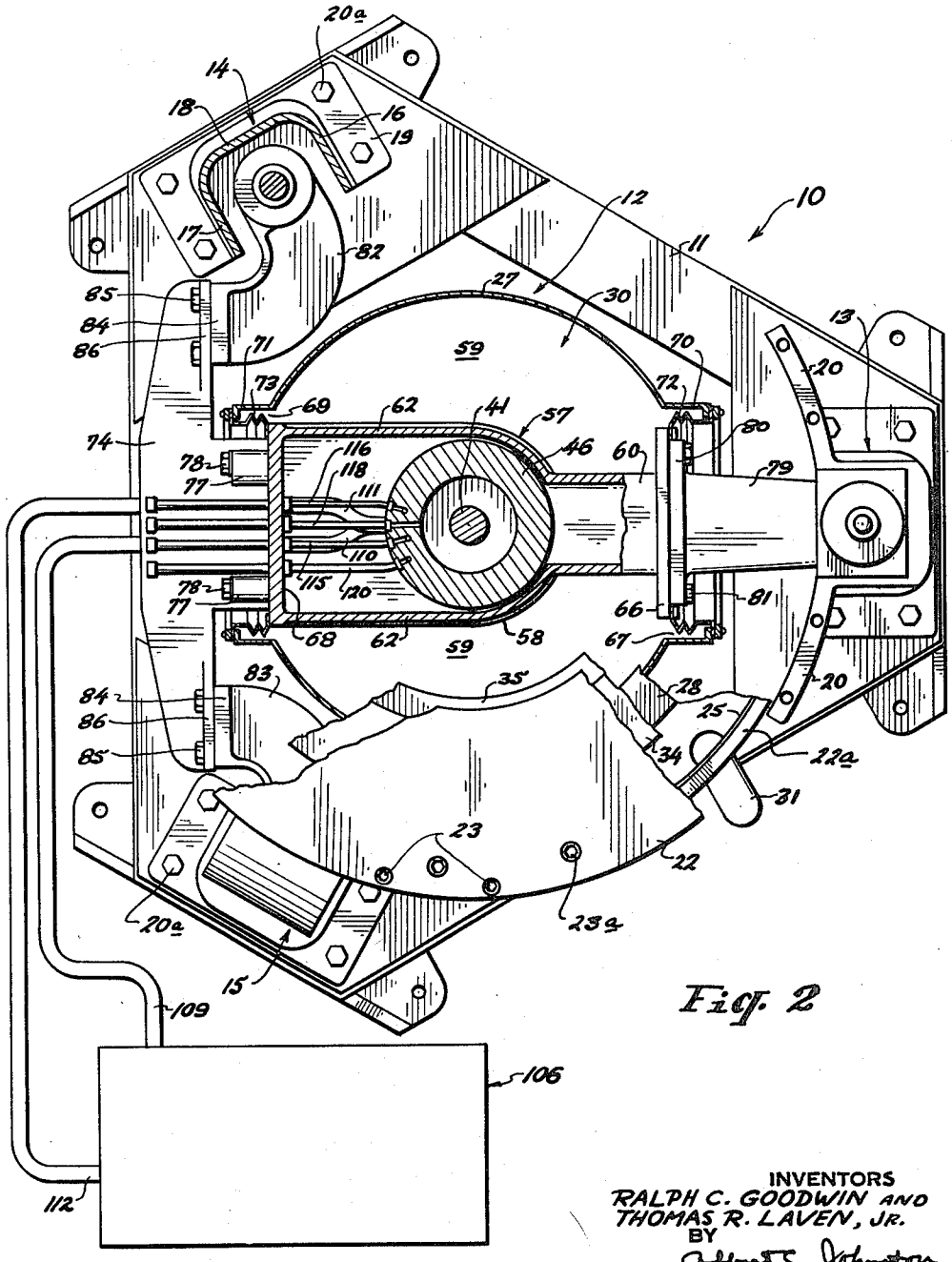


Fig. 2

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Filed Oct. 14, 1960 3 Sheets-Sheet 3

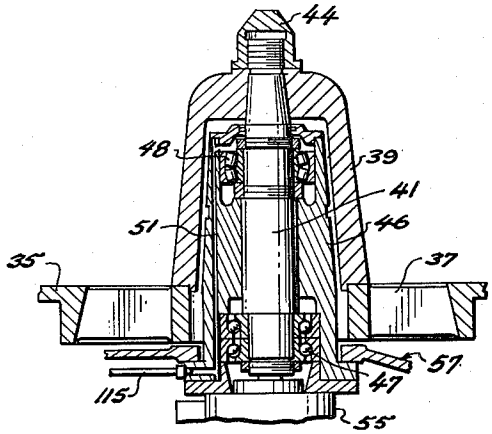


Fig. 5

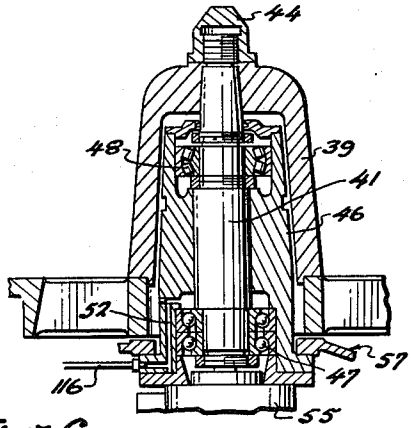


Fig. 6

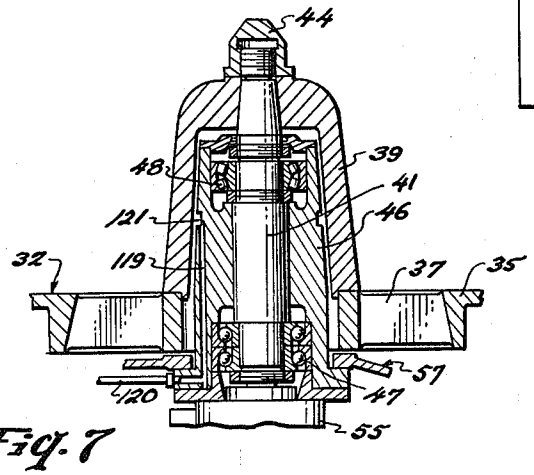


Fig. 7

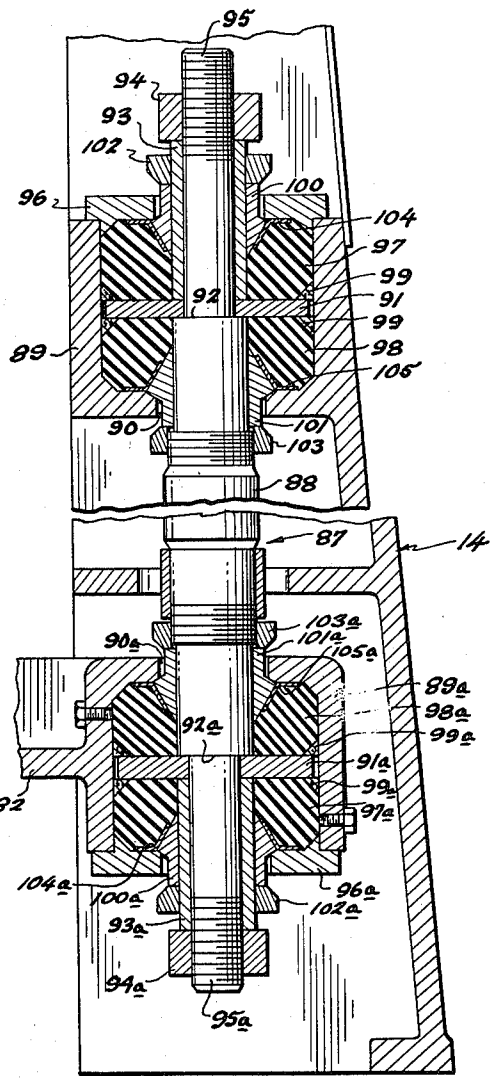


Fig. 4

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United States Patent Office 3,175,689 Patented Mar. 30, 1965

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LINK SUSPENDED CENTRIFUGAL

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Filed Oct. 14, 1960, Ser. No. 62,713
19 Claims. (Cl. 210—365)

This invention relates generally to centrifugals or extractors of the kind used for removing or separating liquids from bulk solids, or for classifying different types of solids, for example, as in the chemical industry, or for removing excess water or other liquid cleaning agents from clothing and other fabrics in laundries and cleaning establishments. The invention is more particularly directed to the provision of an improved centrifugal or extractor having a combination of structural and functional features contributing toward its improved operation and convenient and economic installation and use thereof.

The perforated basket or solid bowl of a centrifugal or extractor of the described character is frequently supported and driven from above in order to facilitate the provision of a bottom discharge for the solids from the basket. However, the overhead drive and suspension of the basket results in a structure of considerable height so that difficulty is experienced in installing a centrifugal or extractor of that type at a location where overhead clearance is limited. Further, overhead suspension machines characteristically have a relatively large, slow precessional gyratory movement of the suspended mass. Accordingly, centrifugals or extractors have been produced with link suspensions for either the rotatable basket alone, or both the basket and the curb structure, and wherein a number of fixed pedestals are spaced uniformly around the perimeter of the curb structure and have links suspended therefrom, with their lower ends either supporting the curb structure which in turn carries the housing for the bearing of the basket, or supporting the housing of the bearing for the basket with the curb structure being fixed relative to the pedestals. With such link suspensions, the joints at the opposite ends of the links permit relative swinging movements of the latter for accommodating translatory or gyratory movement of the basket under the influence of unbalanced loading thereof, thereby to prevent the transmission of excessive vibrations and stresses through the pedestals to the building structure supporting the centrifugal or extractor while keeping down the height of the machine. If the basket is also to be driven from below, that is, underdriven, in order to further reduce the height of the machine, a number of difficulties arise. First of all, there is a limited space available under the basket so that, where considerable power is required for driving the basket, such limited space cannot accommodate a motor of sufficient size for direct drive of the basket shaft. Further, electric motors which are conveniently used for the drive of centrifugal baskets have a large mass if they are to be powerful enough for that purpose, and it is undesirable to have such a large mass participate in the translatory or gyratory movement of the basket caused by unbalanced loading of the latter, as would be the case with a directly underdriven basket. The relatively large electric motor required for the direct underdrive of a centrifugal basket also interferes with the provision of a bottom discharge for the solids from the basket.

In order to avoid the above difficulties inherent in the direct drive of the centrifugal basket from below, underdriven, link suspended centrifugals or extractors have been conventionally provided with the necessary large electric drive motor mounted at the outside of the curb structure, with the power being transmitted to the basket shaft by way of a belt and pulley arrangement. If the

drive motor is mounted on a fixed support, the transmission of power to the basket shaft by way of a belt and pulley arrangement results in a reaction to the drive torque tending to displace the axis of the basket from its normal central position. Further, if the drive motor is mounted on a fixed support while the basket is free to undergo translatory or gyratory movement due to unbalanced loading thereof, such movement produces alternate loosening and tightening of the power transmitting belts, thereby unduly stressing the latter and also adversely affecting the efficiency of the power transmission. If the above disadvantages are avoided by mounting the drive motor at one side of the basket on the bearing support structure of the latter for translatory or gyratory movement along with the basket in response to unbalanced loading of the latter, so that there is no relative movement between the axis of the drive motor and the axis of the basket shaft, the drive motor disturbs the mass symmetry of the assembly mounted for such gyratory movement so that the latter is ellipitical rather than circular. In some existing designs, the curb structure supports the eccentrically located drive motor and is arranged for gyratory movement with the basket, but this creates other problems resulting from the provision of a nonstationary curb structure, for example, difficulties experienced in providing a fully automatic link suspended centrifugal by reason of the necessity of providing numerous flexible piping connections to the auxiliary devices normally mounted on the curb structure and by reason of the vibrations to which such devices are subjected.

Further, existing centrifugals or extractors having a basket with a permanently closed bottom are inconvenient in use, as the discharge of the dried solids, as well as the loading of the mixture to be treated, must be effected through the open top of the basket, whereas, in a centrifugal having a bottom discharge, discharge of the dried solids from the basket is assisted by gravity and thus is far more convenient and less time consuming.

Accordingly, it is an object of the present invention to provide an underdriven, link-suspended centrifugal machine having a fixed curb structure and a bottom discharge.

A further object is to provide an underdriven, link-suspended centrifugal machine providing bottom discharge and mass symmetry of the assembly which undergoes circular gyration in response to unbalanced loading of the basket or bowl.

In accordance with an aspect of the invention, a centrifugal machine is provided with a curb sturcture which is fixed to a plurality of pedestals suitably arranged around the periphery of the curb, while the shaft of the basket is rotatably mounted in a bearing carried by a floating basket support hung on links suspended from the pedestals. The basket support extends across the curb structure at a level below the basket and is cut away at at least one location under the basket bottom to provide a passageway for the free fall of solids vertically from a discharge opening provided in the bottom of the basket. In a preferred embodiment of the invention, the floating basket support extends diametrically across a space circumscribed by a depending curb skirt so that two passages for the gravity discharge of solids are defined between the opposite sides of the basket support and the curb skirt, and opposite end portions of the basket support extend to locations outside of the curb skirt and are in the form of rigid arm structures connected to the lower ends of the swingable links suspended from the pedestals. Further, flexible seals are preferably provided between the curb skirt and the portions of the floating basket support extending to locations outside the curb skirt, whereby the passages provided between the floating basket support and the curb skirt for the gravity discharge of solids

from the basket are isolated from the space surrounding the curb skirt. Such a centrifugal machine can be employed for the treatment of materials developing noxious fumes, for example, in the chemical industry, by providing a top closure for the curb structure and by connecting the lower end of the curb skirt with a discharge conduit for the solids, to avoid the pollution of the surrounding atmosphere by the noxious fumes.

In accordance with another aspect of the invention, the drive assembly for the basket includes a hydraulic, positive displacement motor mounted within the floating basket support and connected directly to the lower end of the basket shaft so as to maintain the mass symmetry of the link-suspended assembly, and with that type of motor making it possible to supply the necessary power for drive of the basket while minimizing the mass of the drive assembly gyrating with the basket under the influence of unbalanced loading of the latter and also minimizing the dimensions of that portion of the drive assembly underlying the basket, so as to permit reduction of the overall height of the centrifugal machine and also to avoid interference with the passages required for the gravity discharge of solids from the bottom of the basket.

In accordance with another feature of the invention, a purge tube leads into the space between the basket hub and the housing for the bearings of the basket shaft and continuously feeds an inert gas into such space for protecting the bearings against atmospheric moisture or corrosive gases within the centrifugal machine. Further the inert gas can be used to either cool or warm the bearing housing as operating conditions may require. After passing through the space between the hub and the bearing housing, the inert gas is discharged into the basket where it forms an inert atmosphere for avoiding oxidation of chemical charge materials or for preventing explosion of the latter during operation of the machine. The inert gas purging the interior of the bearing housing may also serve to cool the bearing.

Another object of the invention is to provide an improved link suspension for centrifugals or extractors of the described character so that the rotated basket is free to gyrate or move in directions perpendicular to the axis of rotation under the influence of unbalanced loading of the basket, while axial displacements of the basket are prevented thereby to avoid tilting of the basket axis as well as undesirable "jumping" or vertical movements of the basket.

Previous attempts to achieve the above object, that is, to permit swinging of the links relative to the pedestals from which they are suspended and relative to the basket support or the basket and curb support, while avoiding relative movement in the axial directions of the links, have employed ball and socket joints, but such joints have metal-to-metal contact between relatively movable surfaces that wear and require lubrication. Where such metal-to-metal contact has been eliminated by the provision of joints which transmit loads from the basket support or from the curb and basket support to each suspension link, and from the latter to its related pedestal by way of rubber bearing elements, the latter have not been completely constrained and therefore permit undesirable relative axial movements as well as the desired swinging movements of the suspension link.

In accordance with the present invention, the opposite ends of each suspension link are mounted in a flowable, but incompressible medium confined within housings secured to the related pedestal and the basket support, respectively, so that such medium is not flowable in response to forces applied axially thereto either from the link or from the housing for the medium, but is flowable only in response to couples applied to the link or the medium housings. The incompressible, flowable medium is preferably an elastic solid, such as, rubber or the like, so that the medium itself yieldably resists the displacement or flow imparted thereto by a couple and tends to

restore the link and related medium housing to a predetermined relative position. Further, seals are preferably provided across the necessary clearances between each link and the related medium containing housings so as to constrain the medium within the latter, and couples applied to the links or to the related medium containing housings to effect relative swinging thereof also result in relative movements between the medium and the housings and between the seals and the housings which movements are resisted by friction absorbing energy, as does the hysteresis of the elastic medium, in order to provide a damping effect.

A still further object of the invention is to provide a link-suspended centrifugal machine having the suspended mass symmetrical about the axis of the basket so that unbalanced loading conditions in the basket result in circular gyratory movements of the basket, rather than elliptical movements, and wherein the mass which is free to undergo such gyratory movements is kept at a minimum.

The above and other objects, features and advantages of the invention, will be apparent in the following detailed description of an illustrative embodiment thereof which is to be read in connection with the accompanying drawings forming a part hereof, and wherein:

FIG. 1 is a side elevational view, partly broken away and in vertical section, of a link suspended centrifugal embodying the present invention;

FIG. 2 is a top plan view of the centrifugal of FIG. 1, shown partly broken away and in horizontal section;

FIG. 3 is a vertical sectional view taken along a diametrical plane of the centrifugal of FIGS. 1 and 2;

FIG. 4 is an enlarged axial sectional view of one of the suspension link assemblies included in the centrifugal of FIGS. 1 and 2;

FIG. 5 is an enlarged, fragmentary sectional view similar to a portion of FIG. 3, but taken through a different diametrical plane of the basket hub and bearing housing;

FIG. 6 is a view similar to that of FIG. 5, but taken through another diametrical plane of the basket hub and bearing housing; and

FIG. 7 is another view similar to that of FIG. 5, but taken through still another diametrical plane of the basket hub and bearing housing.

Referring to the drawings in detail, and initially to FIGS. 1 and 2 thereof, it will be seen that a link suspended centrifugal embodying the present invention and there generally identified by the reference numeral **10** includes a base **11** having a central opening, as at **12**, and a plurality of pedestals which are three in number in the illustrated embodiment and are identified by the reference numerals **13**, **14** and **15**. Each of the pedestals has opposite side walls **16** and **17** and a connecting outer wall **18** to form generally U-shaped cross-sections opening inwardly, as is apparent from the sectional view of pedestal **14** in FIG. 2. A flange **19** is formed at the lower end of each pedestal for attachment to base **11**, as by bolts **20***a*. Arcuate arms **20** extend laterally from the upper ends of side walls **16** and **17** of each pedestal adjacent the inner edges of the side walls and are supported by webs **21**. The arcuate arms **20** curve in a horizontal plane and have radii of curvature concentric with the central axis of base **11**.

Centrifugal **10** further includes a curb structure which, in the illlustrated embodiment, is made up of a circular top plate **22** resting, at its periphery, on arms **20** of pedestals **13**, **14** and **15**, and secured to such arms by machine screws **23** (FIG. 2). Top plate **22** has a central opening **24** for loading of the charge material, and has a concentric ring **22***a* secured to its lower surface, as by screws **23***a*. A cylindrical side wall **25** depends from ring **22***a* and has a ring-like bottom wall **26** directed radially inward from its lower edge. In a simple modification of the above described curb structure, the

ring 22*a* may rest on the pedestal arms 20 and be secured to the latter, while the top plate 22 is secured to ring 22*a*. A cylindrical curb skirt 27 concentric with side wall 25 and having a smaller diameter than the latter is secured to the inner periphery of bottom wall 26 and extends downwardly from the latter through the central opening 12 of base 11 (FIG. 1). The upper edge portion of curb skirt 27 extends above bottom wall 26 and carries an outwardly directed radial flange 28 so that the upper portion of curb skirt 27, bottom wall 26 and the lower portion of side wall 25 cooperate to define an annular channel 29 for collecting the liquids extracted from the charge material during operation of the centrifugal, while flange 28 serves to avoid splashing of the collected liquids from channel 29 into the central space 30 circumscribed by curb skirt 27. An outlet conduit 31 (FIG. 2) extends from bottom wall 26 of channel 29 for the removal of the liquids or effluent collected in that channel. The assembly of side wall 25, bottom wall 26, skirt 27 and flange 28 of the curb structure may be conveniently formed by suitably welding together corresponding sheet metal parts.

A basket generally identified by reference numeral 32 is accommodated within the space or chamber circumscribed by curb side wall 25 and includes a perforated cylindrical side wall 33 having an inwardly directed rim 34 at its upper edge and a radially inward directed flange 35 extending from its lower edge. A downwardly directed flange 36 extends from the inner periphery of bottom flange 35 and is connected, by radial spider arms 37 to a concentric inner ring 38 so that the openings defined between flange 36, spider arms 37 and inner ring 38 constitute a bottom discharge for solids from the basket 32. A hollow hub 39 having a generally inverted, cup-shaped configuration is rigidly secured, at its lower edge, to inner ring 38.

Referring to FIG. 3 in detail, it will be seen that hub 39 is mounted on a basket shaft 41 having a tapered upper end portion 42 which is received in a similarly tapered bore at the center of the top of hub 39, with a key and slot connection 43 being provided between hub 39 and shaft 41 to cause rotation of basket 33 with the shaft, and with a cap nut 44 being screwed on a threaded upper extension 45 of shaft 41 to prevent axial removal of the basket from the shaft.

A bearing housing 46 extends upwardly into hollow hub 39 and houses bearings, for example, a pair of angular contact ball bearings 47 and a spherical roller bearing 48, rotatably supporting basket shaft 41 at axially spaced apart locations along the latter. A cover 49 is secured on the upper end of bearing housing 46 and has a central opening through which shaft 41 extends, with a suitable oil seal 50 being provided in the clearance between cover 49 and shaft 41 to prevent the leakage therethrough of grease supplied to upper bearing 48 through a passage 51 in the wall of housing 46 (FIG. 5). The wall of housing 46 also has a passage 52 (FIG. 6) formed therein for supplying grease to the lower bearings 47 supporting shaft 41.

Housing 46 further has a bottom plate 53 formed with a central opening receiving the drive shaft of a hydraulic, positive displacement motor 55, for example, a vane type motor of the type designated Denison TME 5C, the housing of which is secured by screws 56 to plate 53 (FIG. 3). The drive shaft of motor 55 is coupled to shaft 41 so as to provide a direct underdrive for basket 32.

In accordance with the present invention, bearing housing 46, and hence basket 32 and motor 55, are carried by a floating basket support generally identified by the reference numeral 57. As is shown in FIGS. 2 and 3, basket support 57 includes a central portion 58 extending diametrically across the space 30 circumscribed by curb skirt 27 so as to divide space 30 into two passages 59 for the gravity discharge of solids from basket 32, with such passages 59 being defined between the opposite sides of central portion 58 of the basket support and the inside surface of curb skirt 27.

One end part 60 of central portion 58 of basket support 57 is of substantially tubular configuration, while the remainder of central portion 58 is laterally enlarged and is of generally inverted, U-shaped cross-section, that is, has a top wall 61 (FIG. 3) and spaced apart side walls 62 (FIG. 2), to define a rigid structure having a downwardly directed opening that is normally closed by a bottom pan 63 (FIGS. 1 and 3). If desired, part 60 may also have an inverted U-shaped cross-section and, in that case, pan 63 is extended to also close the bottom of part 60. Top wall 61 is formed with an opening having a marginal rim 64 and through which bearing housing 46 projects, with a flange at the bottom of the bearing housing being secured to rim 64, as by screws 65. Thus, with bearing housing 46 secured relative to central portion 58 of basket support 57, drive motor 55 is conveniently accommodated between side walls 62, and access may be had to the motor by removal of bottom pan 63.

End part 60 of central portion 58 terminates in an outwardly directed flange 66 (FIGS. 2 and 3) which is received in an opening 67 formed in curb skirt 27, while the opposite end of central portion 58 of basket support 57 has an end wall 68 and is received in an opening 69 formed in curb skirt 27 at a location diametrically opposed to opening 67. Collars 70 and 71 extend outwardly from the margins of openings 67 and 69, respectively, and have flanged outer end edges, and seals, in the form of flexible bellows 72 and 73, are connected between the peripheral portion of flange 66 and the outer flanged edge of collar 70, and between the peripheral portion of end wall 68 and the outer flanged edge of collar 71, respectively, thereby to permit movement of floating basket support 57 relative to curb skirt 27 while isolating the passages 59 from the region surrounding the curb skirt.

Basket support 57 further includes superposed upper and lower, laterally elongated plate members 74 and 75 rigidly connected to each other in parallel, spaced apart relationship by a welded web 76 (FIG. 3) and further connected, at their central portions, to end wall 68, for example, by bosses 77 welded to the upper and lower plate members 74 and 75 and receiving screws 78 which engage tapped holes in end wall 68. Thus, as can be seen in FIG. 2, central portion 58 and plate members 74 and 75 of basket support 57 give a generally T-shaped plan configuration to the basket support, with end part 60 of central portion 58 being directed toward pedestal 13, while the opposite ends of the superposed plate members 74 and 75 are directed generally toward pedestals 14 and 15, respectively.

In the illustrated centrifugal embodying the invention, basket support 57 further includes a generally straight hanger or arm 79 having a flange 80 at its inner end secured by bolts 81 to flange 66 of central portion 58, while the outer end of arm or hanger 79 projects into the inwardly opening space defined within the lower portion of hollow pedestal 13. Basket support 57 further includes arcuate hangers or arms 82 and 83 each having a pad 84 at its inner end secured, as by bolts 85 to flanges 86 formed along the opposite outer edge portions of superposed plate members 74 and 75, while the outer ends of arcuate hangers 82 and 83 project into the inwardly opening spaces defined at the lower portions of hollow pedestals 14 and 15, respectively.

In order to suspend floating basket support 57 from pedestals 13, 14 and 15 in a manner to permit gyratory movement of basket 32 relative to the pedestals and the curb structure fixed thereto, centrifugal 10 embodying the present invention further includes a suspension link assembly generally identified by the reference numeral 87 (FIGS. 1 and 4) associated with each of the hangers 79, 82 and 83 and with the related pedestals 13, 14 and 15, respectively.

As is shown in FIG. 4, each of the suspension link assemblies 87 includes a rod or link 88 connected, at its upper end, to the related pedestal and, at its lower end, to the related hanger in a manner to permit relatively free angular displacement or swinging of the hanger relative to the link and of the link relative to the pedestal, while providing very strong restraint against relative axial movements, that is, relative movements generally in the vertical direction. In accordance with the present invention, the foregoing objective is achieved by transmitting loads between each link 88 and the related hanger and pedestal through a flowable, incompressible medium which is preferably elastic. Such medium is confined within a housing so that it is free to flow within the housing only in response to relative angular displacements of the link and medium containing housing, and is not free to flow in response to forces exerted in the axial direction of the link. Thus, in the illustrated centrifugal 10, each of the pedestals 13, 14 and 15 is formed with a generally cup-shaped, upwardly opening housing 89 within its upper portion. The housing 89 has an opening 90 in its bottom through which the upper end portion of the related link 88 can loosely extend, and a disc 91 fitting loosely within housing 89 is secured on the upper end portion of link 88 between a shoulder 92 on the link and a sleeve 93 which is held against disc 91 by a nut 94 on an upper threaded end 95 of link 88. A cap 96 closes the upper end of housing 89 and is formed with a relatively large central opening loosely receiving the upper end portion of link 88 with the sleeve 93 thereon. It will be apparent that disc 91 divides the interior of housing 89 into upper and lower compartments which are filled with an incompressible, flowable and preferably elastic medium, for example, in the form of rings 97 and 98 of rubber or the like, and it is intended that the rubber of each ring, while being free to flow within the respective compartment, should be completely confined within the latter, that is, prevented from bulging through any crevice or clearance between parts of the structure defining the compartment, thereby to offer great restraint against relative movements in the axial direction of link 88 which would tend to decrease the volume of the respective compartment.

In order to absolutely seal the rubber of rings 97 and 98 within the related compartments, leather fillets 99 are provided at the peripheries of the opposite surfaces of disc 91, thereby to seal the radial clearance between disc 91 and the side wall of housing 89 and prevent the bulging of either rubber ring 97 or rubber ring 98 out of the respective compartment through such radial clearance. The rubber rings 97 and 98 are made to completely fill the respective compartments of housing 89, by seal sleeves 100 and 101 which, if the rings 97 and 98 are formed with conical recesses, as shown, are provided with frusto-conical outer surface portions engageable with the conical recesses of rings 97 and 98, respectively. Seal sleeves 100 and 101 are slidable on sleeve 93 and on the portion of link 88 extending through opening 90 of the housing, and are movable axially towards each other by nuts 102 and 103, respectively, which engage externally threaded portions of sleeve 93 and of link 88. Further, bulging of the rubber rings 97 and 98 through the necessary clearances between seal sleeve 100 and cap 96 and between seal sleeve 101 and the bottom of housing 89, respectively, is prevented by rubber sheeting discs 104 and 105 extending across such clearances at the inside of housing 89.

It will be apparent that, if a force is applied vertically upward to link 88, thereby tending to decrease the volume of the compartment containing incompressible rubber ring 97, which completely fills that compartment and is prevented from flowing out of the latter, the incompressible rubber of ring 97 provides great restraint against vertically upward movement of link 88 relative to the respective pedestal. Similarly, if a downward, axially directed force is applied to link 88, the incompressible rubber of ring 98, which completely fills the related compartment and is prevented from flowing out of the latter, provides great restraint against vertically downward movement of the link.

However, since the rubber of the rings 97 and 98 is flowable within the respective compartments of housing 89, such rings offer only yieldable resistance to relative angular displacements of the link 88 and related pedestal which merely alter the shape of the respective compartments without changing the volumes thereof. Thus, couples applied to the link 88 tending to angularly displace or tilt the link relative to the respective pedestal cause the disc 91 to be raised at one side and lowered at the diametrically opposed side, and the rubber of rings 97 and 98 then flows from the portions of the respective compartments which are reduced in effective height to those portions of the respective compartments which are increased in effective height.

During such flowing movements of the rubber of rings 97 and 98 within the respective compartments of housing 89, there are relative movements between the rings and the inner surfaces of the compartments and also between the seals 99, 104 and 105 and the surfaces of the housing engaged thereby, and such relative movements are frictionally resisted. The frictional resistance to the relative movements absorbs energy and cooperates with the hysteresis of the elastic medium, that is, the rubber of rings 97 and 98, to provide a damping effect upon the swinging movement or angular displacement of link 88 relative to housing 89 of the related pedestal.

As is apparent in FIG. 4, the connection between each of the links 88 and the respective hanger 79, 82 or 83 is an inverted reproduction of the connection between each link and the respective pedestal, as described above. Thus, the outer end of each of the hangers 79, 82 or 83 is formed with a downwardly opening, cup-shaped housing 89*a* having an opening 90*a* in its top through which the lower portion of the related link 88 loosely extends, while the bottom of housing 89*a* is closed by a cap 96*a* also having a central opening to permit the loose projection therethrough of the lower end portion of the link with the sleeve 93*a* held thereon by a nut 94*a* in order to secure a disc 91*a* against a shoulder 92*a* of the link. The disc 91*a* which is loosely disposed within the housing 89*a* divides the interior of the latter into two compartments which accommodate rubber rings 97*a* and 98*a*, respectively. The connection between the lower end of each link 88 and the related hanger is further provided with elements which cause the rings 97*a* and 98*a* to fill the respective compartments and which seal the clearances between relatively movable parts so as to prevent bulging of the rings through such clearances, and these elements correspond to the similarly functioning elements previously described in connection with the suspension of link 88 from the related pedestal and are identified by the same reference numerals, but with the letter "*a*" appended thereto.

From the above, it will be apparent that the connection between each of the hangers 79, 82 and 83 and the related link 88 also presents great restraint against movement of the hanger relative to the link in the axial direction of the latter, while leaving the hanger relatively free to undergo angular displacements with respect to the link in response to the application of turning couples, but with a damping action being provided with respect to such relative angular displacements.

It will be apparent that the above described arrangements for suspending each link 88 from the related pedestal 13, 14 or 15 and for suspending each of the hangers 79, 82 or 83 from the related link 88 eliminates all metal to metal contact of relatively moving surfaces, so as to avoid the necessity for lubrication as well as the wear inherent in such contact and, at the same time, permits gyratory movements of basket support 57 in response

to unbalanced loading of basket 32 while substantially preventing any vertical movements of the basket.

As diagrammatically shown in FIG. 2, the centrifugal 10 embodying the present invention further includes a power and flow control unit generally identified by the reference numeral 106 which is connected through a conduit 109 having a flexible section to a supply conduit 110 extending between plate members 74 and 75 of basket support 57 and connected to the inlet port of the hydraulic, positive displacement motor 55. The outlet or discharge port from motor 55 is connected to an outlet conduit 111 which also extends between plate elements 74 and 75 and is connected, in turn, to a conduit 112 having a flexible section and extending back to power unit 106.

When fluid under pressure is supplied to motor 55 through conduits 109 and 110 and exhausted through conduits 111 and 112, the basket 32 is rotated in one direction, whereas, when fluid under pressure is supplied through conduits 111 and 112 and exhausted through conduits 109 and 110, the basket is rotated in the opposite direction. Thus, the described drive arrangement makes it possible to drive the basket in one direction at high speed for normal centrifuging of the charge, and to drive the basket in the opposite direction at relatively slow speed during discharging of the charge. The power and flow control unit 106 conveniently includes at least one pump and a motor for driving the same, together with means for selectively supplying fluid under pressure to one or the other of the motor ports and for selectively obstructing the fluid flow in whichever of the conduits 109 and 112 is receiving the exhaust from the motor, thereby to brake the motor and the basket hydraulically from rotation in either direction. Reference may be had to a co-pending application for United States Letters Patent, Serial No. 63,368 filed October 18, 1960, now United States Patent No. 3,081,598, for detailed disclosures of power and flow control units that are particularly suited for use in connection with the link suspended, underdriven centrifugal with fixed curb and bottom discharge described herein.

It will be apparent that, with the drive arrangement described above, the relatively massive components, that is, the power and flow control unit 106, can be fixedly mounted outside of the curb structure of centrifugal 10, while the hydraulic, positive displacement motor 55 which directly drives basket shaft 41 can have a relatively small mass and dimensions for convenience in mounting the same within basket support 57. Further, the conduits 110 and 111 which extend to motor 55 do not interfere with the downward discharge of solids from the basket, as would a belt and pulley transmission, and the unbalanced torque reaction of a belt and pulley transmission is also avoided.

Referring to FIGS. 5 and 6, it will be seen that pipe lines 115 and 116 extend from passages 51 and 52, respectively, of the bearing housing 46 and pass through end wall 68 of basket support 57 so that grease can be conveniently supplied to the upper and lower bearings 48 and 47, respectively, by way of pipe lines 115 and 116, from locations outside the curb structure, for effecting lubrication of the bearings during operation of the machine.

As shown in FIG. 3, the centrifugal embodying the invention is further preferably provided with a vent passage 117 extending through bearing housing 46 and opening into bearings 47 and 48, with such vent passage 117 being connected to a vent pipe line 118 also extending through end wall 68 of basket support 57 to a location outside of the curb structure.

Finally, bearing housing 46 is preferably provided with a passage 119 (FIG. 7) extending from the bottom of the bearing housing, where it is connected to a supply tube 120, and opening, at its upper end, into an annular groove 121 formed in the outer surface of bearing housing 46. Supply tube 120 extends through end wall 68 of basket support 57 and is adapted to be connected to a source of inert gas which flows through passage 119 into the clearance between hub 39 of basket 32 and bearing housing 46 in order to purge corrosive gases or moisture from that space or clearance and thereby protect the bearings from attack by such gases or moisture. Since the clearance between hub 39 and bearing housing 46 opens, at its lower end, adjacent the bottom discharge openings of basket 32, it is apparent that the inert gas used for purging that clearance will be discharged from the latter into basket 32, so that such inert gas can also serve to protect chemical charge materials in the basket against either oxidation or accidental explosion.

It will be apparent that, in the above described centrifugal machine, the link-suspended mass is symmetrical about the axis of basket 32 so that such mass undergoes circular gyratory movement in response to unbalanced loading of the basket, as distinguished from the elliptical gyratory movement that results when the link-suspended mass is asymmetrical with respect to the basket axis, for example, in the case of a drive having an electric motor which is disposed at one side of the basket axis and connected to the basket shaft by a belt and pulley transmission. By reason of the original vertical disposition of the suspension links 88 and the circular character of the gyratory movement of the symmetrical mass, such gyratory movement can occur without corresponding tilting of the axis of basket 32. Further, the very strong restraint offered to axial displacement of the suspension links 88 relative to the pedestals 13, 14 and 15 and relative to the hangers 79, 82 and 83 enhances the effect of the circular character of the gyratory movement of the suspended mass in avoiding "jumping" of the basket and tilting of the axis of the latter in response to unbalanced loading thereof.

It is also to be noted that the lateral gyratory movements of the link-suspended mass are elastically resisted for the most part by the relatively weak elastic material of rings 97 and 98 or 97*a* and 98*a* in housings 89 or 89*a*, and that only a relatively small frictional damping effect is provided for limiting the extent of the gyratory movements in passing through the critical frequency. This relatively weak elastic restraint is preferable over a purely frictional restraint in that the latter cannot be maintained at a constant effective value and further consumes substantial energy which is dissipated only in the form of heat and wear. Further, a purely frictional resistance to the gyratory movements of the suspended mass has to be set sufficiently high to contain the worst possible unbalance conditions when passing through the critical frequency, and this setting of the effective value of the frictional resistance determines the horizontal reactions to the gyratory movements at the foundations of the machine for all degrees of unbalanced loading. Thus, with a purely frictional restraint to the gyratory movements the horizontal reactions at the machine foundations are at a maximum for all degrees of unbalanced loading, whereas, with a predominantly elastic restraint, as in the link-suspension embodying the present invention, the horizontal reactions at the machine foundations are proportional to the degree of unbalanced loading.

Since the described centrifugal machine has a fixed curb structure, accessories or devices mounted on the curb top and the piping connections therefor are freed of unnecessary vibration, so that the centrifugal machine is ideally suited for fully automatic operation which requires such curb mounted accessories or devices.

It is also clear from the above description of a centrifugal embodying the present invention that the latter further provides a bottom discharge in an underdriven, link suspended machine having a fixed curb structure, and thereby fulfills all of the basic requirements for maximum convenience in installation and operation. Further, although the housing 46 for the bearings supporting the

basket shaft and the motor 55 for driving the basket are carried by the floating basket support 57 which is link suspended from pedestals disposed outside the fixed curb structure so as to permit gyratory movement in response to unbalanced loading of the basket, the passages 59 for the gravity discharge of solids from the basket defined between basket support 57 and the inner surface of curb skirt 27 do not communicate with the region surrounding curb skirt 27, by reason of the sealing bellows 72 and 73. Thus, when the curb structure is closed at the top following loading of the basket and curb skirt 27 is connected to a closed discharge conduit (not shown), the described centrifugal can be conveniently employed for the treatment of materials giving off noxious fumes, and such fumes are prevented from escaping into the surrounding atmosphere.

Although an illustrative embodiment of the invention has been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to that precise embodiment, and that various changes and modifications may be effected therein without departing from the scope or spirit of the invention, except as defined in the appended claims.

What is claimed is:

1. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket, a floating basket support, means rotatably mounting said basket on and transmitting the weight of the basket to said support, said basket support extending across the curb structure at a level below the basket and being cut away at at least one location under the basket bottom to provide a passageway for the free fall of solids vertically from the discharge opening, and links suspended at the outside of said curb structure and connected to said floating basket support to permit gyratory movement of the latter with said basket in response to unbalanced loading of the basket.

2. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a basket support carrying means rotatably mounting said basket thereon and transmitting the weight of the basket thereto and extending across said space and bordering at least two open passages lying between the axis of rotation of said basket and the inner surface of said curb skirt to serve for the gravity discharge of solids from said discharge opening of the basket, fixed pedestals arranged around the exterior of said curb structure, links suspended from said pedestals, said curb skirt having openings therein through which portions of said basket support extend to the outside of said curb skirt, said portions of the basket support being connected outside of the curb skirt to said links, thereby to mount said basket support for gyratory movement together with said basket in response to unbalanced loading of the basket.

3. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support carrying means rotatably mounting said basket thereon and extending across said space and bordering at least two open passages lying between the axis of rotation of said basket and the inner surface of said curb skirt to serve for the gravity discharge of solids from said discharge opening of the basket, fixed pedestals arranged around the exterior of said curb structure, links suspended from said pedestals, said curb skirt having openings therein through which portions of said basket support extend to the outside of said curb skirt, to said portions of the basket support being connected outside of the curb skirt, to said links, thereby to mount the latter for gyratory movement together with said basket in response to unbalanced loading of the basket, and flexible seals extending between said curb skirt and said portions of the basket support extending through said openings to isolate said gravity discharge passages from the region outside of said curb skirt.

4. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support carrying means rotatably mounting said basket thereon and extending across said space and bordering at least two open passages lying between the axis of rotation of said basket and the inner surface of said curb skirt to serve for the gravity discharge of solids from said discharge opening of the basket, drive means for rotating said basket including a hydraulic positive displacement motor supported by said basket support under and coaxially with said basket and directly coupled to said basket, fixed pedestals arranged around the exterior of said curb structure, links suspended from said pedestals, said curb skirt having openings therein through which portions of said basket support extend to the outside of said curb skirt, said portions of the basket support being connected outside of the curb skirt, to said links thereby to mount said basket support for gyratory movement together with said basket in response to unbalanced loading of the basket.

5. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support disposed below said basket and extending diametrically across said space to define open passages between the opposite sides of said support and the inner surface of said curb skirt serving for the gravity discharge of solids from said discharge opening of the basket, means rotatably mounting said basket on said support, said curb skirt having diametrically opposed openings therein through which said basket support extends to locations outside of said curb skirt, and suspension links swingably supported at spaced apart locations around the periphery of said curb structure, said basket support being swingably mounted at said locations outside of the curb skirt on the lower ends of said suspension links to permit gyratory movement of said basket support with said basket in response to unbalanced loading of the latter.

6. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support disposed below said basket and extending diametrically across said space to define open passages between the opposite sides of said support and the inner surface of said curb skirt serving for the gravity discharge of solids from said discharge opening of the basket, means rotatably mounting said basket on said support, said curb skirt having diametrically opposed openings therein through which said basket support extends to locations outside of said curb skirt, three fixed pedestals spaced apart uniformly around the periphery of said curb structure with one end of said basket support being directed toward one of said pedestals, the other end of said basket support being in the form of a laterally elongated extension located outside of said curb skirt and having the opposite ends of said extension directed generally toward the other two of said pedestals, a link swingably suspended, at its upper end, from each of said pedestals, and means swingably mounting said one end and said opposite ends of said basket support respectively on the lower ends of the links suspended from the respective pedestals adjacent to said ends so that said basket support is mounted for gyratory movement with said basket in response to unbalanced loading of the latter.

7. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of

the basket, a floating basket support disposed below said basket and extending diametrically across said space to define open passages between the opposite sides of said support and the inner surface of said curb skirt serving for the gravity discharge of solids from said discharge opening of the basket, means rotatably mounting said basket on said support, said curb skirt having diametrically opposed openings therein through which said basket support extends to locations outside of said curb skirt, three fixed pedestals spaced apart uniformly around the periphery of said curb structure with one end of said basket support being directed toward one of said pedestals, the other end of said basket support being in the form of a laterally elongated extension located outside of said curb skirt and having the opposite ends of said extension directed generally toward the other two of said pedestals, a link swingably suspended, at its upper end, from each of said pedestals, means swingably mounting said one end and said opposite ends of said basket support respectively on the lower ends of the links suspended from the respective pedestals adjacent to said ends so that said basket support is mounted for gyratory movement with said basket in response to unbalanced loading of the latter, and flexible sealing means between said basket support and said curb skirt at said openings in the latter to prevent the escape of gas through said openings from said passages into the region around said curb skirt.

8. A centrifugal as in claim 7; wherein said flexible sealing means includes a flexible bellows extending around said basket support at each of said openings in the curb skirt and secured, at its opposite ends, to said basket support and said curb skirt, respectively.

9. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support disposed below said basket and extending diametrically across said space to define open passages between the opposite sides of said support and the inner surface of said curb skirt serving for the gravity discharge of solids from said discharge opening of the basket, means rotatably mounting said basket on said support, said curb skirt having diametrically opposed openings therein through which said basket support extends to locations outside of said curb skirt, suspension links swingably supported at spaced apart locations around the periphery of said curb structure, said basket support being swingably mounted at said locations outside of the curb skirt on the lower ends of said suspension links to permit gyratory movement of said basket support with said basket in response to unbalanced loading of the latter, and drive means for rotating said basket including a hydraulic, positive displacement motor carried by said basket support under and coaxilly with said basket and directly coupled to the latter, a power unit at a fixed location outside of said curb structure having a pump for hydraulic fluid and conduit means leading from said pump to said motor to supply hydraulic fluid under pressure to the latter for operating said motor.

10. A centrifugal comprising a basket having a central, hollow hub with a bottom discharge opening around said hub and a shaft secured to said hub and extending downwardly through the latter, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support disposed below said basket and extending across said space to define at least two open passages between said basket support and the inner surface of said curb skirt serving for the gravity discharge of solids from said bottom discharge opening of the basket, a housing on said basket support extending upwardly into said hub with a clearance therebetween opening at the bottom of the hub and carrying bearings rotatably supporting said shaft of the basket, means movably supporting said basket support from locations outside of said curb structure, and means for supplying a purging inert gas to said clearance to purge corrosive gases and moisture therefrom, thereby to protect said bearings, and so that the inert gas emerging from said clearance can enter said basket through said bottom discharge opening for suppressing oxidation and explosion of chemical charge materials in the basket.

11. A centrifugal comprising a basket having a central, hollow hub with a bottom discharge opening around said hub and a shaft secured to said hub and extending downwardly through the latter, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support disposed below said basket and extending across said space to define at least two open passages between said basket support and the inner surface of said curb skirt serving for the gravity discharge of solids from said bottom discharge opening of the basket, a housing on said basket support extending upwardly into said hub with a clearance therebetween opening at the bottom of the hub and carrying bearings rotatably supporting said shaft of the basket, means movably supporting said basket support from locations outside of said curb structure, said housing having a passage extending upwardly therein and opening into said clearance between said hub and bearing housing, and conduit means extending through said basket support and connected to said passage of the bearing housing for supplying an inert gas which purges moisture and corrosive gases from said clearance and exits from the latter adjacent said bottom discharge opening of the basket so that the discharged inert gas can act in the basket to suppress explosions and oxidation of chemical charge materials.

12. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support disposed below said basket and extending diametrically across said space to define open passages between the opposite sides of said support and the inner surface of said curb skirt serving for the gravity discharge of solids from said discharge opening of the basket, means rotatably mounting said basket on said support, said curb skirt having diametrically opposed openings therein through which said basket support extends to locations outside of said curb skirt, fixed pedestals arranged around the outer periphery of said curb structure, a suspension link for each pedestal, joint means connecting the upper end of each link to the related pedestal, and joint means connecting said basket support at said locations outside of said curb skirt to the lower ends of said links, each of said joint means including a housing having a member movable therein with said link, each housing defining with the member movable therein spaces above and below that member, each of said spaces being completely filled with a flowable incompressible medium sealed in the space to permit angular displacement of said member with the link relative to the housing while strongly resisting relative displacement in the direction of the axis of the link.

13. A centrifugal comprising a basket having a bottom discharge opening, a fixed curb structure extending around said basket and having a depending curb skirt circumscribing a space below said bottom discharge opening of the basket, a floating basket support disposed below said basket and extending diametrically across said space to define open passages between the opposite sides of said support and the inner surface of said curb skirt serving for the gravity discharge of solids from said discharge opening of the basket, means rotatably mounting said basket on said support, fixed pedestals arranged around the outer periphery of said curb structure, said curb skirt having diametrically opposed openings therein through which the ends of said basket support extend towards said pedestals, an elongated link for connecting

each of said ends to the adjacent pedestal and having disc members adjacent the upper and lower ends of the link, housings on each end and pedestal, respectively, receiving the lower and upper disc members of the related link, each housing defining with the disc member received thereby spaces above and below that member, rubber rings completely filling each of said spaces, and sealing means preventing bulging of said rubber rings out of said spaces, so that each link is swingable with respect to the related pedestal and end while relative displacements in the direction of the axis of the link are prevented.

14. In a centrifugal, the combination of a basket with a hollow hub at the bottom thereof and a bottom discharge opening around said hub, a basket support disposed below said basket and having a bearing housing extending into said hub with a clearance therebetween opening at the bottom of said hub, a shaft extending from said hub into said housing, bearing means in said housing rotatably supporting said shaft, said housing having passage means therein opening into said clearance, and conduit means connected to said passage means for supplying an inert gas to purge corrosive gases and moisture from said clearance, thereby to protect said bearing means, and so that the inert gas energing from said clearance can enter said basket through said bottom discharge opening for suppressing oxidation and explosion of chemical charge materials in the basket.

15. In a centrifugal, the combination of a basket within a curb structure, a floating basket support rotatably carrying said basket and disposed below the latter, link suspension means comprising at least three normally vertical links spaced about and outside said curb structure and carrying said basket support to permit gyratory movement of the latter in response to unbalanced loading of the basket, and drive means for the basket including a hydraulic positive displacement motor carried by said basket support and directly coupled to said basket coaxially with the latter for rotating the basket, said motor having liquid inlet and liquid outlet ports, and being rotatable in one direction by liquid supplied under pressure to said inlet port and being brakable by obstruction of liquid flow from said outlet port, and means for supplying liquid under pressure to and for controlling the flow of liquid from said motor from a fixed location external to the centrifugal for operating said motor, said basket support and motor being substantially symmetrical about the axis of said basket so that said gyratory movement is always substantially circular.

16. In a centrifugal including a basket rotatable within a curb structure, a suspension for the basket permitting gyratory movement thereof in response to unbalanced loading thereof, said suspension comprising

fixed pedestals arranged about and outside said curb structure,

a support member carrying the basket and having end portions extending toward said pedestals,

an elongated link connecting each of said end portions to the adjacent pedestal,

each link having radial members fixed thereto adjacent its upper and lower ends,

housings on each said end portion and pedestal respectively receiving the lower and upper radial members of the related link,

each housing defining with the radial member received thereby spaces above and below that member,

incompressible elastic members completely filling said spaces,

the material of each of said elastic members being flowable under pressure applied thereto by the related radial member,

and sealing means preventing bulging of said elastic members out of said spaces

so that each link is swingable with respect to the related pedestal and end portion against the elastic resistance of the related elastic members while displacements of each link relative to the related pedestal in the direction of the axis of the link are positively prevented by the incompressibility of the elastic members.

17. In a centrifugal, the combination of

a basket rotatable within a fixed curb structure;

a suspension for the basket including

fixed pedestals arranged about and outside said curb structure,

a basket support rotatably carrying said basket and having end portions extending towards said pedestals,

an elongated, normally vertical link for each pedestal and end portion,

and means connecting each link swingably to the related pedestal and end portion while strongly resisting displacements of the link relative thereto in vertical direction;

and drive means for the basket including a hydraulic positive displacement motor carried by said basket support and directly coupled to the basket coaxially with the latter for rotating the basket,

said motor having liquid inlet and liquid outlet ports and being rotatable in one direction by liquid supplied under pressure to said inlet port and being brakable by obstruction of liquid flow from said outlet port,

and means for supplying liquid under pressure to, and for controlling the flow of liquid from, said motor from a fixed location external to the centrifugal,

said basket support and motor constituting a mass which is substantially symmetrical with respect to the axis of the basket,

so that the gyratory movement of the basket upon unbalanced loading thereof is circular and in a horizontal plane.

18. A centrifugal comprising:

a basket having an open bottom for the discharge of material therefrom,

a curb surrounding said basket,

a support below said basket carrying means rotatably supporting said basket on and transmitting the weight of the basket to said support,

a hydraulic positive displacement motor directly coupled to said basket for rotating said basket,

said motor being mounted on said support in a position under but adjacent to said basket with its mass distributed substantially symmetrically about the axis of rotation of said basket and being adapted to receive hydraulic motivating fluid from an external source,

suspension links swingably supported at locations spaced apart about and outside said curb,

a skirt surrounding the path of fall of material from the basket bottom and extending vertically from a location adjacent the bottom opening of the basket downwardly past said support to a location below said support,

said support extending across the space within said skirt and having end portions extending through said skirt and connected to said links,

and vertically open passageways for the fall of said material between said support and opposite wall portions of said skirt.

19. A centrifugal comprising:

a basket having an open bottom for the discharge of material therefrom,

a curb surrounding said basket,

a support below said basket carrying means rotatably supporting said basket thereabove,

a hydraulic positive displacement motor directly coupled to said basket for rotating said basket,

said motor being mounted on said support in a position under but adjacent to said basket with its mass distributed substantially symmetrically

about the axis of rotation of said basket and being adapted to receive hydraulic motivating fluid from an external source,

pedestals spaced apart about and outside said curb,

suspension links swingably supported at their upper ends from said pedestals,

a skirt surrounding the path of fall of material from the basket bottom and extending vertically from a location adjacent the bottom opening of the basket downwardly past said support to a location below said support,

said support extending across the space within said skirt and having end portions extending through said skirt and swingably connected to the lower ends of said links,

and vertically open passageways for the fall of said material between said support and opposite wall portions of said skirt,

said curb, said pedestals and said skirt being mounted

in fixed positions, and said support with said motor and said basket being mounted by said links for gyratory movement in a horizontal plane.

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