May 27, 1958 T. R. SMITH 2,836,083

BALANCING RING SYSTEM FOR ROTATABLE RECEPTACLES

Filed Aug. 25, 1951 2 Sheets-Sheet 1

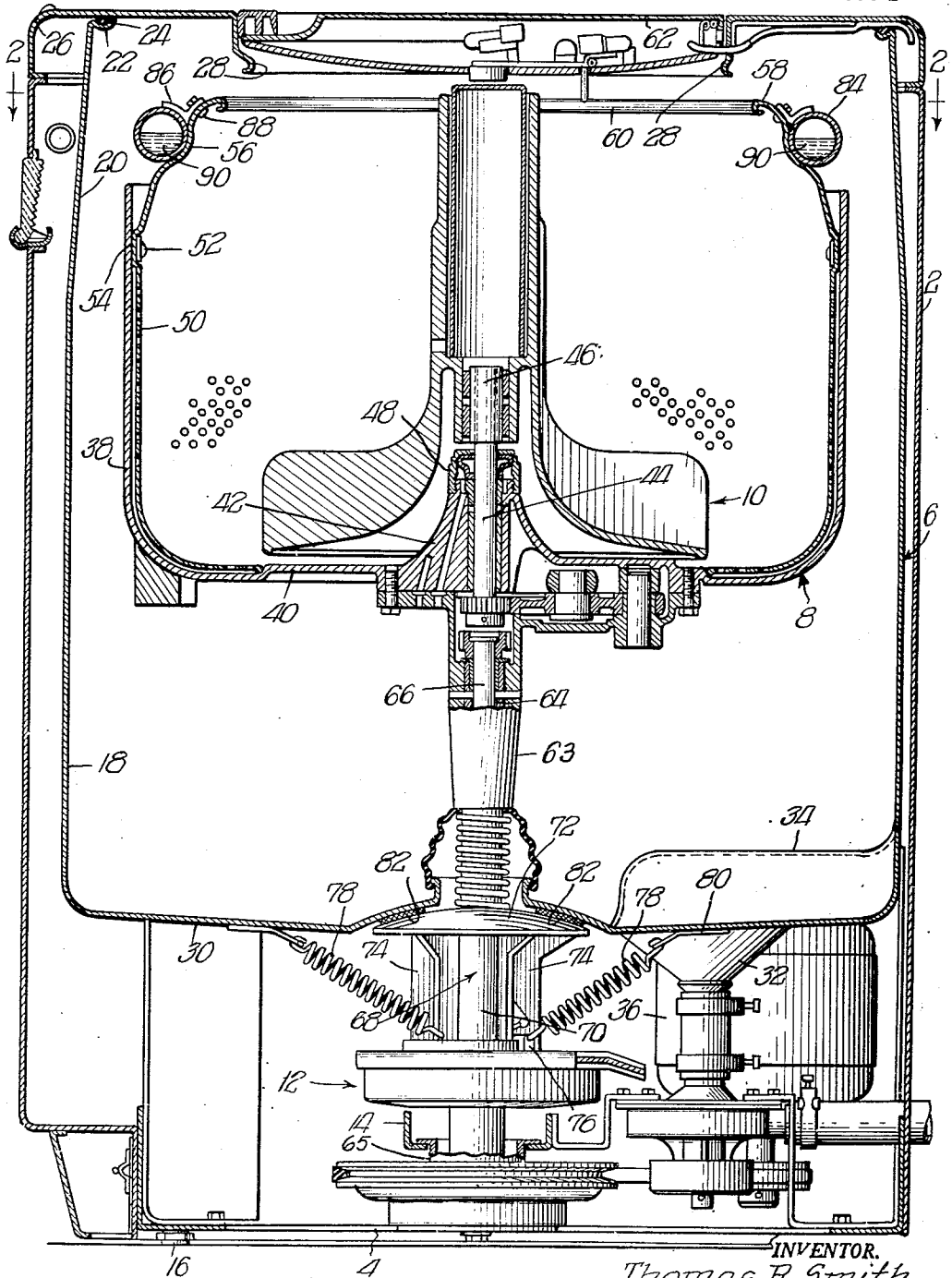


Fig. 1.

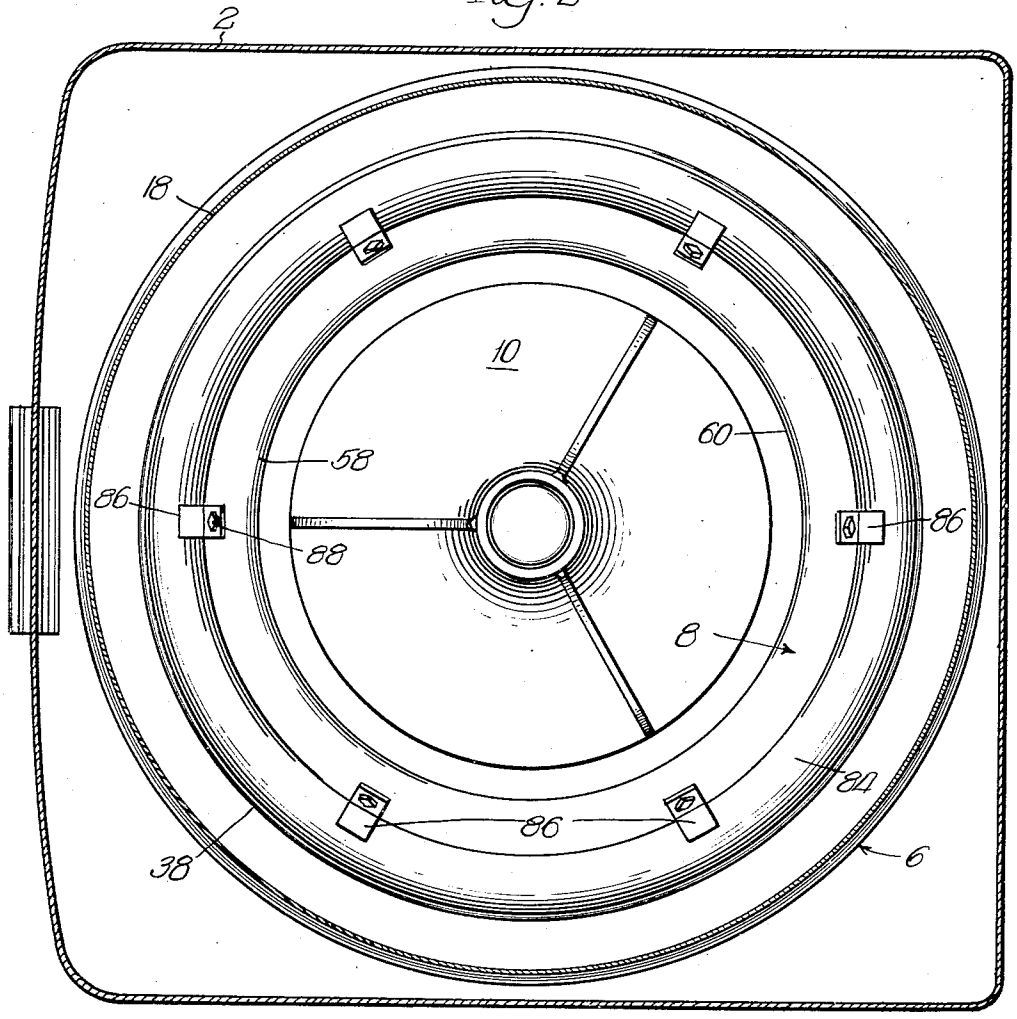
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Fig. 2



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United States Patent Office

2,836,083

Patented May 27, 1958

2,836,083

BALANCING RING SYSTEM FOR ROTATABLE RECEPTACLES

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Application August 25, 1951, Serial No. 243,647

4 Claims. (Cl. 74—573)

This invention relates to centrifuging machines and more particularly to a balancing system for a container which is adapted to be rapidly rotated to extract liquid from the material contained therein to effect at least a partial drying thereof.

In washing machines having a rotatable tub, for example, it is common practice to mount the tub on a centrally disposed support at the base thereof, which mounting permits resiliently, restricted lateral movement of the tub as it is rotated, if it is not completely in balance. With such a mounting and drive mechanism for the rotatable tub, it is also necessary to provide means to dampen out and control such lateral deviations or vibrations of the rotated tub. This form of control is normally divided into two components since the effectiveness of particular types of control will vary depending upon the speed at which the tub is rotated. For example, when the tub is rotating below its critical speed it will normally tend to gyrate about its supporting axis, if the load of material being washed is not equally distributed so that the tub is substantially in balance. After the speed of rotation of the tub is increased through the critical speed of the tub, these gyrations will disappear and the tub will shift in such a fashion as to seek a new axis of rotation distinct from the normal vertical axis. The degree to which the tub will shift its axis of rotation will normally be determined by the degree to which the load therein is unbalanced, since above the critical speed of the tube and its contents, it tends to rotate about a new center of gravity which is different from a geometrical center of the tub.

One method of dealing with this same problem has been disclosed by applicant in his application, Serial No. 66,230, filed December 20, 1948. This application discloses a washing machine of the character described which is provided with an annular member in the form of a hollow tube disposed in concentric relation with the upper portion of the rotatable tub. In the particular embodiment disclosed therein the balancing member is packed with steel wool or other material providing a large amount of exposed area for restricting and retarding the movement of a balancing fluid partially filling the interior of the ring.

In addition to this annular balancing member a stabilizer and damper assembly is provided in the device disclosed in the previously filed application, referred to above, which assembly may be incorporated in the present embodiment.

A disadvantage of the form of balancing assembly disclosed in applicant's previously filed application is that at speeds below the critical speed, the balancing liquid in the annular balancing member has a tendency to actually increase the unbalanced load. Above the critical speed, of course, the fluid alters its distribution within the balancing ring in such a way as to help bring the spinning assembly back into balance wherein the geometrical axis of the assembly and the center of gravity of the unbalanced mass are more nearly coincident.

Because of this undesirable feature at the speeds below the critical speed, applicant has dveloped a new type of balancing system which utilizes a thixotropic liquid within the annular balancing member which alters the characteristics of the system in such a way as to overcome this disadvantage.

It is therefore an object of this invention to provide a balancing system for rotatable containers in centrifuging machines which is effective at speeds above the critical speed of the container to maintain the container in balance and yet which does not tend to emphasize any variation or deviation at speeds below the critical speed of the container.

Another object of this invention is to provide a balancing system which is operable to dampen out and control vibrations and other deteriorating forces normally occurring above the critical speed of such an assembly when the load in the container is not substantially in balance.

Still another object is to provide a balancing system of the character described which is relatively simple in construction and which is particularly useful with a rotating container ssembly that is centrally and resiliently supported at the base thereof.

Yet another object of this invention is to provide a balancing system of the character described which is readily and easily maintained in operating condition at a relatively low cost.

Further objects and advantages of this invention will become evident as the description proceeds, and from an examination of the accompanying drawing which ilustrates one embodiment of the invention and in which similar numerals refer to similar parts throughout the several views.

In the drawings:

Figure 1 is a vertical cross sectional view of one form of washing machine embodying the present invention;

Figure 2 is a view in horizontal section of the washing machine shown in Figure 1, the view being taken along the line 2—2 thereof.

Although applicant has chosen to illustrate his invention as it is applied to a washing machine, it obviously could be utilized with any centrifuging device having a rotating container.

The washing machine shown in Figure 1 is substantially the same machine disclosed in applicant's previously filed application, referred to above, and therefore only the portions thereof which relate in some respects to the balancing system will be described in detail.

The machine may be provided with a casing or cabinet 2 which completely encloses the various parts and is supported on the base structure 4 which also serves to support an outer tub 6. A rotatable tub 8 is mounted within the outer tub 6 and is provided with an agitator or washing device 10 which is, in turn, operated by suitable mechanism 12, the rotatable tub and agitator assembly being suitably supported on the base structure 4. The base structure 4 has secured thereto a channel-shaped frame member 14 for resiliently supporting the inner tub 8 and its associated mechanisms. The base portion 4 is also provided with a short foot or adjustable leg portion 16 comprising a threaded nut secured to the base structure and an adjustable threaded shank having an enlarged head with a center point thereon facing toward and being adapted to penetrate the floor or foundation. These adjustable legs are provided to maintain all four supporting points of the machine in contact with the floor and at the same time to maintain the machine level. This tends to prevent any vibrations which may be set up in the machine from moving or displacing the machine from its operating position. Any suitable locking means may be provided to lock the same in any

adjusted position after the washing machine has been leveled.

The outer tube 6 is formed with a side wall having its lower portion 18 cylindrical in horizontal cross section and its upper portion 20 frusto-conical in shape which terminates in an inwardly extending flange 22 provided with an annular curved recess or groove adapted to receive a toroidal shaped sealing element 24 of resilient and compressible material, such as rubber or the like, which fits within the recess or groove and is compressed against the inner surface of the top wall or cover 26 in spaced relation to the opening 28 thereof to provide a fluidtight joint therebetween and to prevent water within the tub 6 from leaking into the chamber or compartment formed between the outer tub 6 and the cabinet 2 and into the lower part of the cabinet disposed below the said outer tub 6. The outer tub 6 is further formed with a bottom wall 30 sloping inwardly and downwardly from the side wall portion 18 for the purpose of draining liquid falling into the bottom of the outer tub to the conical shaped drain outlet 32 depending from the bottom wall. The tub 6 is also provided with an offset portion 34 which extends upwardly into the tub to provide clearance for the motor 36 which operates the washing machine.

The inner tub 8 disposed within the outer tub 6 is formed in two sections or parts, the outer part having an imperforate side wall 38 and an imperforate bottom wall 40 formed with a central hub 42 in which a shaft 44 is journaled. This shaft extends above the hub portion 42 and is splined, as at 46, to the agitator 10 which is mounted thereon. A sealing device, generally referred to as 48, embraces the upper end of the shaft 44 and the hub 42 provides a fluid-tight joint between the shaft and the interior of the tub 8.

The inner part or section of the tub 8 is in the form of a perforate basket 50, the lower portion of which is disposed in substantially parallel relation to the side and bottom walls 38 and 40 of the outer imperforate part of the tub 8. The inner basket is rigidly secured to the side wall 38 by means of a plurality of screws 52 and is held in spaced relation to the outer imperforate tub by means of the outwardly cupped portions 54 on the inner basket 50 to provide a channel which allows heavy dirt and the like to settle out below the basket so that when the tub 8 is rotated such heavy dirt and the like will be carried by the water passing through the perforations and flowing between the basket and the outer imperforate tub over the top of the wall 38 without passing through the clothes contained within the inner tub 8. The upper portion 56 of the basket 50 is imperforate and extends upwardly and inwardly and terminates in the rolled edge 58 defining an opening 60 disposed in association with the opening 28 whereby the operator is able to gain access to the interior of the rotatable tub 8 when the lid 62 is lifted. The upper portion 56 of the tub 8, by virtue of its inward inclination, serves to restrict the upward movement of clothes or other material contained within the tub 8 when the same is rotated during a drying operation.

The bottom of the tub 8, through the depending hub member 63, has the upper end of the hollow shaft 64 centrally secured thereto, which shaft extends downwardly through an opening in the bottom wall 30 of the outer tub 6 and terminates in a restricted end portion mounted upon a radial and thrust bearing generally indicated by numeral 65 which is, in turn, resiliently supported in the supporting member 14 secured to the base structure 4.

An inner drive shaft 66 is disposed within the hollow shaft 64 and supported by bearings, so as to permit the inner shaft to rotate relatively thereto. Through a suitable arrangement the agitator 10 may be oscillated by rotation of the shaft 66 or the tub 8 may be rapidly rotated by rotation thereof. A suitable clutch mechanism is provided for effecting a driving relation between the inner shaft 66 and the outer shaft 64. Another clutch construction provides for the delivery of a constant torque to the shaft 66 which cannot be exceeded whereby that shaft can be brought gradually up to the speed required for the spinning operation without causing damage to the motor 36 because of excessive loads during the starting period. A damper mechanism 68 in the form of a hollow sleeve 70 with a dome-like collar 72 thereon, is also provided through which the shaft 64 passes.

The sleeve 70 may be provided with a plurality of webs 74, the present embodiment having four, of which two are shown in Figure 1. Each such web is provided at its lower end with an aperture 76 engaged by the end of a coil spring 78. Each of these springs extends at an angle to the vertical axis of the sleeve 70 and has its opposite end mounted in a bracket 80 rigidly secured to the bottom wall 30 of the outer tub 6. Due to the angular disposition of the springs 78 with respect to the vertical axis of the sleeve 70 and their connection to the tub 6, a component of the spring force is applied in a vertical direction to the friction material 82 disposed between the collar 72 and the bottom 30 of the tub 6. It is also apparent that inasmuch as the springs 78 are equally loaded and the springs of each pair are disposed in opposite relation to one another, the spring forces acting through the hollow sleeve 70 will tend to return the tub 8 to its neutral or vertical position where the spring forces are all equal or opposite should said tub 8 tend to move away from its normal vertical position. It is further apparent that the friction material 82 is forced by the springs into effective frictional engagement with the spherical undersurface of the bottom wall 30 of the outer tub and that as the receptacle tends to move in a horizontal plane a certain portion of the energy tending to move the receptacle is absorbed by the friciton material. The friction material, therefore, tends to reduce the amplitude or extent of horizontal movement of the inner tub and absorbs some of the energy applied thereto when the said tub wobbles or moves laterally under eccentric loadings within the tub during the spinning operation.

To provide for additional control of the spinning tub, the upper edge thereof has mounted thereon in concentric relation thereto a hollow, toroidal, tubular member 84 by means of a plurality of brackets 86 secured to said wall portion 56 by means of bolts 88 or the like. As is obvious from Figure 1, the outside diameter of the balancing member 84 is less than the diameter of the tub 8 so that the tubular member will not be engaged by the wall 20 of the outer tub in the event of excessive wobbling or gyratory movement of the inner tub. Disposed in the interior of the tubular member 84 is a thixotropic material 90 of such character that it will remain in a solid or semi-solid state until the tub 8, when rotated, reaches a speed slightly above the critical speed of the tub assembly. In other words, the balancing substance 90 within the tubular member or balancing ring 84 will be substantially immobile at speeds below the critical speed of the tub assembly but when the centrifugal forces applied thereto by such rotation of the tub attain a particular value, it will begin to flow. The resultant movement thereof will be in accordance with the forces exerted thereon by a shifting of the axis of rotation of the tub. The beneficial action of the thixotropic substance acting as a fluid, and therefore as a balancing medium for the spinning tub, is therefore obtained above the critical speed of the tub assembly without the accompanying undesirable feature of the same substance acting as an unbalancing medium below the critical speed. As a matter of fact the fluid being substantially immobile below the critical speed its mass acts to help hold

the tub from deviating from its normal geometrical center.

An additional feature of this type of arrangement is that at the end of the extracting operation, the spinning tub may be rapidly decelerated by the use of a suitable brake member. In such a case, this deceleration tends to redistribute the balancing material evenly about the tubular member 84 so that it has the proper distribution therein when the tub is again rotated below its critical speed.

One form of such thixotropic material which has been successfully utilized in such an application is acetylene tetra bromide, to which has been added as a thickener and damping material, silica aerogel. One form of silica aerogel which is satisfactory for this purpose is sold under the name Santocel by the Monsanto Chemical Co. of Springfield, Massachusetts. The major portion of the product Santocel is silicon dioxide (silica) and the remainder is impurities consisting of volatiles, sodium sulfate, aluminum oxide, and ferric oxide. More specifically, Santocel is represented by the manufacturer as being 89.5 to 94% finely divided silicon dioxide, by weight, in the form of silica aerogel in which the particles may vary in size from 3 microns to that which will pass through a 200-mesh screen.

One satisfactory mixture has been utilized as the balancing fluid is made up of the following percentages by weight:

93.5% acetylene tetra bromide
1.5% Santocel
5% basic lead carbonate

The basic lead carbonate is merely a stabilizer for the acetylene tetra bromide. This mixture normally has a viscosity of 20,000 centipoises at 25° C.

It may be that there are other substances having the characteristics of this mixture which could be used to an advantage in such an application, the primary requisite being that the fluid be heavy and viscous with the additional property of being thixotropic. However, application has found the above composition to be the most satisfactory.

The drawing and the above discussion are not intended to represent the only possible forms of this invention in regard to details of construction. Changes in form and in the proportion of parts, as well as the substitution of equivalents, are contemplated, as circumstances may suggest or render expedient, without departing from the spirit or scope of this invention, as further defined in the following claims.

It is claimed:

1. A balancing system for a rotatable container mounted on a vertical axis and adapted to hold articles to be rotated with said container, a closed annular duct carried by said container concentric to the geometric axis of said container, a thixotropic substance partially filling said duct and remaining immobile below the critical speed of said container, and means for rotating said container above said critical speed to flow said substance within said duct and minimize possible unbalanced conditions resulting from the presence of said articles within said container.

2. A balancing system comprising a member rotatable about a substantially vertical axis, a closed annular duct carried by said member concentric to the geometric axis of said member, a thixotropic material partially filling said annular duct and remaining immobile within said duct at rotational speeds less than the critical speed of said member, and means for rotating said member above said critical speed to cause said thixotropic material to flow within said annular duct and minimize lateral deviations of said member from said vertical axis under unbalanced conditions of said member.

3. A balancing system comprising a member rotatable about a substantially vertical axis and laterally movable from said axis under unbalanced conditions of said member, a closed annular duct carried adjacent the periphery of said member and concentric to the geometric axis of said member, a thixotropic material partially filling said duct and remaining in an immobile state when said member is rotated at speeds less than the critical speed of said member, and means to rotate said member at speeds in excess of said critical speed to move said thixotropic material within said duct to minimize the deviations of said geometric axis from said vertical axis under unbalanced conditions of said member.

4. A balancing system comprising a member rotatable about its geometric axis, a closed annular duct attached to said member and concentric to said axis, a thixotropic substance partially filling said duct and remaining immobile below said member's critical speed of rotation, and means to rotate said member from rest to above its critical speed to render said thixotropic substance mobile to compensate for unbalanced conditions of said member.

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