

Aug. 4, 1953

J. F. YOUNG

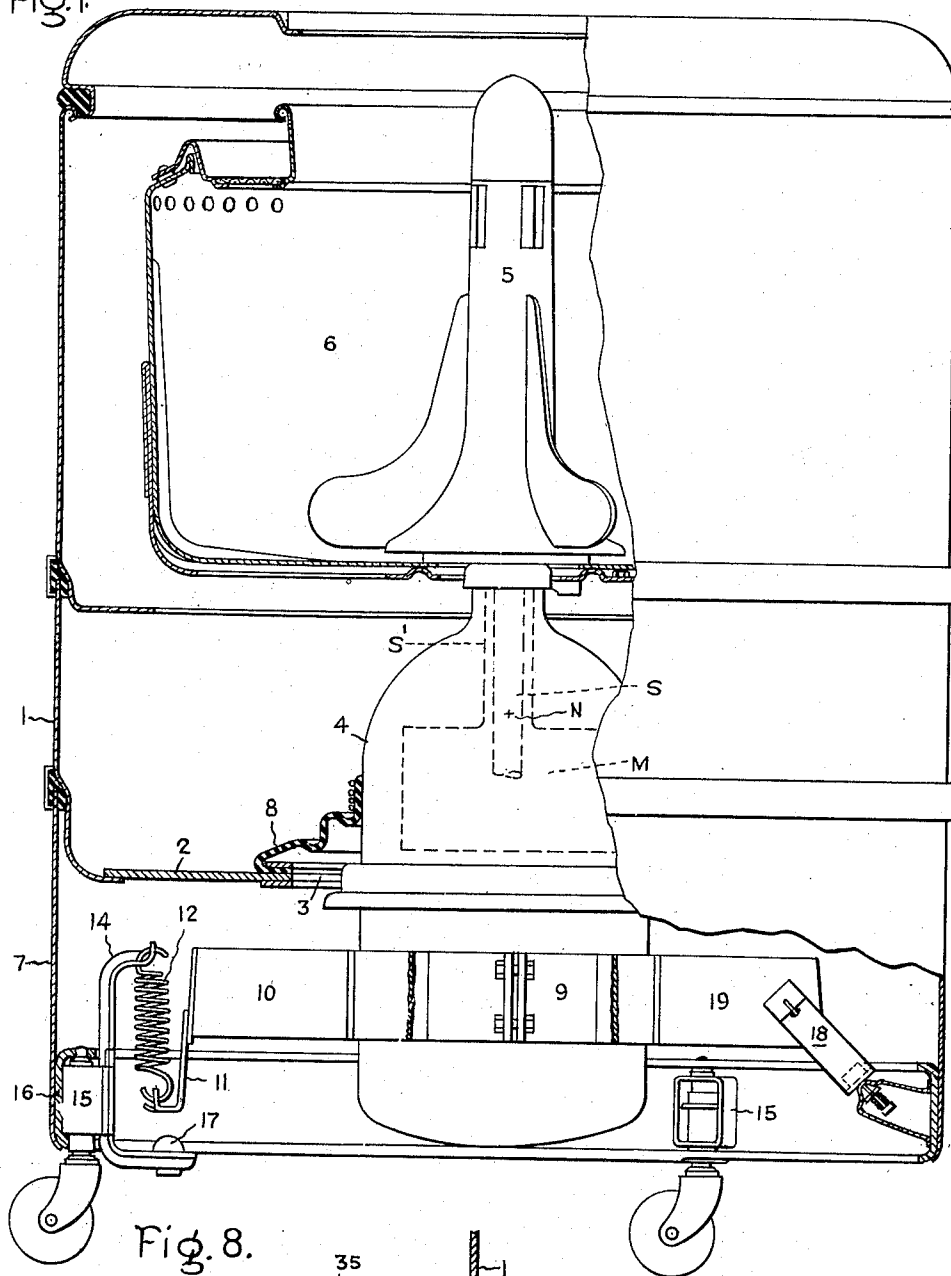
2,647,591

VIBRATION DAMPENER

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2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

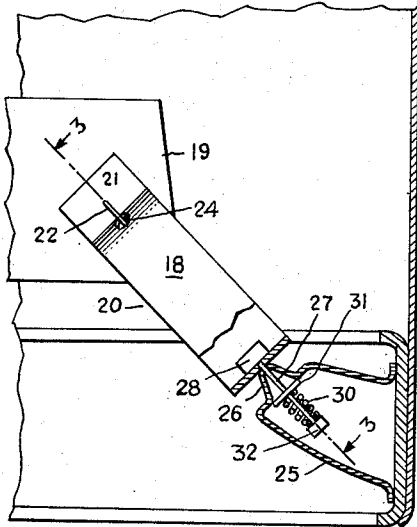


Fig. 3.

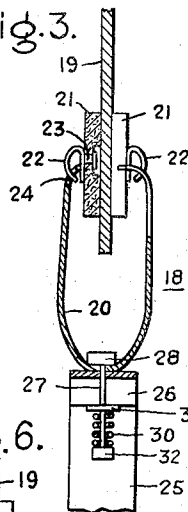


Fig. 4.

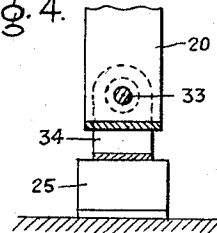


Fig. 6.

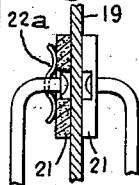


Fig. 5.

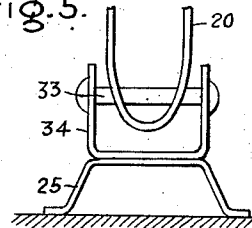


Fig. 7.

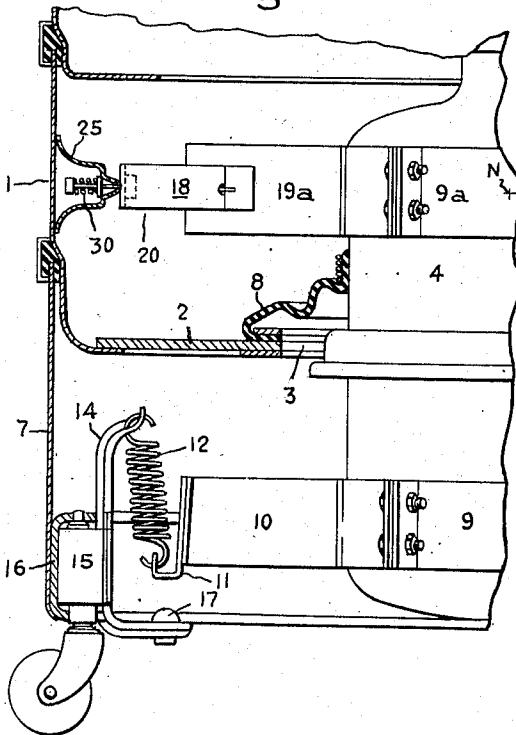


Fig. 9.

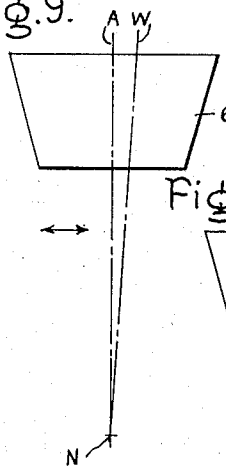
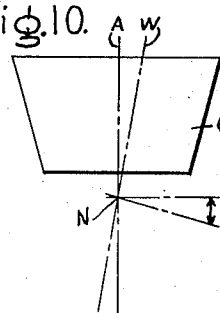


Fig. 10.



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UNITED STATES PATENT OFFICE

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VIBRATION DAMPENER

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Application October 1, 1949, Serial No. 119,186

2 Claims. (Cl. 188—1)

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This invention relates to improved means for dampening the vibrations of rotating bodies.

My invention may be applied to any rotating or rotor-provided mechanism suitably supported to afford at least two degrees of freedom which allow two vibratory modes in one plane; but the vibration condition chosen to exemplify the objectives of my invention is that arising in connection with the spin basket of washing machines of the type in which water in the clothes is extracted by centrifugal force. In particular, I have applied my invention to a washing machine in which the clothes are washed and spin dried in a single basket or receptacle, for in such machines the vibration problem is complicated by the entirely fortuitous weight distribution of the clothes at the commencement of the spin dry operation and the substantial change in the weight of the rotating body which occurs at the early stages of spin by reason of the ejection of the free water from the basket.

In a broad sense, the rotational system of such a washing machine is typical of the rotor-provided mechanisms above noted, in that the vibratory mode of the first critical speed is ordinarily characterized by a nodal position resulting in accentuated horizontal movement, whereas at the second critical and at running speed, the mode of vibratory motion is essentially oscillatory with a node located nearly at and somewhat below, respectively, the center of gravity of the vibratory system. It has long been appreciated by those skilled in the art that dampening should be at a maximum at the relatively low speeds at which suspension resonances may be encountered (i. e., the "critical" speeds) and reduced to a minimum at operating speed.

It is therefore an object of my invention to provide a mechanically simple dampener which will automatically produce substantially greater dampening effect at the low critical speeds than at the running speed.

It is a further object of the invention to provide a dampener which exerts more restraint against horizontal vibrational motion than against the oscillatory motion, thus accommodating itself to the change of vibratory motion accompanying changes in the nodal positions as the machine accelerates to the ultimate running speed.

In accomplishing the above objectives I preferably utilize "coulomb" dampening, that is dry friction dampening and nearly constant friction force, applied by devices pivotally affixed to the frame of the machine so as to be relatively free to rotate in a vertical plane but restricted against horizontal movement. Dashpot dampeners, simi-

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larly applied, are typical of other effective types, but of course are mechanically relatively more complicated. In any event, the dampening devices are arranged so that a plane passing through the pivotal support and the long axis of the dampener passes through the running node; and the relation of this pivot position to the nodal positions at low speed and the running speed thus influences the resistance offered by the dampener to the predominant components of the vibration motion.

The features and advantages of my invention are more specifically set out in the following detailed description of presently preferred embodiments and in the accompanying drawings, in which Fig. 1 is a side elevation, partly in section, showing a washing machine with one form of my dampening means applied thereto; Fig. 2 is an enlarged side elevation of the dampener of Fig. 1, also partly in section, showing in greater detail the pivotal mounting of Fig. 1; Fig. 3 is a plan section taken on lines 3—3 of Fig. 2; Figs. 4 and 5 are respectively fragmentary side and end elevations of another means of pivotal securement of the dampener to its anchorage; Fig. 6 is a fragmentary view of an end of a friction dampener using another type of spring element; Fig. 7 is a fragmentary side elevation of the washing machine of Fig. 1 to show an alternative mounting location for the dampening means; Fig. 8 is a side elevation, in section, of a typical dashpot dampener; and Figs. 9 and 10 are schematic diagrams illustrating the shift in node position from the first critical speed (Fig. 9) to that at the running speed (Fig. 10) and the changed importance of the horizontal and vertical components of the basket vibratory motion accompanying such nodal shift.

Fig. 1 shows so much of a washing machine as is necessary for an understanding of the invention. A tub 1 has a bottom wall 2 formed with a central opening 3 through which extends a casing 4 housing a motor and drive mechanism M and journaling the oscillating agitator shaft S and the shaft S' to which the basket 6 is affixed. By suitable means, not shown, the motor oscillates the agitator 5 within the basket 6 to wash clothes therein, and spins the basket for centrifugal extraction of the free water and the water content of the clothes. The motor mechanism accelerates the shaft S' from a standing start to an ultimate running speed which may be of the order of several hundred R. P. M., or more. The machines themselves are well known in commerce; a disclosure of a typical drive mechanism will be found in the pending application of Jacob S. McNairy, Serial No. 551,105, filed

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August 25, 1944, for "Washing Machine," and now Patent 2,485,621, granted October 25, 1949, assigned to the assignee herein.

It will be noted that the casing 4 projects downwardly into the skirt portion 7 of the machine, the opening 3 being sealed against leakage by suitable means such as the flexible rubber boot 8. The mechanism is supported to provide a stable support during the washing cycle when the basket 6 contains a substantial weight of water and clothes, but nevertheless to afford a resilient suspension after the free water has been removed from the basket during the early stages of the spinning cycle. Accordingly, a yoke 9 clamped or otherwise secured tightly about the lower portion of the casing 4 has radially extending rigid arms 10 terminating in a bracket 11 to which is affixed a low-gradient spring 12 carried by a support member 14. Advantageously there are three equi-angularly spaced suspension units. The supports 14 may comprise elements of the caster mounts 15 carried by the base ring 16 secured to the skirt 7. A similar structure is more particularly described in Patent No. 2,454,112, granted November 16, 1948, to Thomas T. Woodson for "Support for Spin Basket for Clothes Washing Machines and the Like." The relatively low gradient springs 12 yield under the full basket load of water and clothes and set the bottoms of the brackets lightly upon rubber cushions 17 therebeneath, thus providing a three-point support for the basket structure during the washing cycle, in which the agitator is oscillating within a stationary basket. However, the free water in the basket will have been thrown out during the spin cycle when the basket speed reaches about 200 R. P. M. and the basket weight is then carried in suspension on the springs 12.

Observations of a machine of the illustrated type, operating with a conventional washing load, discloses conditions as schematically shown in Figs. 9 and 10 relative to the shift of the node position of the machine at the first critical and running speeds of basket rotation. In each case a node N of the vibration pattern may be considered to be at the intersection of the undisplaced machine axis A and the whirling axis W. At the first critical speed, which is at about 100 R. P. M., the axis intersection and corresponding node position is substantially below the machine base; thus, at any point above the base, the vibrational motions are manifest mainly in a horizontal direction. Under the running condition of Fig. 10 the nodal point shifts to a position relatively closely beneath the center of gravity of the rotating body, and the movement of the system is essentially oscillatory. The present invention provides means whereby the predominant component of motion of the vibration mode at the first critical speed is constrained, whereas at the second critical or running speed the predominant component of the vibration mode is substantially unopposed. Thus, dampening is greater at the lower speeds than at the running speed.

In the Fig. 1 embodiment the dampeners 18 are anchored to the skirt 7 by attachment to the ring 16. Said dampeners (preferably three in number) frictionally engage with arms 19 radially extending from the yoke 9; for structural simplification, the arrangement is preferably such that respective arms 19 are in a 60° relationship with the suspension arms 10. In Fig. 1 a line extending through the longitudinal axis of each

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dampener and the running node N of the machine is illustratively at a 45° angle with the horizontal. In the Fig. 7 arrangement I employ an independent yoke 9a having arms 19a, and support the dampeners 18 so that the line through the longitudinal axis of the dampeners and the running node N is horizontal. It will be apparent that within reasonable limits other angular relationships may be utilized according to the physical structure of the machine.

Referring now to Figs. 2 and 3 a presently preferred form of dampener 18 utilizes a spring structure 20 having rigid arms joined at one end. The free ends of said arms embrace the yoke arms 19. Between said ends and the associated yoke arm are plates or discs 21 of friction material, for example, compressed fibrous compositions such as used for brake and clutch linings. The said plates are held by the spring structure 20 in a tight dry frictional contact with the relatively large-area, vertical, side walls of the yoke arms. It is convenient to utilize a leaf spring bent into the form of a U-clip so that the base juncture is integral with the spring arms; and a suitable arrangement for removably affixing the plates to the spring member is as shown in said Woodson patent, namely by clips 22 comprising a hairpin spring one leg of which is provided with a rivet 23 headed within a pocket provided in the plate. The other leg of the clip snaps through an opening 24 in the spring 20 to bear against the plate 21. Spring wire, of suitable cross sectional shape, may be used instead of plates for the springs 20, and as suggested in Fig. 6 the ends of such wire may pass through the plates 21 for heading and self-riveting. A spring retainer 22a, corresponding to the spring clips 22, positions the ends of the spring wire relative to the plate 21. The dampener anchorage 25 is formed with a peak 26 providing a long fulcrum against which the elongate base of the spring structure 20 is drawn by a suitable tie member. As shown in Figs. 2 and 3 one form of tie member comprises a rod 27 and an enlarged head 28 which is disposed within the spring 20 and held tightly thereagainst by the spring 30 confined between a washer 31 and a suitable base 32 at the end of the rod. The washer 31 may or may not be affixed to the anchorage as desired; a fixed washer would, of course, have an opening relatively larger than the rod 27 to permit free movement of the latter in all directions whereas a free washer would be substantially larger than the base of the peak to preclude the possibility of misalignment relative thereto in use. The relatively large size of the spring biased head 28 and washer 31, in consideration of the length of contact of the spring 20 with fulcrum 26 returns the damper 18 to its angular position shown in Figs. 1 and 2 as the vibrating system returns to rest.

In Fig. 7 the longitudinal axis of the dampener spring 20 is horizontal and is in line with the running node. The only structural change made necessary by such arrangement is the appropriate simplification of the anchorage 25 as shown in said figure. The anchorage may be affixed to the lower portion of the tub wall, or to an anchorage ring similar to the ring 16, as necessary or desirable. The Fig. 7 location is the more efficient, as will later appear; but in applying the invention to washing machines the effects of exposing the dampener structure to wash water and detergent within the tub 1 must be considered.

Because the dampeners are intended to offer

much greater resistance to the horizontal component of the motion of the mechanism than to the oscillatory component it is obvious that separation of the dampener springs 20 from the anchorages 25 should be avoided. Accordingly, the springs 30 should be of substantial stiffness considered in relation to the resistance to which such springs offer to the pivotal movement of the dampener spring bodies 20. An alternative method of anchoring the dampener springs which permits rotation while eliminating longitudinal translation is shown in Figs. 4 and 5 in which the dampener spring 20 is pierced to accommodate a pin 33 to which is pivotally attached the bracket 34 intended for securement to a suitable anchorage 25. The anchorage may be affixed to an anchorage ring 16 or equivalent.

Fig. 8 somewhat schematically illustrates a dashpot dampener in which a cylinder 35 has a lug 36 for pivotal securement to an anchorage bracket 37 to be suitably affixed relative to the tub 1. The ported piston 38 operates in a suitable body 40 of oil or other appropriately viscous material. The bellows seal 41 is secured about the shaft 42 to prevent oil leakage. As illustrated, shaft 42 affixes to arm 19 by hooking through an opening therein, but other ways will suggest themselves to those skilled in the art. The illustrated construction will restrain motion in a horizontal direction while pivoting freely in a vertical direction. It will be understood that although the location of this embodiment corresponds to that of Fig. 7, this is for purposes of illustration only.

In considering the respective dampener locations it is important to note by comparison of Figs. 9 and 10 that the transition from the predominantly horizontal movement of the dampener yoke arms at the low critical speed to the relatively large-amplitude oscillating motion of said arms at running speed is most advantageously utilized when the longitudinal axis of the dampener springs aligns with the running node of the machine at an angle in which the horizontal component of vibratory motion is at a maximum. While the horizontal alignment of Fig. 7 is thus the most preferable, other angular relationship may be employed. As a practical matter, the 45° angular disposition of Fig. 1 is probably the maximum. The dampener arrangement provides substantial dampening at low speed and relatively little dampening at high speed because the relative movement of the yoke arms within the friction blocks 21 is relatively much greater for the movement at low nodes than for the movements of the yoke at the running speed node, during which latter occurrence the dampeners are substantially free to rotate vertically and blocks 21 therefore have only a small amplitude of movement with respect to the yoke arms.

The effectiveness of resistance to horizontal motion and relative freedom of oscillatory motion is evident when it is considered that the dampening effect may be expressed in inch-pounds of energy absorbed per second according to the formula:

$$E=4FdN$$

where

F=friction force, pounds

d=1/2 amplitude of relative motion between pad and mating member, in.

N=revolutions/second.

E=inch pounds/second.

A dampener constructed and arranged accord-

ing to my invention effectively reduces the value of d by taking advantage of the nodal shift as the rotating body accelerates to its running speed. The value of d is large at the low speed when the node of vibration is very low relative to the dampener location and therefore the horizontal component of motion is high, and is very low at the running speed when, because of the nodal shift, the horizontal component is low and the oscillatory component is substantially unopposed by the pivotal mounting of the dampeners.

In such fashion, namely, by dampening the major directional component of vibration of the rotating system at the low critical speeds while substantially not restraining the major directional component at running speed, my invention fulfills its objective. It should be understood, however, that while I have described my invention by reference to presently preferred embodiments and as operating in a specific manner in accordance with the patent statutes, it should be understood that I do not limit my invention thereto, since various modifications thereof within the spirit of my invention, the scope of which is set forth in the annexed claims, will suggest themselves to those skilled in the art.

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

1. In a system having a generally vertical rotatable shaft with an unbalanced body fixed to its upper end, drive means constructed and arranged to rotate said shaft at a predetermined normal operating speed, a casing for said drive means disposed below said unbalanced body and providing journaling means for said shaft, and means resiliently supporting said drive means casing and said shaft to locate a first vibrational node at the first critical speed of shaft rotation a substantial distance below a second node at the normal operating speed; the improvement in means for damping shaft vibration at said first critical speed to a greater extent than at said operating speed, comprising a fixed frame spaced radially from said drive means casing, a plurality of rigid arms attached to said casing and extending toward said frame, friction dampeners carried by said frame and each engaging one of said rigid arms, said frame providing pivot means on which said dampeners are mounted for rotation upon vertical movement of said arms thereby to minimize damping of the vertical component of vibration, each of said dampeners being positioned substantially symmetrically with respect to a line between its pivot means and said second node, and the acute angle between said line and said shaft being at least forty-five degrees.

2. In a system having a rotatable shaft with an unbalanced body fixed to its upper end, drive means constructed and arranged to rotate said shaft at a predetermined normal operating speed, a casing for said drive means disposed below said unbalanced body and providing journaling means for said shaft, and means resiliently supporting said drive means casing and said shaft whereby a first vibrational node at the first critical speed of shaft rotation is located a substantial distance below a second node at the normal operating speed; the improvement in means for dampening shaft vibrations at said first critical speed to a greater extent than at said operating speed, comprising a fixed frame spaced radially from said drive means casing, a plurality of rigid arms attached to said casing and extending toward said frame, friction dampeners carried by said frame and each including a pair of

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friction blocks spring biased into engagement with a selected one of said rigid arms, said frame including a plurality of elongated pivot means about which said dampeners are mounted for rotation upon vertical movement of said arms, each of said dampeners being positioned substantially symmetrically with respect to a line between its pivot means and said second node, and the acute angle between said line and said shaft being at least forty-five degrees whereby the horizontal component of vibration is damped at least as much as the vertical component of vibration.

JAMES F. YOUNG.

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