CLOTHES WASHING MACHINE HAVING VIBRATION ISOLATING MEANS


7 Claims. (Cl. 68—24)

This invention relates to vibration isolating arrangements, and more particularly to suspension systems for machines, such as washing machines, which operate at a relatively low speed to wash and to raise the centrifugal liquid out of the clothes at a relatively high speed.

It is an object of my invention to provide an improved vibration isolating system for a machine such as a washing machine which has a low speed operation and a high speed operation.

A more specific object of my invention is to provide a relatively high critical speed when the machine is operating at low speed and a relatively low critical speed when the machine is operating at high speed.

A further more specific object of my invention is the provision of a structure in which the change in critical speed when the machine is operating at high speed caused by raising the tank is compensated by raising the critical speed when the machine is operating at low speed.

In one aspect of my invention, I provide a washing machine in which a moving system with a rotatably mounted clothes basket is so arranged that, alternatively, clothes may be washed in the basket, or the basket may be rotated at a high speed for centrifuging liquid out of the clothes. This moving system is supported on a rigid base through expansion means which may be expanded by fluid pressure so as to raise the moving system. The movement of washing of clothes is intended that the expansion means be fully deflated, so that the moving system is firmly seated on the base. The expansion means has a relatively small volume, and it is connected both to a container of relatively large volume and to a compressor means. When the expansion means is deflated, the machine has a relatively high critical speed of its moving system because the moving system is firmly seated on the base. On the other hand, when the expansion means is expanded, the machine then has a relatively low critical speed of the moving system.

To take advantage of this structure, I provide means for connecting the expansion means to the tank and the compressor means above the low critical speed. As a result, the high speed centrifuging, during which there is substantial force involved if there is any unbalance in the rotating basket, is conducted entirely above the general area of the critical speed. This is important since the magnitude of the vibrations resulting from the unbalance forces is dependent on how close the actual speed is to the critical speed. Thus, by suddenly changing from a relatively high to a relatively low critical speed, the machine may accelerate up to its full centrifuging speed without having the speed at any time be near the critical speed.

The features of the 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 other objects and advantages thereof, may best be understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

In the drawings, FIGURE 1 is a rear elevational view of a domestic laundry machine, specifically a washing machine, which incorporates my improved vibration isolating system;

FIGURE 2 is a fragmentary side elevational view of the machine of FIGURE 1 with a side panel removed, the view being partially in section and having certain surfaces broken away in order to illustrate details;

FIGURE 3 is a fragmentary side elevational view in cross section illustrating a component of my improved suspension system; and

FIGURE 4 is a view similar to that of FIGURE 3 showing a second condition of the component.

Referring now to FIGURES 1 and 2, I have shown my invention in one form applied to a domestic laundry machine comprising a clothes washing machine. Machine 1 includes a cabinet 2 which has a base 3 and carries a separate top 4 on which is supported a back splash panel 5. Panel 5 may, as shown, be mounted on posts 6. The control panel 5 may be provided on its front with appropriate controls (not shown) for selecting appropriate cycles of washing operations for the machine. Access to the interior of the machine is provided by the door 7 formed in section 2, mounted on concealed hinges and which may be opened and closed by any suitable means (not shown).

The machine illustrated is of the horizontal axis type, that is, it has a substantially cylindrical clothes basket or receptacle 8 mounted for rotation on a generally non-vertical (in this case, horizontal) axis within an outer enclosing tub structure 9. Basket 8 comprises a cylindrical shell or wall 10 which is closed at its rear end by a suitable wall or plate 11. The basket also includes a front wall 12 which is formed so as to define an access or loading opening 13 in registry with an opening 14 in cabinet section 2 provided for door 7. The basket is rotatably supported by a shaft 15 which is mounted in an elongated bearing 16 supported from rear walls 17 and 18 of tub 9. The tub is also provided with an opening 19 aligned with openings 13 and 14 so that clothes may be placed into and removed from the basket when door 7 is open. The door seals against a suitable gasket 20 during operation of the machine.

The machine is run by a suitable drive arrangement which will be described briefly. For instance, a suitable bracket 21 may be secured to tub 9, and the bracket in turn may be arranged to support a combination motor and speed changing transmission assembly 22 partly seen in FIGURE 2. The speed output from assembly 22 may be controlled by any suitable means which may, for instance, take the form of a solenoid 23. Thus, for instance when the solenoid 23 is energized a high speed output is provided, and when the solenoid 23 is deenergized a low speed output is provided.

Assembly 22 includes an output shaft 24 connected to a pair of pulleys 25 and 26 respectively driving belts 27 and 28. Belt 28 in turn drives a pulley 29 secured to and coaxial with the end 30 of shaft 15. The low speed output of assembly 22 provides a speed of rotation to pulley 29 (and thus to shaft 30 and basket 8) which is appropriate for causing the tumbling of clothes within the basket for washing purposes. An appropriate speed in this connection, for a basket having a diameter on the order of 26 inches, has been found to be about 47 r.p.m. The high speed output of assembly 22, when solenoid 23 is energized, provides a basket rotational speed suitable for centrifuging liquid out of the clothes; for instance, such a speed may be on the order of 500 to 550 r.p.m.

The belt 27 drives a pulley 31 which is connected in driving relationship to an air compressor 32. During the slow speed output of assembly 22 there is little compression of air by the compressor 32. However, when the high speed output is provided compressor 32 is caused to operate at a speed which provides substantial compression of air therein. Connected to the outlet of compressor 32 by a suitable conduit 33 is a storage tank 34. As shown the tank and the compressor may be mounted together so as to be supported by a bracket 35 from tub 9.
on the other side thereof from assembly 22. The functioning and purpose of air compressor 32 and storage tank 34 will be more fully explained herebelow. The means whereby water is admitted to tub 9 during operation of the machine is shown in FIGURE 1. The water supply means includes conduits 36 and 37 through hot and cold water is supplied to the machine for the washing operation. A valve controlled by a solenoid 38 admits hot water to the machine, and a valve controlled by an opposed solenoid 39 admits cold water to the machine. Hot and cold water valves are under the control of solenoids 38 and 39 discharge through a common outlet conduit 40, through a suitable air gap, and then through a funnel 41 which leads through a conduit 42 to a liquid inlet 43 formed in the side of tub 9. The air gap provided for funnel 41 makes it impossible for water to be siphoned from the machine to contaminate the incoming water supply line. A pressure actuated sensing device, or water level control, 44 controls both solenoids 38 and 39 in the usual way to provide the proper level in the machine during washing operations. Sensing device 44 is connected to the interior of tub 9 by a suitable line 45 which connects with the tub at almost the bottom thereof at 46 as shown.

Vaporated water may be removed from tub 9 at the end of washing and rinsing operations through a conduit 47 connected to a sump 48 formed at the bottom of tub 9. Conduit 47 may then in turn be connected to a suitable pump (not shown) which may be located in the manner well known in the art so as to cause the water to be pumped out when it is desired to drain water from tub 9, and so as to retain water in the tub at other times. It will be observed that all the components described thus far, that is, the basket and tub, the liquid supply means, the driving means, and the air compression means, form a part of a unitary moving system which is supported on the base 3. This support is achieved by forming a pair of support members 48 and 49 extending from the front to the back of the machine. On member 49, as shown, there are a pair of members 50 and 51 which are expandable so that they may be moved from a fully deflated position (shown in FIGURE 3 for member 50) to an expanded position, shown in FIGURE 4, by the introduction of fluid under pressure. With knowledge of the weight of the supported assembly and of the support area provided by the expandable members, it is a simple matter to determine what pressure of fluid is needed within the expandable members to expand them and thus raise the entire moving system against the force of gravity.

On support member 48 a pair of expandable members 52 and 53, similar to members 50 and 51, are provided. Thus, in effect, each of the expandable members is provided under each corner of the structure in supporting relation thereto. The expandable members are, in the illustrated embodiment, in the form of bellows formed of flexible material so as to provide a measure of horizontal flexibility both in the expanded condition and in the contracted condition. The two pairs of members 50 and 51, and 52 and 53, support beam members 54 and 55 respectively. Each of the beams 54 and 55 is, in turn, secured through an appropriate bracket member, such as 56 and 57, to the lower part of tub 9 on opposite sides thereof. Thus, between the members 49 and 48 secured to the base and the members 54 and 55 secured to the moving system, the expandable members 50, 51, 52 and 53 are provided.

As best shown in FIGURE 3 in connection with member 50, the particular form of expandable member provided in the illustrated embodiment may include a metal plate member 56 as a restraining member for the upper part of beam 54. Also, a rigid metallic member 59 may be provided at the bottom of member 50 for strengthening purposes. The provision of members 56 and 59 insures that the deformation of member 50 (and the other identical members 51, 52 and 53) in response to fluid pressure therein will be at the sides thereof so as to increase the vertical distance between the top and the bottom of the members. Beam 54, the top of member 50, and plate 58 all have matching openings formed therein through which extends a valve body member 60. Member 60 is shown in FIGURE 6a resting on plate 59. The openings in the upper part of member 59 and in plate 58 are such that they are readily movable vertically relative to member 60 but so that there is a seal against fluid leakage provided by the engagement.

Movement of the arms into a tubular housing structure 62 rigidly secured to beam 54. As shown, at its upper end the tubular member 62 is necked down so that it terminates in a conduit 63 to which is secured the end of a hose 64. Between the shoulder 65 forming the necked-down portion at the top of housing 62 and the top of member 60 there is provided a coil spring 66. Spring 66 has a normally expanded position but is weak enough so that the weight of the moving system is ample to insure its complete collapse as shown in FIGURE 3. Member 60 is provided with a passage 67 therethrough which extends from its top down into communication with the interior 67a of member 50. Passage 67 constitutes a junction between hose 64 and the space 67a inside member 50. Branching off from passage 67 is a second passage 68 which extends out to the side of member 60. An opening 69 is normally provided near the base of housing 62 in such a position that it is substantially below member 60; operated there is a fairly close engagement of member 60 within housing 62, there is virtually no escape of fluid through opening 69 when the structure is in the position shown in FIGURE 3. However, upon expansion of member 50, housing 62 is raised relative to member 60, spring 66 operating to hold member 60 down on plate 59.

As a result, the opening 69 may move up until it is substantially aligned with passage 68, as shown in FIGURE 4; further expansion is then prevented by escape of air through passage 68 and opening 69.

Conduit 64 is connected to a valve 70 through which it communicates with tank 34. Similarly, a conduit 71 joins member 51 to valve 70, a conduit 72 joins member 52, and a conduit 73 joins member 53 to the valve. The valve is maintained in a closed position except when a solenoid 74 causes it to open. The solenoid in turn is controlled by a centrifugal switch 75 of any commercially available type which is provided adjacent the basket pulley 29 so as to sense rotational speed thereof.

It is well known that any moving system has a critical or resonant speed wherein an unbalance in the system will cause vibrations of maximum amplitude. In other words, as the speed of operation of a system rises, any unbalance in the system will cause vibrations to occur, and the amplitude of these vibrations will increase, slowly at first and then substantially and rapidly as the critical speed is approached. Then, when the critical speed is passed, the vibrations will decrease as the speed increases further, rapidly at first and then more slowly. It is thus important that operation of a machine, wherein there is likely to be an unbalance, be provided at speeds which are substantially removed from the critical speed. With this in mind, and with awareness that basket 8 is rotated at a low speed such as 47 r.p.m. for tumbling operations and at a high speed on the order of several hundred r.p.m. for spinning operations, it is desirable to provide a relatively high critical speed during tumbling. This high critical speed will be substantially removed from tumbling speed, and will therefore permit the vibrations to remain of small amplitude. By the same token, since with a high critical speed a spin of several thousand r.p.m. would be required for the upper member to provide much greater amplitude for a given unbalance, it is desirable to provide a low critical speed during spin, such that the spin will be provided far above the critical speed. This is particularly important since the vibrational forces at the critical speed increase approximately with the square of that speed. Therefore,
if there is to be any operation anywhere near the critical speed, it is desirable that the critical speed be a low one.

It is further known that relatively stiff systems, wherein the elements combine to provide high spring gradients, have relatively high critical speeds. Thus, for instance, the structure of FIGURES 1 and 2, with the expandable material shown in FIGURE 3, has a critical speed of 51, but when the collapsed position of FIGURE 3, would have a critical speed up in the vicinity of 1,000 cycles per minute because the moving system would be firmly seated on the base 3. Conversely, once the members 50, 51, 52 and 53 are inflated, as in FIGURE 4, the machine will have a relatively low critical speed of the moving system. The reason that the moving system is actually floating on a cushion of air, the extent to which the moving system can be raised being limited by the escape of air when opening 69 rises into alignment with passage 68. Vibrations of the system cause contraction and expansion of the members 50 through 53. As a result, the volume in these members changes. But because these members are all connected to the storage tank 34, which has a large volume compared to the combined volume of members 50 through 53, there is a very small difference in the total volume of compressed air. This causes a very low spring gradient to be provided by the members 50 through 53 in their expanded position of FIGURE 4.

It has been found that a spring gradient low enough to be able to provide a critical speed on the order of forty cycles per minute may readily achieved with this type of construction. Thus, in order to effect the goal of my invention, the suspension system shown is caused to be in the position shown in FIGURE 3 during tumbling operations so that a very high critical speed is provided and the vibrations accordingly are very small because the operating speed is far removed from the critical speed. By the same token, the operating speed during centrifuging, when the members are in the position of FIGURE 4, will again be very small because the critical speed is very low and again is substantially removed from the centrifuging speed.

In order to provide a transition from the deflated conditioned shown in FIGURE 3 to the expanded condition of FIGURE 4, the centrifugal switch 75 permits the pressurized fluid in the storage tank to fill the members 50 through 53 at a suitable basket speed during the rapid speed rise when solenoid 23 has been energized. For instance, at a rotational speed of 80 r.p.m., even a grossly unbalanced loads in basket 8 will only cause vibrations in minor forces. Thus, it is appropriate to make switch 75 close valve 70 as the speed rises to about 80 r.p.m. The members 50 through 53 then become inflated and the critical speed of the moving system of the machine is quickly dropped from about 1,000 cycles per minute to about 50 cycles per minute. Conventionally, speed changes, mechanisms such as that shown cause a rapid increase in speed, so the speed will continue to increase rapidly after the members 50 through 53 have been inflated, thereby de-fating even further from the new low critical speed.

The critical speed is thus suddenly dropped from substantially above the rotational speed of the machine to substantially below the rotational speed of the machine. This results in vibrations of small amplitude. The essence of the structure is, then, to provide means which will provide a relatively rigid system for low speed operation, thereby providing a high critical speed, and will change the characteristics of the moving system, the critical speed whenever the speed of the structure is raised for centrifuging purposes. This should be done at an intermediate speed so as to insure that when the transition is made the basket will already be rotating at a speed substantially above the new low critical speed.

While the invention is described in the manner described it may equally well be done by other means. For instance, the change in critical speeds could be effected by providing an intermediate speed in a transmission, and causing the transmission to first raise the speed to the intermediate speed, and then to raise the speed to the final speed with the transition from second to third speed constituting a signal to change the suspension from a rigid one to one with a low spring gradient. Of course, the system may also be combined with other structures known to be useful in connection with machines of this type. A conventional unbalance switch may be provided so that, even with the improved suspension system I have provided, excessively unbalanced loads will not be permitted to exist, but will be re-distributed. It will be clearly clear that while a particular construction has been shown for the fluid system of changing critical speeds, other constructions will readily come to mind. One example still in the field of fluid-operated systems, is the use of cylinders mounted for swivelling movement. The swivelling of such cylinders would be a substitute for the substantially free horizontal motion that the members 50 through 53 permit, within confined limits, for the moving system both in the deflated and expanded conditions. 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 which fall within the true spirit and scope of the invention.

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

1. A washing machine comprising:
(a) a moving system including a rotatably mounted clothes receiving basket;
(b) means for alternatively washing clothes in said basket and for rotating said basket at high centrifuging speeds;
(c) a rigid base for supporting said moving system;
(d) expansion means of relatively small volume, expandable by fluid pressure, interposed between said base and said moving system so as to support said moving system and raise said moving system upon expansion, said expansion means being fully deflated during washing of clothes;
(e) a container of relatively large volume connected to said expansion means in fluid supply relation thereto;
(f) compressor means connected to said container in fluid supply relation thereto;
(g) said machine having a relatively high critical speed of said moving system when said expansion means is deflated and said moving system is therefore rigidly seated upon said base, said machine having a relatively low critical speed of said moving system, substantially below said high centrifuging speed, when said expansion means is expanded, and
(h) connecting means for connecting said expansion means to said container and said compressor means when said basket is rotating at a speed above said low critical speed.

2. A washing machine comprising:
(a) a moving system including a clothes receiving basket mounted for rotation on a non-vertical axis;
(b) multi-speed transmission means for rotating said basket at a low speed for washing clothes and at a high speed for centrifuging liquid out of the clothes;
(c) a rigid base for supporting said moving system;
(d) expansion means of relatively small volume, expandable by fluid pressure, interposed between said base and said moving system so as to support said moving system and raise said moving system upon expansion, said expansion means being fully deflated during washing of clothes;
(e) a container of relatively large volume connected
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to said expansion means in fluid supply relation thereto;

(f) compressor means connected to said container in fluid supply relation thereto;

(g) said machine having a relatively high critical speed of said moving system when said expansion means is deflated and said moving system is therefore rigidly seated upon said base, said machine having a relatively low critical speed of said moving system, substantially below said high centrifuging speed, when said expansion means is expanded; and

(h) connecting means for connecting said expansion means to said container and said compressor means when the speed of rotation of said basket rises substantially above said low critical speed.

3. The apparatus defined in claim 1 wherein said expansion means includes a plurality of bellows members positioned beneath said moving system.

4. The apparatus defined in claim 1 wherein said expansion means includes an outlet uncovered only when said expansion means is expanded to a predetermined extent thereby to limit expansion of said expansion means.

5. The apparatus defined in claim 1 wherein said connecting means including centrifugally responsive control means controlling said connecting means, said centrifugally responsive control means being positioned to be responsive to the speed of said basket.

6. The apparatus defined in claim 1 wherein said moving system is supported for substantial flexibility in a horizontal direction at all times, said expansion means controlling the flexibility of said moving system in a vertical direction.

7. A washing machine comprising:

(a) a moving system including a clothes receiving basket mounted for rotation on a non-vertical axis;

(b) transmission means for rotating said basket at a relatively low speed for the washing of clothes therein and for rotating said basket at a relatively high speed for the centrifuging of liquid out of clothes in said basket;

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