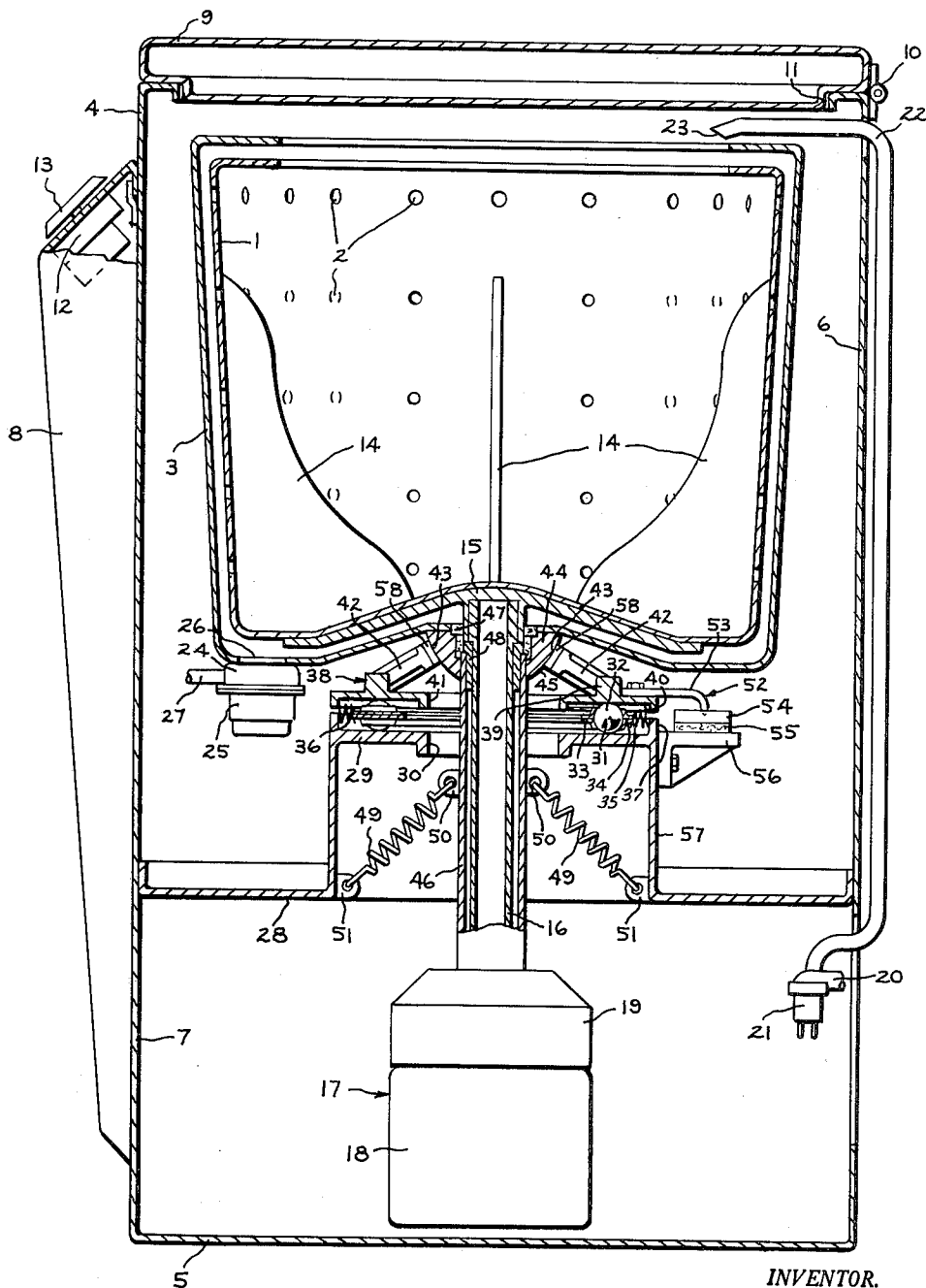


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COMBINED WASHING AND CENTRIFUGING MACHINE WITH
VIBRATION-ISOLATING SUSPENSION SYSTEM
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COMBINED WASHING AND CENTRIFUGING MACHINE WITH VIBRATION-ISOLATING SUSPENSION SYSTEM

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This invention relates to centrifuging machines, and more particularly to such machines wherein improved vibration-isolating means are provided to prevent unbalance-caused vibrations of the rotating parts from being transmitted to the casing of the machine to the extent that damage to or "walking" of the machine may occur.

In addition to the need for isolating vibrations of the rotating parts of a centrifuging machine from the stationary parts thereof, it is often also necessary to allow the moving parts of the apparatus only a certain number of degrees of freedom. As an example of the problems encountered along this line, most automatic washing machines of the type presently commercially available for domestic use provide a clothes basket in which the clothes are washed and rinsed, and then the basket is rotated at a high speed so as to centrifuge the liquid out of the clothes. Very often the system for effecting this washing and centrifuging operation does not have its weight symmetrically distributed about the axis of rotation, so that there is inherently an unbalance in the system. In addition, the clothes which are being laundered often will not distribute themselves perfectly about the inner surface of the clothes receptacle, but will instead provide an additional unbalance. Nonetheless, despite these unbalances, vibration-caused motion of the moving system must be maintained within reasonable limits within a supporting frame or cabinet small enough to be commercially attractive for home usage.

It is therefore an object of my invention to provide, in apparatus having parts rotatable at high speed, an improved vibration-isolating suspension system.

As a further object, directed toward a more specific structure, I provide by my invention an improved vibration isolating suspension system for vertical axis washing machines.

A specific object of the invention is to provide a vibration-isolating suspension system for centrifuging machines wherein the suspension is effected by providing for horizontal motion of an intermediate supporting structure on a frame, and then tilting motion of a moving system on the intermediate structure; this permits the moving system to have all degrees of freedom of movement, save for vertical motion which is substantially restrained. This restriction of vertical motion is highly desirable in vertical-axis washing machines, both for optimum functioning of the machine itself and because of restrictions on the size of a commercially successful appliance for home use.

In one aspect of my invention, I provide a centrifuging machine in which an assembly is supported on a horizontal surface formed on a rigid frame so as to be movable in all directions on the surface, and is biased to a substantially centered position. A moving system including a rotatable container is mounted for rotation on a substantially vertical axis and further includes drive means positioned below the container in rotative relation thereto. The moving system is provided with a support portion substantially coaxial with and below the container, the support portion being supported on the assembly in tiltable relation thereto. The mass of the moving system is so distributed as to cause its center of gravity always to move up upon movement of the container away from a vertical axis during tilting of the support

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portion on the assembly. This combination permits horizontal movement in all directions and also permits tilting, or rocking, movement about all horizontal axes and the vertical axis of the system. The only degree of freedom of movement which has been eliminated is movement of the assembly along a vertical axis.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. The invention itself, however, both as to organization and method of operation together with further object and advantages thereof, may best be understood by reference to the following detailed description taken in conjunction with the accompanying drawing.

In the drawing, the single FIGURE is a side elevational view, partly broken away and partly in cross section to show details, of a centrifuging machine, more particularly a vertical axis washing machine, incorporating the improved suspension system of my invention.

Referring now to the figure of the drawing, there is shown therein a vertical axis centrifuging machine which, for illustrative purposes, is depicted as a washing machine having a clothes basket 1 provided over its entire side wall with perforations 2 and which is disposed within an outer imperforate tub or casing 3. Enclosing basket 1 and tub 3 is a frame in the form of an appearance cabinet 4 which includes a base 5, a vertically extending back wall 6, a vertically extending front wall 7 with a control panel 8, and a lid 9 pivotable on a hinge 10. In closed position, lid 9 covers opening 11 provided to afford access to the interior of basket 1 so that clothes may be inserted into and removed from the basket. Secured on the control panel 8 is an appropriate sequence control device 12 which may be preset by means of a manually operable member 13 to provide a washing operation.

Within basket 1, suitable means are provided for effecting a circulatory motion of water contained therein in order to effect washing of clothes placed in the basket. In the present case, these means comprise vanes 14; as will be further described herebelow, the basket 1 may be oscillated and during such oscillation the vanes 14 cause a suitable circulatory motion of the water in the basket to effect washing of the clothes. It will, of course, be recognized that a separate agitator device may be provided extending up into the basket 1 as is the case with many commercially available machines, but for simplicity of the explanation of the general structure the vanes 14 may be considered as typical.

The basket 1 is rigidly secured through an intermediate supporting flanged member 15 to a shaft 16 formed substantially coaxially with basket 1 and extending downwardly into a driving and transmission structure generally indicated by the numeral 17. In the conventional manner, the structure may include a reversible electric motor 18; when motor 18 is rotated in one direction, a transmission 19 transmits the motor movement to the shaft 16 so as to cause rotation of basket 1 at high speed for centrifuging purposes; when the motor rotates in the opposite direction the transmission 19 causes it to provide an oscillatory motion to the shaft 16. This oscillates the basket back and forth to cause vanes 14 to circulate water therein in the appropriate manner for washing purposes. Transmissions for effecting a rotary motion of a shaft in one direction of rotation of a motor and an oscillatory motion of the shaft in the opposite direction of the motor are well known in the art, and therefore the transmission is not described in detail herein.

Conventional means for introducing water into the machine are provided. These are schematically shown in the present case by an inlet conduit 20 leading into a valve 21 which controls flow of liquid through a conduit 22 having an outlet 23 discharging into the basket

1. Of course, both hot and cold water may be brought into the machine in this manner so that hot, cold or warm (mixed) water may be used for any given operation. In order to discharge liquid from the machine, a suitable pump 24, which may be driven by any desired means such as a separate motor 25 for instance, is secured to the tub 3 so as to have an inlet 26 communicating with the lowest point in the tub. The pump 24 leads through a suitable conduit 27 to an appropriate drain (not shown) so that when removal of the water is desired (as during centrifuging operations for instance) motor 25 may be energized to run pump 24 which then pumps water from the tub 3 through inlet 26 and then through conduit 27 to drain.

With the structure described thus far, a suitable sequence of operations may be provided in the machine. As one typical cycle, a liquid may be introduced by energization of valve 21 for a period appropriate to fill basket 1 and tub 3 to the desired level; then the motor 18 is energized in the direction to cause basket 1 to oscillate back and forth to wash the clothes. After a predetermined period of this washing action, the motor 18 is reversed and the motor 25 is energized to cause, respectively, the basket to rotate at a high centrifuging speed and the pump to remove the liquid from the basket 1 and tub 3. Liquid centrifuged out of the clothes passes through the perforations 2 into the outer tub 3 and then is removed by the pump. Following this extraction operation, a supply of clean liquid may then be introduced into the basket to rinse the clothes as the basket is once again oscillated. Finally, the basket may then be once more rotated at high speed to extract the rinse water and discharge it from the clothes for removal by pump 24. All of these operations may be effected automatically in sequence by suitable connections from control 10 to the operating components; the control of the components by conventional sequence control means is well known in the art and therefore is not further described herein.

Rigidly secured to the vertically extending walls of cabinet 4 is a rigid member 28 which includes an annular horizontally extending portion 29 having a central opening 30 providing a wide clearance for the assembly which includes the downwardly extending shaft 16. Positioned on the surface of horizontal member 29 is a ball bearing type structure, generally indicated by the numeral 31, which includes a number of balls 32 spaced in a circle and secured together by inner and outer races 33 and 34. The outer race 34 may be provided with a number of evenly spaced projections 35 on which an equal number of relatively light coil springs 36 are provided with their outer ends seated against an upwardly extending member 37 formed at the radially outer edge of member 29. With this structure, it can be seen that the balls 32 are free to roll on the surface 29 in any horizontal direction, subject only to the limitation on their movement provided by the springs 36. As stated, a number of these springs are equally spaced around the member 31; this exerts a force biasing the member 31 to a centered position within cabinet 4 yet does not prevent movement of member 31 away from the centered position.

Positioned so as to be supported by the balls 32 is an assembly, generally indicated by the numeral 38, having an annular section 39 with a flat lower surface 40 adapted to be engaged by the balls 32. It will readily be seen that the assembly 38 is horizontally movable in any direction relative to the frame 4 since the balls 32 of member 31 will roll in any horizontal direction thereby to permit movement of assembly 38.

Annular part 39 of assembly 38 has a central opening 41 similar to opening 30 of member 29 and provided for the same purpose, that is, to provide substantial clearance for the assembly which includes the downwardly extending shaft 16. Extending upwardly

and inwardly from the annular part 39 are suitable support means which may, as shown, be a number of equally spaced arms 42 which terminate at their inner ends in surfaces 43 which are formed as surface portions of a sphere. Nested within these members 42 and supported thereby is a member 44 having a spherical surface 45 and which forms a part of the centrifuging system secured in rigid relationship to the tub 3; in the present case, the securement is directly achieved by positioning the member 44 immediately below the tub. Surfaces 43 and 45 are formed as parts of a single sphere having its center on the axis of rotation of basket 1, so that in effect the part 44 may tilt, or rock, in any direction within the supporting members 42.

As stated, member 44 is secured to the bottom of the tub 3. In addition, the bottom of member 44 is rigidly secured to a sleeve member 46 which extends downwardly about rotatable shaft 16 and, at its base, supports the driving assembly 17. Thus, the tub 3 and basket 1 are joined to the driving assembly 17 through shaft 16 and sleeve 46 so as to form together a moving system tiltably supported by the engagement of member 44 within members 42. This moving system may, of course, include suitable sealing means 47 interposed between the nonrotating tub 3 and the rotating member 15 so as to prevent leakage of water down from the tub, and may also include a suitable top bearing member 48 for providing a top rotatable support for the shaft 16 and basket 1, it being understood that suitable bearing means for rotatably supporting the shaft 16 may be provided down within the transmission 17 in the usual manner (not shown).

As an important part of my invention, I cause the mass distribution of the moving system to be such that its center of gravity is sufficiently low that upon tilting of the system (by movement of the member 44 in members 42) the center of gravity will always move up upon movement of shaft 16 away from a vertical axis. This may be readily effected by causing the motor 18 and transmission 19 to have sufficient mass to insure that, even when basket 1 is full of clothes and the tub 3 is full of water, the center of gravity of the system will not rise above the center of the sphere of which surfaces 43 and 45 are a part. When this relationship is provided, it insures stability of the system: when tilted away from a vertical axis, the system always tries to right itself because its center of gravity attempts to move down to its lowest point, and at its lowest point the system is in its desired vertical position.

Suitable means are necessary to establish correct horizontal positioning of the system since the system is made free to move in all horizontal directions. In order to achieve this, suitable relatively light coil springs 49 (two or more, and preferably equispaced) are provided connected at one end to lugs 50 extending from sleeve 46 and at the other end to lugs 51 which form a part of member 28. Since any horizontal movement of the system of assembly 38 away from the position shown will permit retraction of one of springs 49 and cause extension of another one of springs 49, the springs tend to return assembly 38 and the moving system to a horizontally centered position. In addition, springs 49 limit any pivoting of the moving system about a vertical axis.

As basket 1 is brought up in rotational speed from its rest condition to its maximum speed, it passes through various critical speeds, also known as resonant speeds. As the critical speed, the frame-vibrating forces which are caused by rotating unbalances are at a peak. It is usually, although not invariably, desirable to provide suitable energy absorbing or damping means which will absorb this energy of the frame vibrating force of the moving system as it passes through critical speeds. For this purpose, suitable damping means may be provided. In this connection, I have shown damping means for the horizontal forces which, as shown, may be provided by

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equispaced assemblies such as the one generally shown by the numeral 52 in which a spring arm 53 extends outwardly from member 39 and terminates in a horizontally extending member 54 having a surface 55 formed of a suitable damping material such as, for instance, nylon or brake lining material similar to that used on automobile brakes. The spring arm 53 causes the member 54 to bear down on the flat surface of a member 56 rigidly secured to upwardly extending portion 57 of member 28, so that as horizontal movement is caused by rotating unbalances in basket 1 the surface 55 will rub on member 56 thereby to absorb energy.

In addition, the inner ends 58 of members 42 may also be formed of the same suitable damping material, or a different damping material, so that the rubbing of surface 45 on the surfaces 43 also cause dissipation or absorption of energy. It is to be noted with respect to the damping structures that, because the suspension arrangement described is formed primarily of rigid members (the springs 36 and 49 serving primarily to limit motion rather than as supports), it causes the critical speeds of the system to be very low. This in turn permits the amount of damping which must be provided to be kept to a minimum, it being recognized that damping is merely the absorption of energy in the form of heat and consequently useless except insofar as it assists in permitting the system to pass through critical speed without undue vibration-causing forces being transmitted to the frame 4.

In effect, when the drive system 17 is causing high speed rotation of basket 1 through shaft 16, horizontal movement occurs as a result of the assembly 38 rolling on the ball bearing assembly 31. Also, tilting movement in all directions occurs as a result of the member 44 being supported within the members 42. The combination of these two supporting structures provides, in effect, five degrees of freedom for basket 1 relative to frame 4 (two horizontal degrees of freedom, two degrees of freedom to pivot about horizontal axes, and one degree of freedom to pivot about a vertical axis). This leaves only the vertical direction of movement in which no freedom is provided. It has been found that the forces in this direction are relatively small and therefore are not likely to cause harmful transmission of vibrational forces to the frame. In addition, the structure of vertical axis washing machines in particular among centrifuging machines is such that any degree of vertical freedom is generally undesirable.

It will be recognized that the essence of the invention is to provide a horizontally movable support which in turn permits rocking movement of the moving system. Thus, while a particular arrangement for permitting movement on a horizontal surface has been provided for illustrative purposes, it will be recognized that the invention is not confined thereto. Similarly, while a particular structure for permitting tilting motion has been provided, other structures permitting the same tilting effect may also be used. For instance, while spherical surfaces which, relative to the clothes receptacle, are concave have been provided, it is also possible to provide spherical surfaces convex relative to the receptacle. The major effect of such a change would be to lower the center point of rotation around which the spherical surfaces are formed, and thereby to lower the highest point at which the center of gravity of the moving system may be provided.

Thus, while in accordance with the Patent Statutes I have described what at present is considered to be the preferred embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and I therefore aim in the appended claims to cover all such changes and modifications as fall with the true spirit and scope of my invention.

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What I claim as new and desire to secure by Letters Patent of the United States is:

1. A centrifuging machine comprising: a rigid support frame including a horizontal surface; an assembly supported on said surface and movable thereon in all directions relative thereto; means biasing said assembly to a predetermined position relative to said surface; and a moving system including a container mounted for rotation on a substantially vertical axis, drive means positioned below said container in rotative relation thereto, and a support portion substantially coaxial with and below said container; said support portion and said assembly being formed so that said support portion is supported on said assembly in tiltable relation thereto, said moving system having its mass distributed low enough to cause its center of gravity always to move up upon movement of said container away from a vertical axis during tilting of said support portion of said assembly.

2. The apparatus defined in claim 1 wherein said support portion and said assembly have mating spherical surfaces whose center is on the axis of rotation of said container.

3. The apparatus defined in claim 1 wherein said support portion and said assembly have mating spherical surfaces concave relative to said container and whose center is on the axis of rotation of said container.

4. The apparatus defined in claim 1 wherein said drive means is positioned below said support portion.

5. The apparatus defined in claim 1 wherein said drive means is positioned below said support portion coaxially therewith.

6. A centrifuging machine comprising: a rigid support frame having a horizontal surface; ball bearing means rollably seated on said frame surface; an assembly seated on said ball bearing means in rollable relation thereto; means biasing said assembly to a predetermined position relative to said frame; and a moving system including a container mounted for rotation on a substantially vertical axis, drive means positioned below said container in rotative relation thereto, and a support portion substantially coaxial with and below said container; said support portion and said assembly being formed so that said support portion is supported on said assembly in tiltable relation thereto, said moving system having its mass distributed low enough to cause its center of gravity always to move up upon movement of said container away from a vertical axis during tilting of said support portion on said assembly.

7. A vertical axis washing machine comprising: a cabinet including a rigid support frame including a horizontal surface; an assembly supported on said surface and movable thereon in all directions relative thereto; means biasing said assembly to a substantially centered position relative to said cabinet; and a moving system including an imperforate substantially non-rotatable tub, a clothes basket nested within said tub and rotatable on a substantially vertical axis, means within said basket for washing clothes therewithin, drive means positioned below said basket and connected thereto, said drive means being effective alternatively to operate to cause washing of clothes in said basket and rotation of said basket to centrifuge liquid out of the clothes therein, and a support portion substantially coaxial with and below said basket; said support portion and said assembly being formed so that said support portion is supported on said assembly in tiltable relation thereto, said moving system having its mass distributed low enough to cause its center of gravity always to move up upon movement of said container away from a vertical axis during tilting of said support portion on said assembly.

8. The apparatus defined in claim 7 wherein said support portion and said assembly are provided with engaging spherical surfaces having a common center on the axis of rotation of said basket, said moving system having its mass distributed low enough to cause its center of gravity al-

ways to fall at a point lower than said center of said
spherical surfaces.

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