April 20, 1965 J. F. BELAIEFF ETAL 3,178,916

MACHINE FOR WASHING AND CENTRIFUGING TEXTILE

Filed Feb. 25, 1963 4 Sheets-Sheet 1

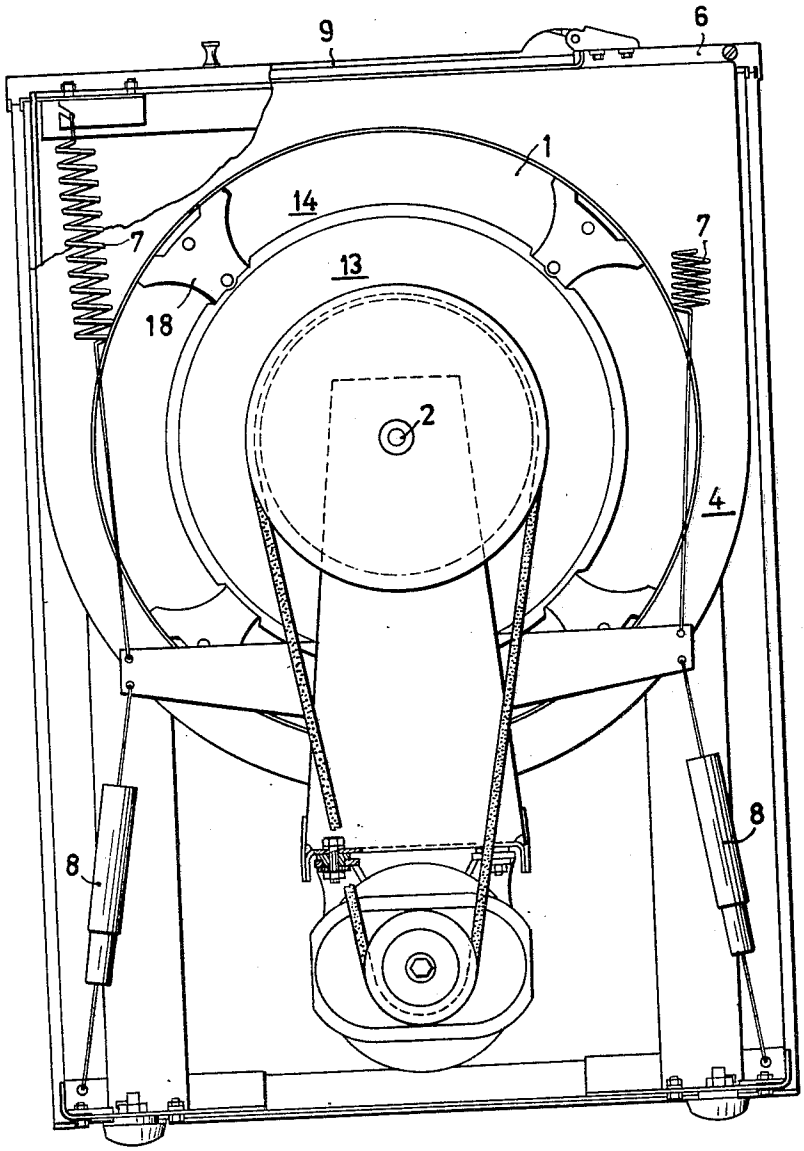


FIG. 1

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MACHINE FOR WASHING AND CENTRIFUGING TEXTILE

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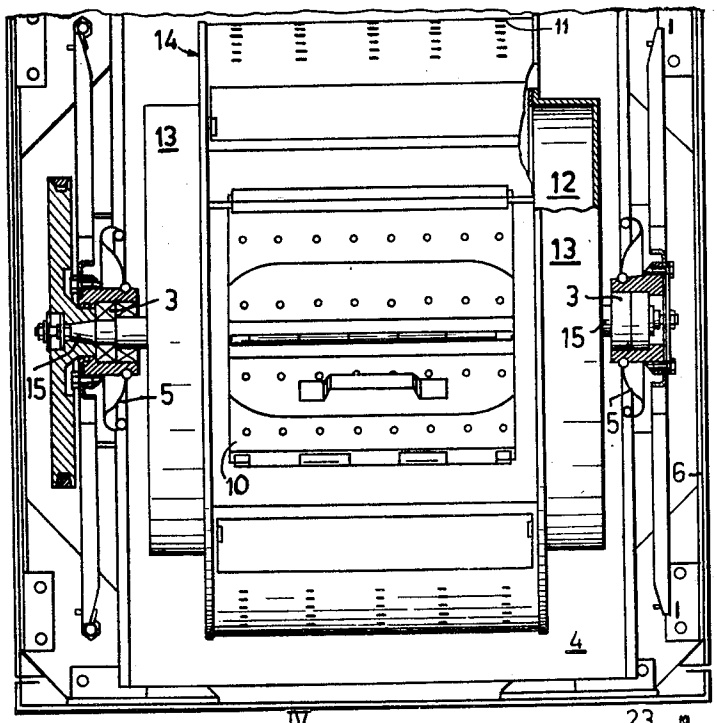


FIG.2

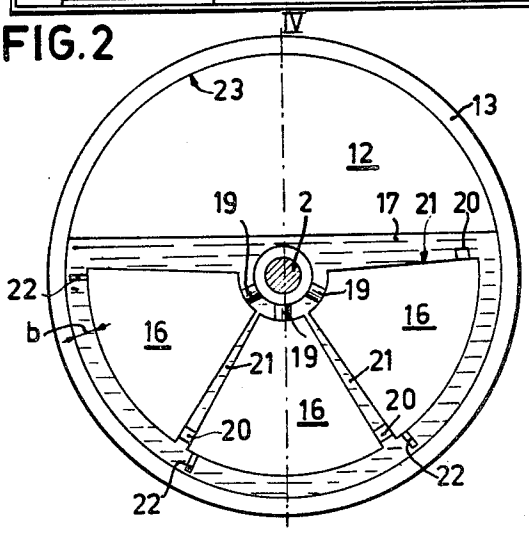


FIG.3

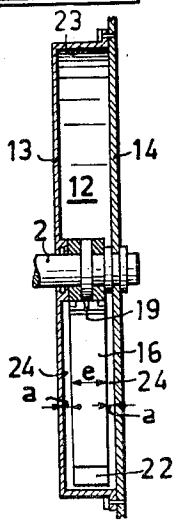


FIG.4

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MACHINE FOR WASHING AND CENTRIFUGING TEXTILE

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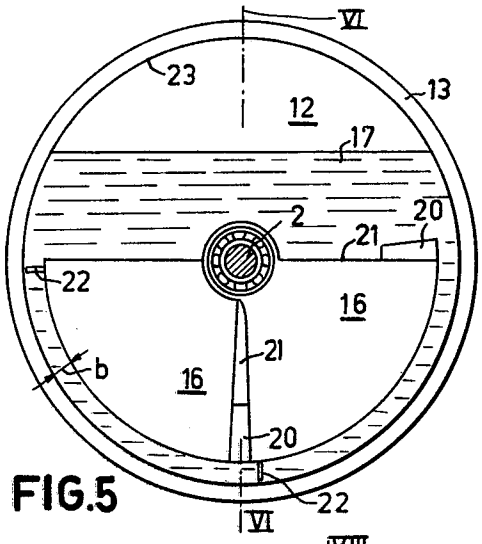


FIG.5

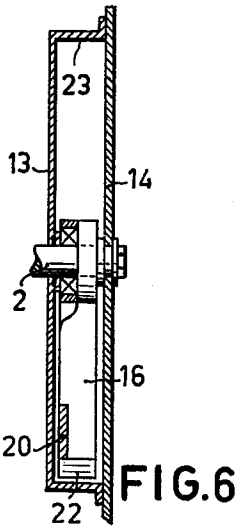


FIG.6

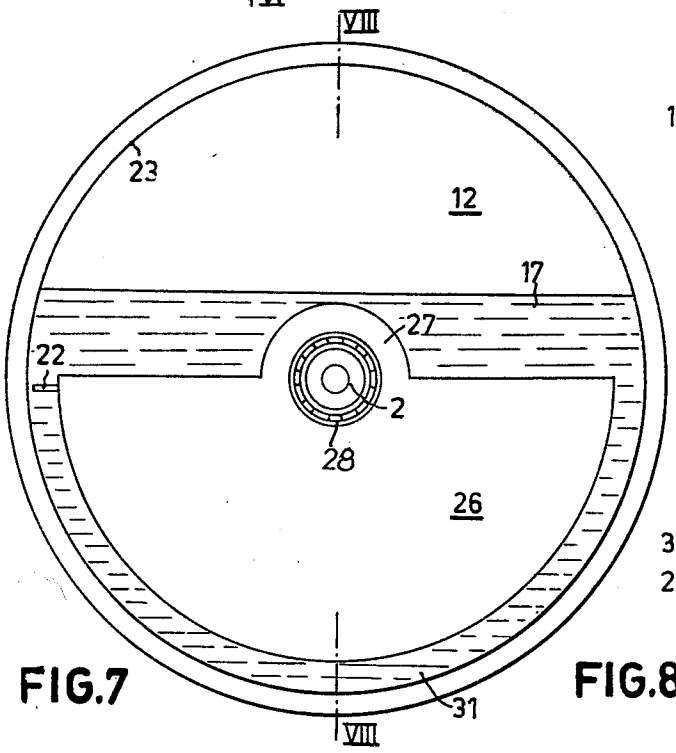


FIG.7

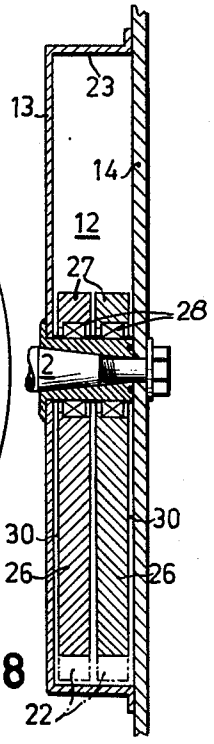


FIG.8

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MACHINE FOR WASHING AND CENTRIFUGING TEXTILE

Filed Feb. 25, 1963 4 Sheets-Sheet 4

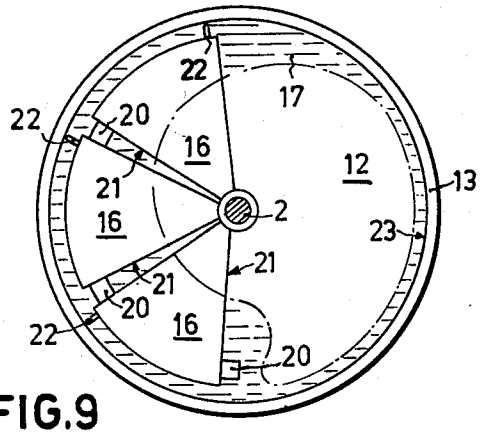


FIG.9

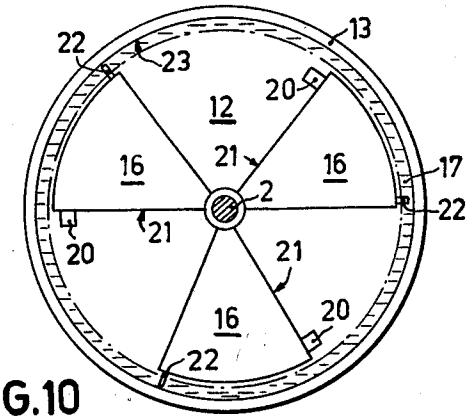


FIG.10

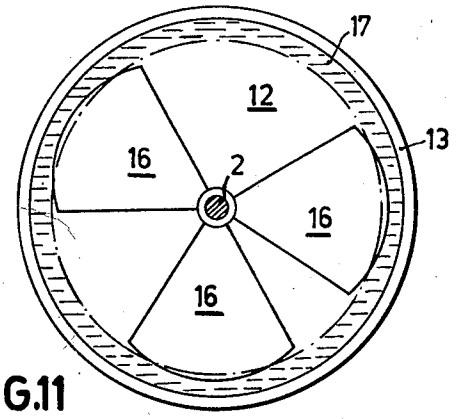


FIG.11

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3,178,916

MACHINE FOR WASHING AND CENTRIFUGING TEXTILE

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Claims priority, application Switzerland, Feb. 26, 1962, 2,365/62
5 Claims. (Cl. 68—24)

This invention relates to machines for washing and centrifuging textile, comprising a rotary container with perforated walls, provided with a balancing device, which container is suspended on the frame or on the tub of the machine and has a rotary shaft which is positioned in one direction or the other, but preferably horizontally. The balancing device is intended more particularly for a washing machine comprising a rotary drum with perforated walls which is displaceable in at least two directions at right angles to the frame of the machine, and the tub of which has an upwardly directed opening, the drum having, in addition, a little door fitted on its peripheral surface.

The present invention relates to a machine for washing and centrifuging textile, comprising a rotary container with perforated walls, provided with a balancing device having two closed compartments which are positioned symmetrically relative to the transverse plane of symmetry of the container and concentrically of its axis of rotation and which are rigidly connected to said container, and it is characterized in that each compartment of the balancing device contains at least two eccentric masses which can rotate freely about the axis of revolution of the container and in that each compartment is partly filled with a viscous liquid which constitutes a means for transferring the movement of the compartment to the said masses the driving action of which is greater at rotational speeds of the container which are almost equal to, but higher than its rotational speed during washing, than at rotational speeds of the container which are almost equal to, but lower than a so-called balancing rotational speed of the container, which speed itself is lower than the rotational speed during centrifuging.

In order that the invention may be readily carried into effect, it will now be described in detail, by way of example, with reference to the accompanying drawings showing diagrammatically one example of a washing machine according to the invention and several embodiments of the balancing device for the washing and/or centrifuging drum.

FIG. 1 is an elevational view of such a machine equipped with the balancing device, several parts being omitted and others being shown in section;

FIG. 2 is a plan view of the machine shown in FIG. 1, in which likewise several parts are omitted and others shown in section;

FIG. 3 is a side view of a closed compartment of a first embodiment of the balancing device, several parts being omitted and others being shown in section;

FIG. 4 is a sectional view, taken on the line IV—IV of FIG. 3.

FIG. 5 is a side view of a closed compartment of a second embodiment of the balancing device, several parts being omitted and others being shown in section;

FIG. 6 is a sectional view, taken on the line VI—VI of FIG. 5.

FIG. 7 is a side view of a closed compartment of a third embodiment of the balancing device, several parts being omitted and others being shown in section;

FIG. 8 is a sectional view, taken on the line VIII—VIII of FIG. 7;

FIG. 9 is an elevational view of the first embodiment, with the cover removed, of a closed compartment which illustrates the position of the balancing masses at the moment when driven through the liquid;

FIG. 10 is an elevational view of the first embodiment, with the cover removed, of a closed compartment which illustrates the position of the balancing masses when occupying their active balancing positions;

FIG. 11 is an elevational view of a variant, with the cover removed from the compartment, which illustrates the position of the masses when occupying their active balancing positions.

Although the drawings and the description relate to a machine for washing and centrifuging textile for domestic use, that is to say with a capacity of from 2 to 7 kgs. of dry washing, the invention also relates to such machines for industrial use which have a very high capacity.

The washing machine shown comprises a rotary drum 1 with perforated walls, provided with a driving shaft 2, which is synonymous with its rotary shaft, which shaft 2 is placed horizontally and the ends of which are journalled in bearings 3 located outside a tub 4 of the washing machine. Flexible connections 5 ensure the tightness of the tub 4 at the areas where the shaft 2 is passed through the walls. The tub 4 is rigidly secured to a frame 6 of the washing machine, while the drum is mounted to be slidable relative to the frame 6, that is to say displaceable in at least two directions at right angles thereto, and is subject to the action of backsetting springs 7 and damping springs 8 which form the connections between the drum 7 and the frame 6 of the washing machine.

The tub 4 has, at the top, an opening which can be closed by means of a cover 9 hinged to the frame 6 of the washing machine. The drum 1 has a door 10 giving access to the drum, which door is fitted on a peripheral surface 11 of the drum and serves to introduce and remove the washing into and out of the drum respectively.

The balancing device comprises two identical combinations of parts arranged one on each side of the drum. Each combination comprises a closed compartment 12 which, in the example shown, is formed by a cover 13 which is rigidly secured to a side wall 14 of the drum 1. The compartment 12 is arranged concentrically of the driving shaft 2 of the drum, which shaft is passed through it. Outer ends 15 of the drawing shaft 2 are journalled in bearings 3 which are mechanically connected to the frame 6 of the washing machine.

Each of the closed compartments 12 contains at least two masses 16 located eccentrically of the driving shaft of the drum, each mass being rotatable about said shaft and immersed in a viscous liquid 17, for example oil, which partly fills the closed compartment 12. Said liquid constitutes a means of transferring the movement of the compartment to the balancing masses.

The balancing device thus comprises, on the one hand, two closed compartments 12 the envelopes or covers 13 of which are integral with the drum and, on the other hand masses 16 which are divided over said compartments and are rotatable about the driving shaft 2 of the drum and hence movable relative thereto.

It will be evident that the masses 16 placed in one of the compartments, together with the dimensions of this compartment and the characteristics and the amount of the filling liquid have to be identical with the corresponding elements of the other compartment to ensure satisfactory balancing of the drum.

In the first embodiment shown in FIGS. 3 and 4, each closed compartment 12 comprises a bottom formed directly by the side wall 14 of the drum 1, and a cover or envelope 13 which is rigidly secured to said bottom,

resulting in a closed compartment **12**. This compartment has two openings (not shown) which are usually located diametrically in opposition and are closed, for example, by means of threaded caps. Said openings serve to fill and empty the compartment **12** with viscous liquid **17**.

Each of the closed compartments **12** contains three masses **16** each having a radial arm **19** which is rotatable about the rotary shaft **2** of the drum **1**.

Each of the three masses **16** is identical with the other two and thus has the same dimensions, the same weight, etc. The three masses **16** are located in the same plane at right angles to the shaft **2** and thus are at an angle to one another in the rest position (FIG. 3). It will be evident that for structural reasons, the radial arms **19** of the masses **16** are located in different planes to permit free rotation of the masses about the shaft **2**.

In the example shown, the radial arms **19** rotate about the shaft **2** through slide bearings. It will be evident, however, that other types of bearings may be used as well, for example ball bearings or roller bearings, etc.

In the example shown, each of the masses **16** has the general form of a crown-shaped sector the external diameter of which is distinctly smaller (1 to 4 cms.) than the internal diameter of the compartment **12**. Each mass **16** has a damper **20** which is provided on one of its edges **21** and serves, on the one hand, to damp the impacts between the masses, especially upon stopping the drum **1** when the masses fall back to their rest position and on the other hand to prevent the edges of the masses **16** from adhering to one another due to the action of surface tensions of molecular films of liquid which might arise between said edges if they would not be mechanically maintained spaced apart.

Said dampers have a height of about 0.1 to 3 mms. and may be made of any arbitrary material, but especially suitable therefor are plastics since such materials form an acoustic as well as a mechanical damper because of their properties.

Each of the masses **16**, has in addition, driving members which, in this example, are formed by one or more driving fins **22** which project from the largest diameter and have dimensions such that the outer edge of each fin lies in direct proximity of the circular inner surface **23** of the cover **13**.

The weight of the masses **16** is determined as a function of the maximum value of the washing that must be capable of being balanced.

The thickness *e* of each mass is such that, if the masses are located in the compartment **12** in their operating position, channels **24** are formed between the inner side walls of the compartment and the sides of the masses. The thickness *a* of the channels **24** determines, for a given filling liquid of the compartment with a given viscosity and at a given relative speed between the masses and the compartment, the driving force which, due to friction of the liquid and because of its resistance to flow, acts upon the masses **16** in order to set them into rotation when the drum passes from its rotational speed during washing to its rotational speed during centrifuging.

The distance *b* between the circular inner surface **23** of the compartment **12** and the outer edge of a mass **16** is such that, when the drum **1** and hence the compartment **12** are driven at a rotational speed which is sufficient, but lower than the speed of centrifuging, the liquid in this compartment is already thrown against the wall **23** of the compartment due to centrifugal force and the masses **16** already come, at least in part, out of contact with said liquid. However, the driving fins **22** are invariably immersed in the liquid in order to ensure that the masses are driven in synchronism with the compartment, although the masses then have great freedom of motion and can be displaced very rapidly at an angle, in order to compensate for any modification in the washing.

The first embodiment of the washing machine described for domestic use operates as follows:

When the washing machine proceeds to washing a quantity of textile present in the drum **1**, the drum rotates at its washing speed which usually lies between 45 and 55 rev./min. At this washing speed, the driving forces transferred to the masses **16** by the liquid **17** present in the compartments **12** are not sufficient to impart rotation to the said masses. Thus, the compartment **12** rotates during washing, but the masses **16** remain in the positions shown in FIG. 3.

Since the rotational speed of the drum is low, the channels between the masses **16** and the side walls of the compartment **12** have a cross-section sufficient to pass the amount of liquid corresponding to this speed of the drum, without any appreciable loss of power being involved. It is to be noted that the washing water is heated during washing so that the whole of the drum is brought to a high temperature of the order of 70° C. to 90° C. Said heating causes a decrease in the viscosity of the liquid **17** in the compartments **12** so that the driving forces resulting from friction of the masses **16** decreases still further. However, during centrifuging, which takes place after rinsing several times, the last time with cold water, the liquid **17** has regained its normal viscosity compatible with the driving of the masses **16**.

When the drum **1** is accelerated from its washing speed to its centrifuging speed, the frictional forces and the resistance to flow of the liquid **17** present between the masses **16** and the walls of the compartment suddenly increase, resulting in the masses **16** being set into rotation. The masses **16** are first brought out of their rest position (shown in FIG. 3) to an intermediate position (FIG. 9) at which the first mass **16** is placed approximately vertically, while the third one is approximately in the position occupied by the central mass when at rest. At this moment (when the masses are positioned as shown in FIG. 9), the liquid **17** in the compartment starts to be centrifuged and shows approximately the distribution illustrated in FIG. 9. This distribution is such that the masses **16** are in practice still wholly immersed so that the driving forces are at their maxima, while the frictional forces are exerted on almost the whole surface of the masses.

During this first phase of the acceleration of the drum from its rotational speed during washing to its rotational speed during centrifuging, the speed of the drum is comparatively low, for example lower than 150 rev./min. During this first phase of balancing, the geometrical axis of the drum lies between the center of gravity of the washing in the drum and the shaft about which the drum actually rotates. At these low speeds of revolution of the drum, the washing has a tendency to describe as large a periphery as possible.

One moment later, when the rotational speed of the drum has increased still further and reached a speed which is almost equal to, but less than the balancing speed, the masses **16** driven by the driving forces are arbitrarily spread in the compartment **12** and the relative speed between the masses and the compartment is in practice zero. At the same time, the liquid **17** is centrifuged so that a layer of substantially uniform thickness is formed on the whole periphery of the compartment **12**, so that the masses **16** are suddenly extracted (un-immersed and, at least to a great extent, free from the driving action of said liquid. After this moment, only very small forces act upon the fins **22** and, as the case may be, upon a small surface of the masses **16** which is still immersed in the liquid, to keep the masses **16** in synchronism with the compartment **12**. During this second phase of the acceleration of the drum, the rotational speed of the drum increases and it is seen that the shaft about which the drum actually rotates has a tendency to approach its centre of gravity. This occurs at a rotational speed of the drum between, for example, 150 and 250 rev./min.

From the moment when the drum reaches a so-called balancing speed corresponding to the moment when the actual rotary shaft of the drum passes through its geometrical axis, that is to say a speed of, for example, 200 to 300 rev./min., the third phase of the acceleration of the drum, or balancing phase, is reached and the masses rotatable about the shaft **2**, which have great freedom of motion, move automatically and almost immediately the balancing position (FIGS. 10 and 11) at which the centrifugal forces corresponding to the masses **16** compensate for the forces associated with the masses of washing. In this balanced position, the actual rotary shaft of the drum is thus synonymous with its geometrical axis and the masses **16** lie opposite the washing so that the centrifugal forces resulting therefrom are balanced.

If upon acceleration of the drum **1**, the masses of washing soaked with water are divided regularly or symmetrically along the inner wall of the drum, the masses **16** are divided evenly, regularly or symmetrically around the driving shaft **2** from the moment when the masses are released, that is to say at the moment when the drum has reached its balancing speed. However, if the masses of washing are divided irregularly, the masses **16** are automatically placed opposite said masses so as to balance them.

A so-called stationary balancing is thus obtained whereby the centrifuged liquid **17** is thrown against the peripheral wall **23**. The masses **16** lie partly or wholly outside the liquid **17** so that the driving forces of the masses are highly decreased. The fins **22**, however, are still immersed in the liquid **17** and serve to maintain the masses **16** at the speed of the drum. The forces required therefore may be low since the masses are already in motion. To permit the drum to be balanced efficaciously during centrifuging, it is even necessary for the masses **16** to move as freely as possible about the shaft **2**, that is to say that the frictional forces in the bearings, as well as the holding forces, are small so that the masses **16** rapidly react to changes in the value and the distribution of the washing, for example due to the extraction of water from the washing.

Since the drum has two closed compartments provided with balancing masses, which compartments are located one on each side of the transverse plane of symmetry of the drum and at the same distance from this plane, the balancing obtained is substantially perfect. From then onwards, it is possible to drive the drum without a risk of damage to the bearings or dangerous actions upon the frame, at very high speeds of the order of from 700 to 1000 rev./min. in order to obtain efficacious centrifuging of the washing. From this it follows that, after a short period of time, the user can stop the driving motor of the drum, open the door **10** and remove the washing therefrom which has been centrifuged sufficiently to be ironed without preliminary drying.

The tests carried out with household washing machines having a capacity of from 3 to 7 kgs. of dry washing have shown that, if the frictional forces resulting from the centrifuging of the liquid **17** become small enough and the drum reaches its balancing speed (for example 200 to 300 rev./min.), the mass or masses of washing irregularly distributed in the drum is or are balanced automatically and that, in addition, the relative positions of the masses **16** change automatically according as water is extracted from the washing during centrifuging, so that this device automatically maintains a substantially perfect balancing of the drum **1** despite the continuous changes in the magnitude of the masses of washing irregularly distributed in the drum.

The tests carried out with such household washing machines have also shown that the second phase of the acceleration of the drum is reached after a few revolutions of the drum, which corresponds to a speed of the drum of, for example, 120 to 150 rev./min. allowance being made for its acceleration. The third phase of acceleration or effective balancing phase is obtained at a speed of the drum of, for example, 200 to 300 rev./min. that is to say before the drum performs dangerous movements of deflection.

Furthermore, in a washing machine having a single-phase motor (comprising an auxiliary phase for starting at a very low internal resistance) for driving the drum it is necessary for the acceleration of the drum to take place very rapidly within a time at the most equal to 2 seconds, since otherwise the energy consumed by said auxiliary phase is prohibitive and gives rise to deterioration of the motor or melting of a safety fuse. To bring about such rapid starting, the masses **16** have to be rapidly brought into the balancing position at which their drive requires only a minimum power.

So it is absolutely necessary for the driving forces of the masses **16** to be high at the beginning of the acceleration of the drum and then to decline to a negligible value, which result has actually been obtained in the device described.

When the drum **1** is stopped, the liquid **17** and the masses **16** fall back into their positions shown in FIG. 3. The dampers **20** prevent the masses **16** from impacting against one another with noise.

It will be evident that the dimension *a* of the channel **24**, the distance *b* between the outer periphery of the masses and the peripheral surface **23** of the closed compartment, the viscosity and the amount of the liquid **17**, and also the weight of the masses **16** are determinative of the driving forces of the masses. At any rate, these parameters must be matched so that said driving forces are not sufficient for driving the masses **16** when the drum **1** rotates at its washing speed. However, said driving forces must be sufficient for driving the masses **16** at a speed of the drum which is higher than, but almost equal to its washing speed, but which is lower than its balancing speed, in order to guarantee the driving of the masses, and must then fall off to a low value when the speed of the drum is almost equal to, but still lower than its balancing speed.

The amount of liquid **17** may be varied within certain limits and makes it possible to change inter alia the manner in which the masses fall back to their rest position when the drum is stopped. The amount of liquid also permits of varying the value of the forces for maintaining the masses in rotation, since these forces are dependent upon the surface area of each of the masses **16** which is still immersed in the liquid during centrifuging.

In the second embodiment shown in FIGS. 5 and 6, the balancing device comprises only two balancing masses **16** and the dampers **20** are formed by impact edges, for example of plastic.

The further structural particulars and the operation of this second embodiment are identical with those of the embodiment first described.

In the third embodiment shown in FIGS. 7 and 8, the the balancing device comprises compartments **12** which are identical with those of the two embodiments already described, but the balancing masses have a different shape.

In fact, this third embodiment has compartments **12** each containing two masses **26** which are positioned side by side in the transverse direction of the compartment **12**. Each of the masses has a general semi-circular shape and an axle **27** with a bearing formed in it, which in the example shown is a ball or roller bearing **28**, so that the mass can rotate about the driving shaft **2**.

In the rest position shown in FIG. 7 and 8, the two masses **26** are located side by side in the lower portion of the compartment **12**. Each of the masses also has a fin **22** which has a similar function to that in the first two embodiments.

When the drum **1** passes from its washing speed to its centrifuging speed, the masses **26** are driven, as before, by the liquid **17** which has to flow through channels

30 present between each mass 26 and the side walls of the compartment.

To balance the washing in the drum 1 during centrifuging, the masses 26 occupy positions which are at an angle to one another dependent upon the positioning and the volume of the washing. The operation of this embodiment of the device is similar to that of the other embodiments.

In FIGS. 7 and 8, the amount of liquid 17 in a compartment 12 is distinctly less than in the other embodiments described and so this liquid finds itself, on being centrifuged, substantially within an annular channel 31 present between the wall 23 of the compartment and the outer edge of the masses 26 so that these masses are kept in rotation only by the driving forces corresponding to the fins 22.

Furthermore, in this embodiment, one of the masses of each compartment could be matched so that, at the beginning of the acceleration of the drum, it is driven by higher driving forces than are the others. Thus, one of the masses is thrown before the others and it is prevented that during the second phase of the acceleration of the drum during which the masses are arbitrarily spread, the two masses are in too closely adjacent angular positions so that the weight of the washing could be increased during a certain period of time when the said two masses would be located close to the masses of washing. To obtain a preferred drive, it is possible to provide, for example, a channel between the compartment and one of the masses which is narrower than that between the compartment and the other mass. It is necessary, however, that the dynamic effect of each mass of a compartment is the same. The preferred drive of one mass with respect to the other could alternatively be obtained by means of different diameters of the masses, or by adding driving fins to only one of the masses.

Three embodiments of the balancing device have been described by way of example, but it will be evident that numerous variants are possible within the scope of the invention.

More particularly, the diameter and the shape of the cover 13 of the compartment 12 could be different, as well as the shape of the masses 16.

It will also be evident that each of the described embodiments can have driving fins or not, insofar in the latter case the balancing masses are still in contact with the centrifuged liquid 17 in their balancing position.

In an embodiment not illustrated, the driving fins could have the form of protuberances, projections or other driving elements which are provided on the perphery of the masses and manufactured, for example, integrally therewith.

A variant shown in FIG. 11 illustrates a balancing device which has no driving fins 22. In this embodiment, the radius of curvature of the external peripheral surface of a mass is smaller than that of the peripheral surface 23 of the compartment, resulting in an arc the top of which

remains immersed in the liquid 17 during centrifuging, even when the liquid is centrifuged.

What is claimed is:

1. In a washing and centrifugal drying machine the combination comprising a drum rotatable about an axis, means for rotating said drum at washing speed and at centrifuging speed, a closed compartment connected with said drum at each end thereof, each said compartments being positioned symmetrically relative to the transverse plane of symmetry of said drum and concentric with said axis, at least one pair of eccentric masses dimensioned to be freely moveable in each said compartment, means mounting said masses for free rotation about said axis within said compartments, and a viscous fluid only partly filling each said compartment, the quantity of said fluid being sufficient to submerge said masses substantially completely at said washing speed.

2. In a washing and centrifugal drying machine according to claim 1 with the addition of radially extending projections on each said mass extending into the said liquid at said centrifuging speed.

3. A washing and centrifuging machine according to claim 2 wherein said eccentric masses in the same compartment are in the same plane at right angles to the axis of rotation of the drum and are displaced at an angle relative to one another.

4. A washing and centrifuging machine according to claim 3 wherein each balancing mass has an elastic damper separating each mass from its adjacent masses.

5. In a washing and centrifugal drying machine the combination comprising a drum, a shaft mounting said drum for rotation, means for driving said drum at washing speed and at centrifuging speed, a closed chamber at each end of said drum symmetrical relative to the transverse plane of symmetry of said drum and concentric with said shaft, at least one pair of eccentric masses in each said chamber dimensioned for free movement within said chamber and means mounting said masses for rotation about said shaft within said chambers, a viscous fluid in each said chamber for only partly filling said chamber, and said chamber and masses being dimensioned for substantially complete submersion of said masses in said fluid at the said washing speed of said drum and said masses being substantially completely free of said liquid at the said centrifugal speed of said drums.

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