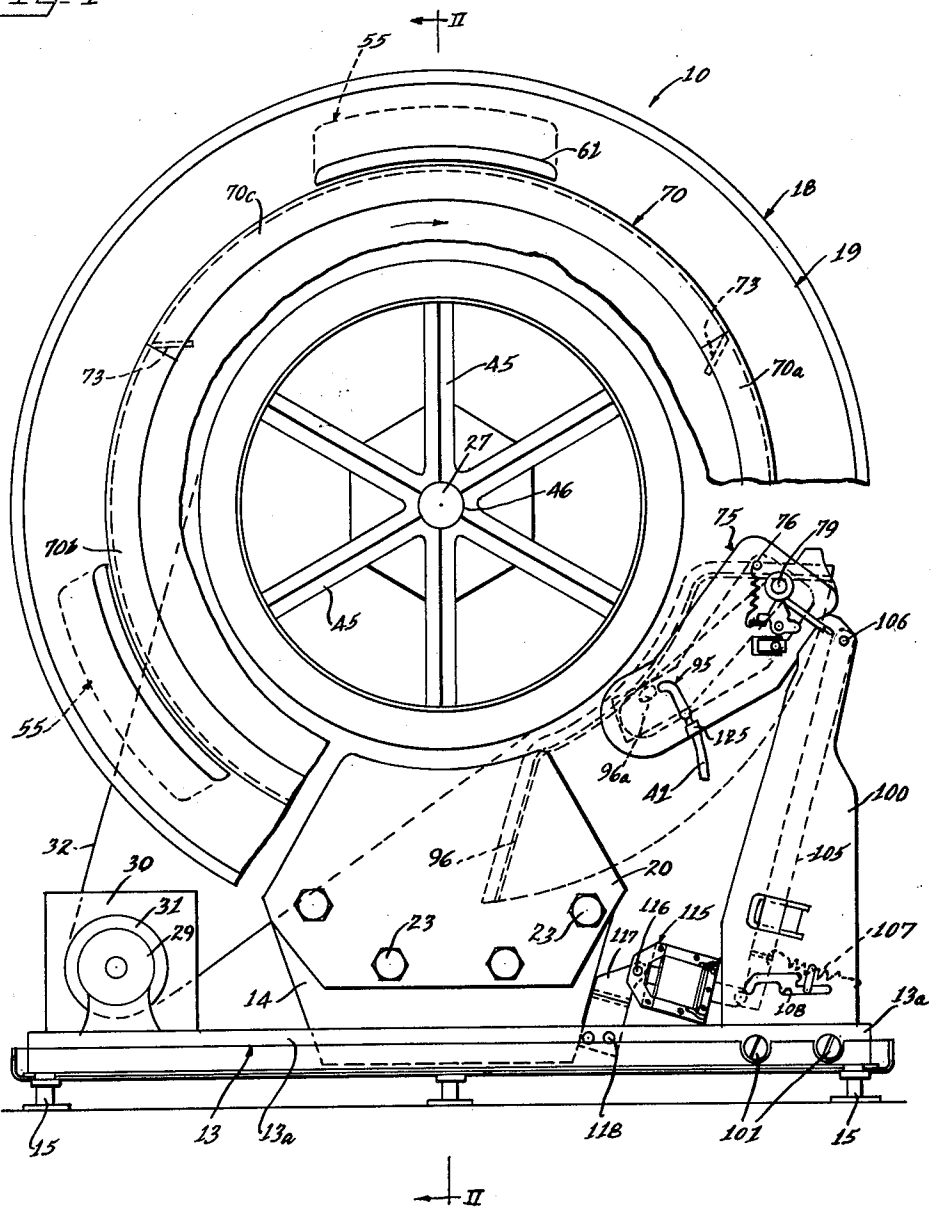
June 22, 1965 W. F. SCOTT ETAL 3,190,447

ROTATABLE RECEPTACLE BALANCING APPARATUS WITH ROLLER BEARING DEFLECTOR MOUNTING

Filed March 23, 1961 4 Sheets-Sheet 1

Fig. 1



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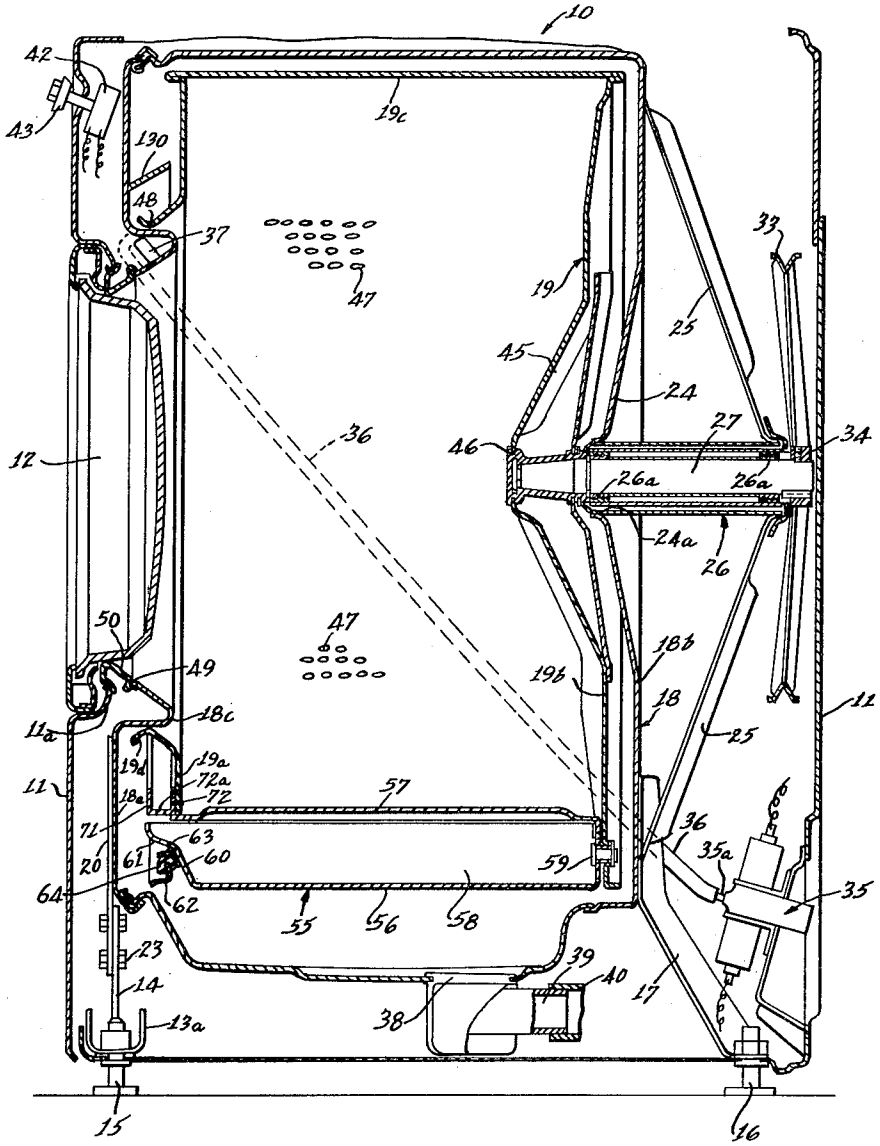
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ROTATABLE RECEPTACLE BALANCING APPARATUS WITH ROLLER BEARING DEFLECTOR MOUNTING

Filed March 23, 1961 4 Sheets-Sheet 2

Fig. 2



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ROTATABLE RECEPTACLE BALANCING APPARATUS WITH ROLLER BEARING DEFLECTOR MOUNTING

Filed March 23, 1961 4 Sheets-Sheet 3

Fig. 3

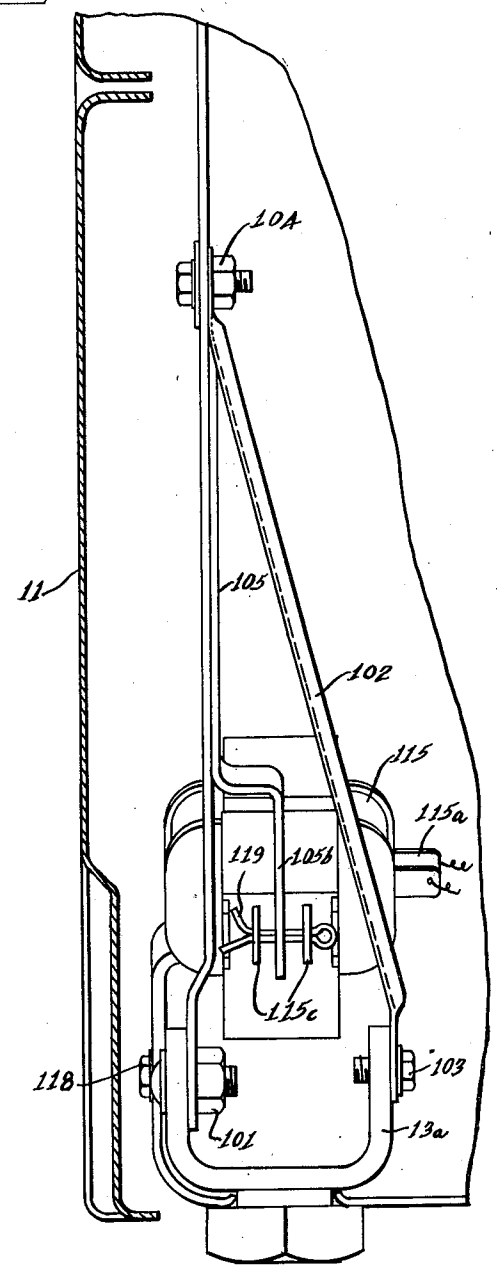
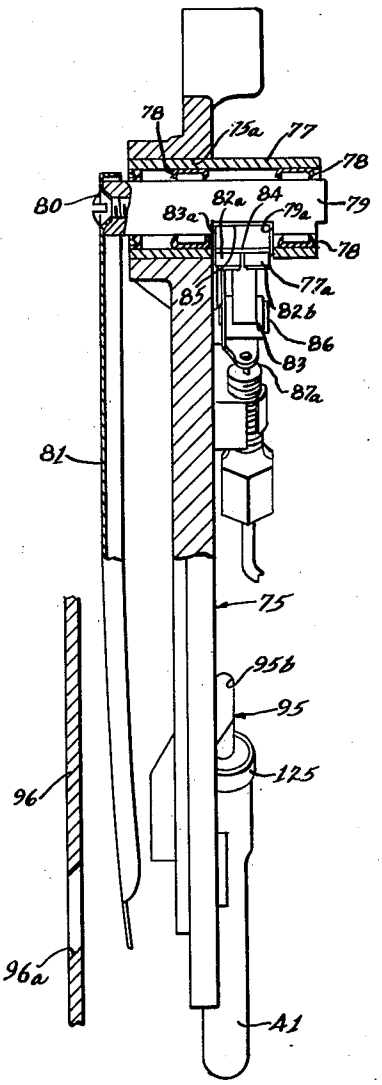


Fig. 6



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ROTATABLE RECEPTACLE BALANCING APPARATUS WITH ROLLER BEARING DEFLECTOR MOUNTING

Filed March 23, 1961 4 Sheets-Sheet 4

Fig. 4

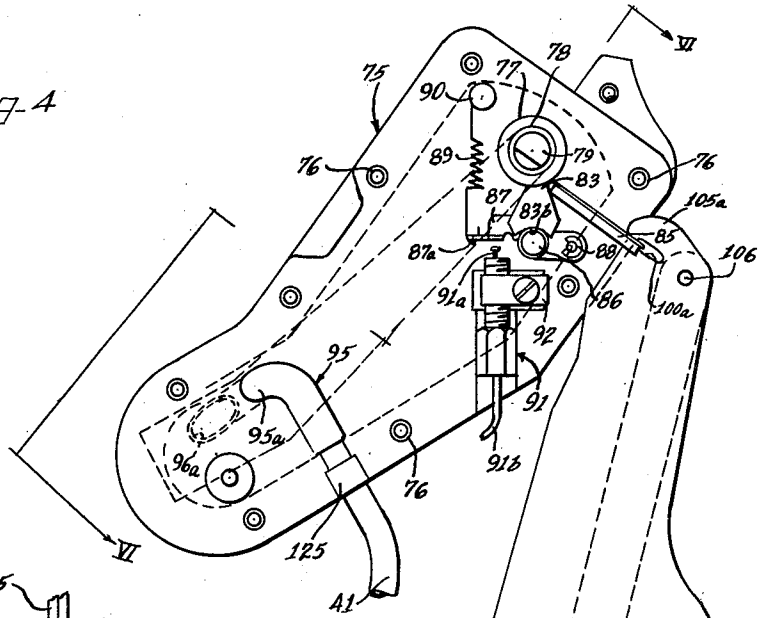
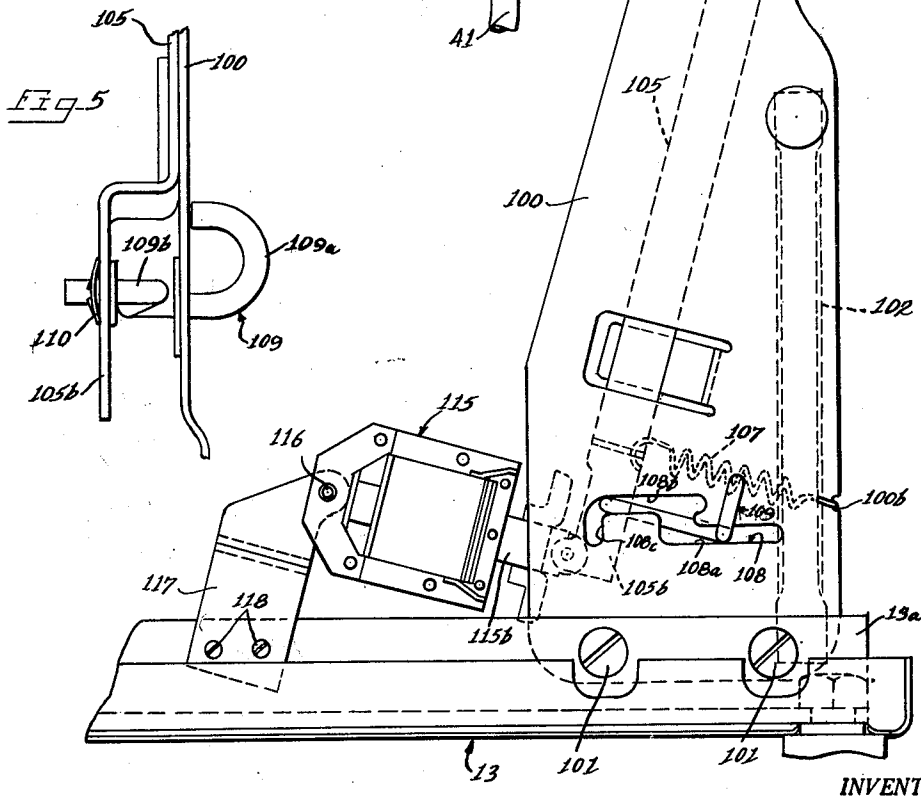


Fig. 5



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United States Patent Office 3,190,447 Patented June 22, 1965

3,190,447

ROTATABLE RECEPTACLE BALANCING APPARATUS WITH ROLLER BEARING DEFLECTOR MOUNTING

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Filed Mar. 23, 1961, Ser. No. 97,899
6 Claims. (Cl. 210—144)

The present invention relates broadly to the art of counterbalancing unsymmetrically distributed centrifugal forces in a rotating body, and is more specifically directed to laundry apparatus wherein a substantially horizontal axis type drum containing materials to be laundered is rotated at high speeds for optimum water extraction, but without the detrimental effects caused by excessive uncontrolled vibrations.

The principles of the present invention are generally applicable to any balancing system wherein it is desired to counterbalance unsymmetrically disposed centrifugal forces generated because of unbalance in a rotating body, however, because the principles of the present invention find a particularly useful application to a laundry machine, the invention is described and illustrated in connection with a specific laundry machine associated with domestic utilization such as a typical home laundry appliance.

From the point of view of a laundry machine operator, it is highly desirable that a laundry load be completely washed and dried in as short a time as possible. Such criterion is applicable whether the load of clothes to be laundered is to be line-dried or machine-dried. In either case, the length of time required to dry a particular load will be substantially directly proportional to the quantum of liquid retained in the material at the end of a washing cycle.

In contemporary domestic laundry appliances, including automatic washing machines wherein clothes are washed and centrifuged, or in so-called combination washer-dryers wherein clothes are washed, rinsed, spun dry and tumbled dry with the application of heat energy, that part of the total washing and drying time preceding the tumble dry or line dry portion of a total laundering cycle time is designated as the wash portion of the total cycle and consumes substantially the same amount of actual time for all available machines. Thus, to decrease the overall wash and dry time of a particular load, the most practical substantial time savings can be made by shortening the dry portion of the total cycle.

The usual approach to an attempted improvement of machine drying involves the consideration of increasing the drying heat input to the dryer which is somewhat undesirable from a standpoint of the power consumption rate of usage and the somewhat increased cost of operation thus incurred, but it is most undesirable from a standpoint of engineering design considerations which are required because of the increased power input to the drying means.

In accordance with the principles of the present invention, a second approach is made which is desirable not only from a standpoint of machine drying, but also from a standpoint of line drying and that is to increase the rotative cylinder speed used during the extraction part of the wash cycle, thereby to remove larger amounts of water from the load prior to the beginning of the tumble or line drying of the load. By increasing the spin speed utilized to remove additional water from the load, a rate of power consumption savings of 8 to 15 times may be accomplished over the removal of this additional water by the high power input drying process.

With properly designed bearing and transmission systems power input is the primary consideration that has to be made with respect to the limit of spin speed attained in driving a mass about its exact center of mass. An empty laundry receiving cylinder or drum rotated about its bearing axis parallels an optimum operating condition, but when a load is introduced into the cylinder, the load is likely to be distributed in such a manner that the center of mass of the loaded cylinder will not coincide with the cylinder bearing axis, thereby producing an unbalanced centrifugal force which is directly proportional to the mass of the unbalanced portion of the total rotating mass, the square of the angular velocity of such unbalanced mass and the radius of the unbalanced mass from the axis of rotation of the cylinder.

In addition to affecting the power input necessary to rotate the cylinder or drum, an unbalanced condition causes serious vibration conditions which are even more pronounced in horizontal machines than in vertical axis machines, since the unbalanced force directed substantially opposite the gravitational forces acting on the machine may be sufficiently great to actually lift the machine from its supporting surface and produce a violent movement colloquially referred to as "walking."

Because of these problems, some contemporary laundry machines of the horizontal axis type operate at a sufficiently limited spin speed so that the unbalanced loads encountered during normal operation will not produce a sufficient amount of centrifugal force to bodily lift the machine from its support. It has also been contemplated in prior art machines to provide control means whereby a spin mechanism will be inactivated in response to excessive motion in the apparatus, whereupon the drum or cylinder will decelerate to a tumbling speed for redistribution of the contents thereof. In such prior art machines, the final spin speed is limited to a value such that the total amount of liquid centrifugally extracted from the contents of the drum or cylinder is much less than is desired. It will be readily appreciated that all such extra retained liquid is required to be evaporated either by a longer period of evaporation if the goods are line dried or by consumption of an additional supply of heat energy due to a longer drying period, if the goods are machine-dried.

Other forms of balancing mechanisms employed in laundry apparatus contemplate suspension of the entire laundry machine along with an additional mass producing dead weight within the enclosing cabinet on a complex spring system. Such arrangements depend upon isolation of the source of vibration, whereupon the suspended system is allowed to violently vibrate within the enclosing cabinet, with the dead weight tending to minimize the effects of the unbalanced centrifugal forces.

With such prior art arrangements, it is inevitably necessary that the size of the enclosing cabinet must be greatly increased to allow for the violent gyratory motions of such system during operation of the machine, or if the cabinet size is a limiting factor, the cylinder size must be reduced to a size which is somewhat detrimental to the quality of wash of an average size clothes load and completely inadequate for the wrinkle free drying of an average clothes load in the same cylinder.

In other forms of prior art machines, eccentric motions of the rotating body are sensed and located by relatively complex mechanisms which control the addition or subtraction of weights from the rotating components of the machine, thereby to counteract the unsymmetrically disposed centrifugal forces generated by the unbalanced conditions within the cylinder or drum.

In accordance with the principles of the present invention, a drum is journaled for rotation on a horizontal axis within a casing rigidly connected to a base frame. Vibratory movements of the casing are mechanically

sensed by shaft means rotatably mounted on movable structure and positively conected to immovable structure, the shaft means converting the vibratory oscillations of the casing into angular displacements of the shaft which are amplified mechanically through a lever arm or deflector member connected thereto. The resultant pivotal movements of the lever arm or deflector member are used to control the introduction of counterbalancing liquid into certain of a plurality of liquid balance pockets disposed on the periphery of the drum.

It is a further feature of this invention that the shaft means be equipped with means in control of drum acceleration and means to restore the deflector member to a properly indexed position with respect to the liquid introducing means. By this provision, drum acceleration is regulated during performance of the counterbalancing function, and the deflector member is restored to a "zero locked position" subsequent to movements of the laundry apparatus, occasioned by either shipment from the factory to the user or within the user's home.

By virtue of these relatively simple mechanical provisions, the situs of the unbalance is not only automatically determined and only as much counterbalancing liquid as is required is added to the rotating system of the machine, but increased drum acceleration during counterbalancing is prevented and the deflector member is at all time returned to its original pre-set indexed position relative to the liquid introduction means.

It is an important aim of the present invention to provide improved counterbalance control means for a rotating receptacle.

Another object of the present invention is to provide a balancing system for a rotating receptacle which efficiently adds to the rotating system only so much balancing liquid as is required to place the system in operational equilibrium.

Another object of the instant invention is to provide a balancing system for a laundry apparatus wherein the laundry liquid may be effectively utilized as a balancing fluid.

A further object of this invention lies in the provision of a mechanical sensing and control device for a balancing system which automatically compensates the device to keep the operation thereof in phase with the unbalanced forces.

An even further object of the present invention is to provide balancing apparatus wherein there is precisely coordinated balancing, indexing and acceleration control functions.

Other objects and advantages of the invention will become more apparent during the course of the following description, particularly when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals designate like parts throughout the same:

FIGURE 1 is a front elevational view of a laundry machine constructed in accordance with the principles of this invention, but with the outer cabinet removed and with other parts broken away and with other parts removed for clarity;

FIGURE 2 is a cross-sectional view taken substantially along the line II—II of FIGURE 1, but with portions of the cabinet added and with other operative components of the machine added for the sake of clarity in completing the description of the inventive subject matter;

FIGURE 3 is a fragmentary sectional view of a portion of the base frame structure and further illustrating a portion of the frame assembly provided to effect a positive connection with the rotatable sensing shaft means;

FIGURE 4 is an enlarged fragmentary view constituting a layout of sensing apparatus embodying the features of this invention;

FIGURE 5 is a view of lever operating means and related structure constituing a part of the zero locking system of this invention; and

FIGURE 6 is a sectional view taken substantially along the line VI—VI of FIGURE 4 and further illustrating the sensing apparatus of this invention.

Referring now first to FIGURES 1 and 2, there is shown a so-called combination washer-dryer intended for use as a domestic laundry appliance, the machine being designated generally in the drawings by the numeral **10**. The machine comprises an outer cabinet **11** providing an esthetically appealing enclosure for the machine, and having a front wall characterized by an access door **12** through which a batch of materials to be laundered may be placed in or withdrawn from a treatment zone formed within the machine.

Within the outer cabinet **11** is a rigid base structure identified generally at **13**, and comprising a channel member **13***a*, plate **14** fixedly secured thereto, and front legs **15** bolted or otherwise secured to the channel member **13***a*. As appears in FIGURE 2, the base frame **13** further includes a leg **16** bolted to bracing means **17** welded or otherwise secured to an outer casing **18** within which is mounted for rotation a perforate drum **19**.

The casing **18** is connected to and supported on the base frame **13** by a front support plate member **20**. The plate member **20** is integrated with a front wall **18***a* of the casing **18**, as by welding, and is securely fastened to the upstanding leg or plate **14** of the base frame **13** by fastening means **23**.

At the rear portion of the machine **10** the casing **18** is provided with a rear wall **18***b*, and integrated therewith is a single vertical supporting structure provided by a shaped metal form member earlier designated by the numeral **17**. The rear wall of the casing **18** has an embossed central portion **24** centrally apertured as at **24***a* and cooperable with a support spider **25** connected in firm assembly with the rear wall **18***b* to rigidly mount a bearing assembly designated generally at **26**, and in which is journaled a shaft **27** connected for corotation with a rear wall **19***b* of the drum **19**.

It may be observed from FIGURE 2 that the bearing assembly **26** includes an outer housing which engages directly against the rear wall **18***b* of the casing **18** and the support spider of the casing. The bearing assembly **26** includes bearing races **26***a* associated with the shaft **27** to provide a relatively rigid bearing mount for the drum **19** within the casing **18**. The rigid bearing means thus provided for the drum insures the cooperative relation required between the drum **19** and casing **18**, in accordance with the principles of the present invention.

It may be further noted that the connections provided by the parts **14** and **20** between the base frame **13** and casing **18** are rigid connections, however, sufficient yieldability exists in such connections or in the channel member **13***a* so that some very small movement of the casing **18** relative to the base frame **13** may occur. The connections afforded by integration of the parts **14** and **20** to the channel member **13***a*, and the connection of the brace member **17** to the casing **18**, are sufficiently rigid to confine the casing **18** for limited oscillatory movements about an axis positioned parallel to and located below the horizontal rotational axis of the drum **19** prescribed by the shaft **27**. In the machine exemplified by the instant disclosure, such allowable arcuate movement is of the order of 0.010 inch from its normal centered position, as measured from an approximate sixteen inch lever arm.

The machine **10** is equipped with an electric drive motor **29** having a power take-off shaft (not shown) drivingly connected with a transmission designated generally at **30**. The transmission is provided with take-off shaft means (not shown) to which is connected a pulley **31** over which is positioned a pulley belt **32** driving a pulley wheel **33** connected in driving relation to the shaft **27** by keylocking means **34**.

The machine **10** further includes conventional inlet water mixing valve construction, shown generally at **35**, and including the conventional cold and hot water inlets

which are connected to the usual source of domestic supply. The mixing valve assembly 35 has an outlet 35*a* connected to a hose or conduit 36 leading to a fresh water inlet 37 carried in the front wall 18*a* of the casing 18, the inlet 37 discharging fresh temperature-conditioned water into the treatment zone for mixture with a suitable additive, such as a detergent rinsing agent.

As appears in FIGURE 2, the machine 10 has a sump 38 in the bottom of the casing 18, the sump having an outlet 39 connected by means of a conduit 40 to suitable pump and two-way valve means (not shown). As is known, such valve means has an outlet connected to drain and another outlet connected to conduit means 41 (FIGURE 1) for performance of the counterbalancing function.

The laundry machine 10 is of course equipped with heater and blower means to direct heated air into the interior of the drum 19 to reduce the moisture content of the fabrics therein, the moisture-bearing air then being discharged to atmosphere in the manner known to the art. Since such structure is not essential to an understanding of the instant invention, it has been eliminated from the drawings in order to clarify the disclosure.

It will be understood that the machine 10 has a sequential control means shown generally at 42 which is presettable by the operator as at 43, and which is associated by the usual electrical circuitry with all of the operating components of the machine, including the electric drive motor 29, mixing valve means 35, two-way valve means, transmission means 30 and pump means 35 to actuate the machine through a program consisting of washing, rinsing, extracting and drying periods. Thus, in a typical operation, the operator will load a batch of clothes to be laundered through the door 12 into the drum 19. Upon initiation of a preselected program, the casing 18 will be charged with a supply of water. Following the washing operation, the laundry fluid will be drained through the sump 38 and discharged to drain. The materials within the drum are then subjected to an extraction operation followed by rinsing and a subsequent extraction operation, which portion of the washing cycle may be repeated as often as may be desired in accordance with the preset program. After the final extraction operation, the machine either continues through a drying period involving operation of the drying system, and including the addition of heat of vaporization to the stream of ventilating air circulated through the treatment zone, or the batch of materials being laundered may be removed from the machine by the operator for line drying.

Having thus described the general operation and organization of an exemplary embodiment of the inventive subject matter, the specific improvements contemplated in the balancing system will now be referred to in greater detail.

Upon continued reference to FIGURE 2, it will be noted that the drum 19 has formed along its rear wall 19*b* a plurality of radially extending, angularly spaced strengthening ribs 45. At the center of the rear wall 19*b*, the drum is connected as at 46 to the shaft 27. The outer peripheral wall of the drum 19 is formed by a foraminous wrapper 19*c* and is particularly characterized by a plurality of openings 47, through which liquid may escape from the interior of the drum into the casing 18. The drum 19 has a front wall 19*a* which extends radially inwardly of the outside wrapper 19*c* and terminates in an axially offset outwardly flared mouth or lip 19*d* forming an opening 48 through which materials to be laundered may be charged into the interior of the drum 19. The opening 48 is in registry with the door 12, and also registers with a front opening 49 formed in the front wall 18*a* of the casing 18. In order to prevent leakage and to aid in the removal of the clothes load, the front wall 18*a* of the casing 18 is particularly characterized by an axially inwardly extending annular rib 18*c*.

The rib 18*c* of the casing 18 and an inwardly extending flange 11*a* on the outer cabinet 11 are interconnected with one another by a rubber sealing gasket 50, the radially inwardmost portions of the gasket 50 being resiliently sealed against the glass surface of the door 12.

At a plurality of circumferentially spaced locations on the periphery of the drum 19 recess means are provided to accommodate mounting therein a liquid balancing receptacle, indicated generally by the numeral 55. Each receptacle comprises a generally trough-shaped tray member having a wall 56 which is spaced radially outwardly of an imperforate wall portion 57 formed on the drum 19 at the recessed area. The receptacle 55 further includes side and end walls 58 to facilitate connection as at 59 between the rear portion of such walls and the adjoining rear wall 19*b* of the drum 19.

The front wall of each receptacle 55 is characterized by an inclined portion 60, thereby having both radial and axial extent and terminating in an axially protruding spout or nose 61 which projects beyond the axial extent of the front wall 19*a* of the drum 19. It is to be observed in this regard that the spout 61 extends inwardly of an outer front flange 62 formed at the outer extremity of the drum front wall 19*a*. To facilitate mounting of the receptacle 55 in the drum, a bracket member 63 on the receptacle 55 fits snugly against a resilient gasket 64 which fits over an inwardly extending leg of the flange 62 to wedge the receptacle 55 into sealing engagement with wall portion 57 of drum 19.

Each receptacle or balancing compartment 55 is provided with a separate inlet segment 70*a*, 70*b* and 70*c*, respectively, the inlet assembly being designated generally by the numeral 70. Each inlet segment is generally U-shaped in configuration and has an outer leg 71 (FIGURE 2) spaced axially from the wall 19*a* of the drum 19, and an arcuate peripheral wall 72 having formed therein an opening 72*a* through which all of the fluid within an inlet segment is discharged radially outwardly into the spout 61 of the receptacle 55. Illustratively, there are three receptacles 55, and accordingly, each segment 70*a–c* may desirably extend through 120° of arc on the front wall 19*a* of the drum, and each segment is attached in firm assembly by welding or related techniques to the drum front wall 19*a* in registry with the liquid supply means provided to introduce balancing fluid thereinto. As appears in FIGURE 1, each inlet segment 70 has an end wall 73 disposed between its side walls to divide the inlet assembly into three separate compartments.

In order to control the introduction of balancing fluid into the receptacles 55 by way of the inlet segments 70*a–c*, there is utilized in accordance with the instant invention, as a controlling variable, a mechanical signal manifested as a relatively small oscillatory movement between the casing 18 and a relatively stationary reference means. A balance housing, designated generally in FIGURES 4 and 6 by the numeral 75, comprises a plate-like member attached by fastening means 76 to the front wall 18*a* of the casing 18.

The balance housing 75 is passaged at 75*a* adjacent its upper end, and firmly received in the opening thus provided is a sleeve member 77 having a generally D-shaped opening 77*a* formed therein by a notch extending approximately half way through the sleeve member 77. Journaled in bearings 78 within the sleeve member 77 is a rod or shaft means 79 having a notch forming a flat portion and defining a generally D-shaped recess 79*a* mating with the similarly shaped opening 77*a* in the sleeve member 77. The shaft means 79 threadably receives at one end screw means 80 to effect attachment of a flag, stream interrupter or deflector member 81.

The shaft means 79 is radially tapped and threaded on the flat portion of the D-shaped recess 79*a* to receive therein screw means 82*a* and 82*b* to eccentrically mount on the shaft means cam means 83, washer means 84 and a relatively thin leaf spring member 85 directly adjacent flat portion 79*a* (FIGURE 4). As appears in

the drawings, attaching portion 83*a* of the cam member 83, the washer means 84 and one end of the leaf spring member 85 are essentially entirely contained in the recessed portion 79*a* of the shaft means 79 and the passage 77*a* of the sleeve member 77.

The cam member 83 which corotates with the shaft 79 in a limited arcuate motion is provided with a cam portion 83*b* engaging a roller-like follower means 86 rotatably carried by an arm member 87 pivotally connected at 88 to the balance housing 75. The end of arm member 87 extends beyond follower means 86 and has a flange portion 87*a* formed thereon to which is connected spring means 89 which in turn is connected to a stationary anchor member 90 rigidly connected to the balance housing 75.

The balance housing 75 further mounts bleed valve means 91 by clamp means 92, the valve means 91 having a stem portion 91*a* located for actuation by the flange portion 87*a* on the arm member 87. As will be later described in detail, the bleed valve means 91 connects through conduit means 91*b* to the transmission means 30 to slip or disengage a friction clutch (not shown) in the transmission means, whereby increased acceleration of the drum 19 is prevented so that during performance of the counterbalancing function the drum is maintained at the rotative speed which caused the off-balance condition to produce the sensed vibratory deflections of casing 18. In practice, the pneumatic clutch control and the water balance system are coordinated so that the fluid balancing takes place prior to slipping of the friction clutch. In such a case the controls are adjusted so that greater oscillation of casing 18 is required to actuate valve 91*a* than to move stream deflector 81.

The leaf spring reaction member 85 is clampingly engaged at its opposite end by stationary or immovable structure during drum rotation so that if the drum vibrates by reason of an off-balance load therein, the shaft 79 is slightly rotated to pivot the deflector or stream interrupter member 81 out of blocking relation with nozzle means 95 to permit the discharge of counterbalancing fluid from the nozzle opening into the proper inlet segments 70*a–c* and into proper balancing compartment or compartments 55 diametrically opposed to the off-balance load. In this regard, it is to be observed that there is provided a splash housing 96 (FIGURE 1) mounted on the casing front wall 18*a* between the casing 18 and drum 19. The splash housing has formed therein a slotted opening 96*a* (FIGURE 4) in register with the outlet of the nozzle 95.

The clamping means for the leaf spring reaction member 85 comprises a stationary or immovable frame member 100 erected from the channel member 13*a* of the base frame structure 13 and attached thereto by fastening means 101, which may take the form of bolts. The stationary frame member is rigidified by brace means 102 connected to the channel member 13*a* by bolt means 103 and to the stationary frame member 100 by bolt means 104. The stationary frame member 100 has a relatively flat surface 100*a* at the upper end thereof providing a first clamping surface, and the other jaw or second clamping surface is provided by a bar member 105 pivotally connected at 106 to the frame member 100, and having at its upper end an inwardly turned jaw portion 105*a*. The pivotally mounted bar member 105 is rigidly connected at its lower end to the stationary frame member 100 during drum rotation to cooperatively clamp the leaf spring reaction member 85 between surfaces 100*a* and 105*a*, although as will now be noted, the clamping member 105 can be pivotally swung clockwise to release the reaction member 85 and to permit return of the deflector member 81 to its originally indexed or zero position by action of the spring 89 and cam surface 83*b*.

A first mechanical system for controlling the clamping action on the yieldable reaction member 85 is shown in FIGURES 4 and 5. It is to be observed therefrom that the bar member 105 has a rearwardly turned lower end portion 105*b* and connected thereto is spring means 107 connected at its opposite end to the frame member 100, as at 100*b*. The frame member 100 has formed therein a slot generally designated as 108 and comprising a pair of generally horizontal groove portions 108*a* and 108*b*, the latter groove terminating in a generally downward groove portion 108*c*. Movable within the groove portions 108*a–c* of the slot 108 is an actuating member 109 having a hand manipulable portion 109*a* and a body portion 109*b* received in the slot 108 and pivotally connected at its opposite end, as by fastening means 110, to the end portion 105*b* of the pivotally mounted clamping member 105.

In summary it can be seen that frame member 100 serves as a stationary abutment or reaction member to which one end of leaf spring member 85 is attached, the other end of the latter member 85 being attached to the flat on shaft 79 to which flag 81 and cam 83 are also rigidly connected. Oscillation of casing 18 during rotation of unbalanced loads in the machine places leaf spring 85 alternately in tension and compression and the resulting flexing and buckling of the eccentrically connected spring member 85 oscillates members 81 and 83 to control the water balancing and clutch control functions during the fluid extraction operation of the machine.

During operation of the laundry machine 10, or when the machine is not moved between machine cycles after the balancing and acceleration control systems have been properly indexed, the actuating member is in the lower groove portion 108*a*, and accordingly, the rod member 105 is in cooperating clamping relation with the frame member 100, essentially as appears in FIGURE 4. The clamping force exerted by the jaw portion 105*a* of the rod member 105 is then provided by the spring means 107, and illustratively, the clamping force may be of the order of 20 pounds or more. However, if the yieldable leaf spring member 85 was firmly clamped by the frame 100 and rod member 105 during movement of the machine 10 to a different location, as within the house of the operator, there exists the possibility that the drum 19 and casing 18 would shift with respect to the base frame structure 13, causing the zero position of the deflector member 81 to be out of phase. Although the actual dimensional shift between the casing 18 and base structure 13 is very small, this shift is amplified approximately 40 to 50 times by the flag or deflector 81 with respect to the nozzle outlet 95*b* in its pivotal movement with the shaft 79. Accordingly, during movement of the machine the actuating member 109 is moved into the upper groove portion 108*b*, which unlocks the clamping member 105 to release the leaf spring member 85, permitting the spring means 89 to move the deflector 81 and cam means 83 in control of the transmission clutch bleed-off to return to a zero or indexed position. In this manner, after repositioning of the machine and return of the actuating member 109 to the lower groove portion 108*a*, the water balancing and acceleration control systems are maintained in proper phase or in a "zero locked" position.

It may be desired during machine movements, as for example when the machine is transported from the factory to a distributor or to a householder, to release the spring 107 entirely, the spring is disconnected either from the frame member 100 or from the rod member 105, and the actuating member 109 moved into the downwardly directed groove portion 108*c* to release the clamping action.

It is also within the contemplation of this invention that the clamping engagement of the drive member 85 be automatically released by electrical means responsive to the timing cycle of the laundry machine 10. An electrical system for this purpose is illustrated in FIGURES 3 and 4, and may be seen to comprise solenoid means 115 pivotally connected at 116 to bracket means 117 rigidly associated with the channel member 13*a*, and connected thereto as by fastening means 118. The solenoid means 115 has a current supply connection 115*a*, as well as shaft

or armature means 115*b* having a bifurcated end portion 115*c* connected by cotter pin means or the like 119 to the lower end portion 105*b* of the pivotally mounted rod member 105.

As was stated, the solenoid means 115 is connected into the electrical circuitry of the laundry machine 10 and is under control of the conventional timer motor 42 controlling the various portions of the laundry cycle. Accordingly, at least once during each cycle, and prior to the high spin extraction portion thereof, the solenoid means 115 is energized to move the shaft portion 115*b* thereof to the left as viewed in FIGURE 4, which has the effect of rotating the rod or lever member 105 clockwise about the pivot point 106. This of course releases the clamping force on the relatively thin leaf spring member 85, so that under action of the resilient means 89 the balance control system is permitted to return to its zero set position in which deflector 81 is properly positioned relative to nozzle 95*a*. The solenoid means 115 is thereafter deenergized after an interval of timer operation, and the spring means 107 returns the clamping rod member 105 to the position shown in FIGURE 4. It is thus to be observed that by the described electrical system in control of the clamping forces there is eliminated the possibility of an out-of-phase condition of the balance system by inadvertence on the part of the operator in failing to utilize the actuating member and slot arrangement after the machine has been moved. Normally, the mechanical and electrical systems in control of the rod member 105 are substitutes one for the other, although certain applications may indicate the desirability of providing both systems.

The nozzle assembly 95 may be permanently mounted by the balance housing 75, and as appears in FIGURES 4 and 6, the balance housing may support a coupling member 125 receiving the conduit means 41 either by a threadable connection or a press fit. The coupling member 125 further receives the nozzle assembly 95, and of course, the balance housing 75 is suitably apertured to receive therethrough the nozzle discharge portion 95*a* so that the nozzle outlet 95*b* is aligned with the slotted opening 96*a* in the splash housing 96 and located directly adjacent to the arcuate path of movement of the deflector or interrupter member 81.

In operation, movements or deflections of the casing 18 produced as a function of the rotation of any unsymmetrically disposed load in the rotating drum 19 is sensed by the shaft means 79, to which of course the cam member 83 and deflector 81 are connected for limited co-rotation or oscillation. The leaf spring member 85 during machine operation is of course clamped by the surfaces 100*a* and 105*a* so that vibratory movements of the balance housing 75 relative to the stationary surfaces 100*a* and 105*a* causes oscillation of shaft 79 and pivotal movement of the deflector member 81 out of blocking relation to the nozzle outlet 95*b* and slotted opening 96*a* in the splash housing 96. Since shaft 79 is carried in the bearing means 78 on the assembly 75 fastened to casing 18, shaft 79 can be said to "float" relative to the stationary members 13 and 100 while moving with casing 18. The collector segments 70, balance tanks 55, deflection of the drum 19 and casing 18 and movement of the deflector 81 are coordinated, as will be later explained, to assure that the proper balance tank or tanks diametrally opposite the off-balance load receive the balancing fluid.

Counterclockwise movement of the shaft means 79, which occurs as the unbalance load moves to the left of the vertical centerline of the machine, essentially simultaneously swings the cam member 83, rocking the camming surface 83*b* thereof against the follower means 86 on the lever member 87, forcing the flange portion 87*a* on the lever member 87 against the valve stem 91*a* of the bleed-off valve 91. This action releases air pressure on friction clutch means (not shown) in the transmission means 30, causing clutch slippage and a termination of increased acceleration of the drum 19. The friction clutch means is periodically slipped in accordance with vibrations of the balance housing 75 so that the drum 19 does not rotate at a speed in excess of that which caused the vibrations due to the unbalanced condition. However, as was noted, the bleed-off action is preferably coordinated with the initiation of the water balancing function by control of the space between the lever member flange 87*a* and valve stem 91*a* so that air release and clutch slippage occur only when the drum or cylinder 19 deflects an amount greater than the deflections which cause initiation of the water balancing action. In this manner, there is prevented the circumstance of clutch slippage and reduction in the speed of the drum by deflections of an amount only sufficient to initiate counterbalancing, which would interfere with the balancing function, since if the drum rotative speed was reduced to below the speed which caused initiation of the water balance function due to the off-balance condition, introduction of counterbalancing fluid would not occur and, of course, the off-balance in the drum could not be corrected properly.

In the absence of an off-balance condition, the nozzle outlet 95*b* discharges balancing fluid against the deflector member 81 from where it is directed downwardly into the sump 38. On the other hand, counterbalancing fluid injected into any of the balancing pockets 55 during the extraction operation will drain by gravity from these pockets upon deceleration of the drum 19 at the end of an extraction operation. However, to insure that such draining fluid does not again enter the drum through possible passage through the opening 48, there is provided on the front wall 18*a* of the casing 18 a baffle ring 130 extending around the upper half of the rib 18*c*, but spaced radially outwardly thereof.

The water or liquid used for balancing, in accordance with the principles of the present invention, is taken from the machine sump 38 and is fed to the balancing nozzle assembly 95 by the machine pump (not shown) to assure a constant flow pressure independent of the inlet water pressure to the machine 10. A water level control system can be incorporated into the machine to assure that there will always be enough water in the sump 38 from a remote fluid source for proper and rapid counterbalancing. The deflector or interrupter member 81 merely diverts the flow from the nozzle assembly 95 back into the sum 38, unless a large enough unbalanced load is present at a particular drum rotative speed to cause the deflector member 81 to be pivoted out of the path of fluid emanating from the nozzle assembly 95, whereby the liquid flow enters the proper input segment or segments of the inlet assembly 70 on the front of the drum 19 for discharge through an opening 72*a* into a corresponding receptacle or receptacles 55.

In the exemplary form of structure herein described, each of the three illustrated inlet segments 70*a–c* are aligned with the centerline of the associated receptacle 55, although as will be later explained, it may be desirable that these inlet segments start at the approximate centerline of the associated receptacle 55 and extend for approximately 120° from the centerline of the corresponding receptacle, that is, in the direction of rotation of the drum 19. Moreover, in the illustrated embodiment, the nozzle assembly 95 is located approximately 60° below the horizontal centerline and approximately 30° to one side of the vertical centerline of the drum 19. As well, the nozzle outlet 95*b* is arranged so that the angle of dispersion of the fluid stream discharged from the nozzle outlet 95*b* will be directed approximately 30° in the direction of rotation of the drum 19 and approximately 15° downwardly. In the illustrated embodiment, the offset from the vertical centerline is toward the righthand side of the machine using the orientation of FIGURE 1. With this orientation, the direction of rotation of the drum 19 is in a clockwise direction, as indicated by the arrow in

FIGURE 1. It will be appreciated, however, that the rotational direction of the drum and the actual positioning of the nozzle assembly and sensing device can be modified to suit any desired circumstances.

Since the highest drum speed is substantially below the critical frequency of the nearly rigid mounting system, an assumption may be made for explanatory purposes that there is no angular difference between the deflection of the casing 18 and the unbalanced force producing that deflection, and which unbalanced force results from the unsymmetrically disposed centrifugal forces produced during rotation of the drum 19. This assumption is what is referred to as an "in phase condition." In the illustrated embodiment, the maximum annular deflection of the casing 18 and the cylinder or drum 19 will occur to the left of the vertical centerline as the unbalanced load passes the horizontal centerline in an upward direction. Furthermore, the maximum annular deflection to the right will occur as the unbalanced load passes the horizontal centerline in a downward direction and to the right of the vertical centerline.

To correct an unbalanced load causing the casing and drum assembly to oscillate about its center of oscillation, it is necessary with the assumed "in phase condition" to add counterbalancing fluid to the balance tank or tanks in the drum directly opposite the unbalanced load. To accurately accomplish the introduction of balancing fluid to the inlet segments 70, so that the situs of the unbalance will actually be located or sensed by the device, the nozzle and the sensing means are located to the right of the vertical centerline and below the horizontal centerline, thereby to respond to deflections of the casing and drum assembly to the left of the vertical centerline for balance fluid injection. Of course, at this time the assumption is also made together with such "in phase condition" that the relationship between the deflector member 81 and the deflection of the casing and drum assembly is such that the deflector member 81 will be pivoted to a position to allow the balancing fluid to enter the inlet segments 70 over the upper edge of the deflector or interrupter member 81.

When a laundry load is being spun out in the machine cylinder, it is normal that due to the uncontrolled positioning of the load along the cylinder inner periphery, an unequal mass distribution will exist causing an unbalanced load. Even though during the duration of the spin period the distribution of the load along the cylinder inner periphery will not change, the rate of centrifugal extraction of the water retained in the load at different sections of the cylinder will be different, so therefore the mass distribution is constantly changing and new unbalanced loads will appear at different locations in the cylinder until all of the water that can be moved by the particular cylinder speed has been removed. In accordance with this invention, however, an automatic adjustment is effected whereby the necessary relationship between the deflector member 81 and the deflection of the casing and drum assembly is maintained throughout the complete extraction period, regardless of the changing or relocation of any new unbalanced loads appearing during the course of the extraction period.

It is to be noted that as the unbalanced load in the drum 19 rotates clockwise past the bottom portion of the geometric vertical centerline of the system, deflection of the mounted system would tend to be in the vertical direction and at this point, which may be referred to as a "zero" degree reference point, the vertical centerline of the suspended system corresponds to the geometric vertical centerline of the machine.

As the unbalanced load progresses upwardly toward the horizontal centerline or 90° position, the deflection of the drum and casing to the left of the geometric machine vertical centerline will increase from zero at the zero reference point to a maximum as the unbalanced load crosses the horizontal centerline. From 90° to 180° rotation of the unbalanced load from the zero reference point in the upward direction, the deflection of the mounted system decreases back toward the geometric vertical centerline to where it would again be zero as the unbalanced load passes the geometric vertical centerline. The last 180° travel of the unbalanced load would be the same as the first 180° of travel, with the maximum deflection to the right occurring as the unbalanced load passes the horizontal centerline of the 270° position in a downward direction.

For proper counterbalancing of such an unbalanced load in an assumed "in phase condition," it is necessary that when the maximum deflection of the casing and drum assembly occurs to the left, the interrupter member 81 will be in its lowest pivotal position to allow the balance water to pass over the top of the member 81 and into the inlet segments 70 on the front wall 19*a* of the drum 19, so that the balance water can pass from the inlet segments 70 into the proper receptacle or receptacles 55 directly opposite the unbalanced load. Thus, in the system illustrated, when the casing and drum assembly is at its maximum deviation to the right of the vertical centerline, the deflector or interrupter member 81 will be in its uppermost pivotal position, but will still be interrupting the flow from the balance water nozzle 95. This assures that no balance water enters the system that would actually add to the amount of unbalanced load.

However, when an unbalanced load appears in the drum 19, it is necessary to have the flag or interrupter member 81 positioned so that every time maximum casing and drum deflection occurs to the left of the vertical centerline, the interrupter member 81 will be in its lowermost position to allow for the passage of the maximum amount of balancing water from the nozzle outlet 95*b* into the inlet segments 70. This system assures in the exemplary structure that the counterbalancing water will enter the balance tank or tanks 55 directly opposite the unbalanced load, which is the necessary condition to eliminate the effects of the unbalanced load.

In the arrangement illustrated, whenever the drum and casing assembly moves to the left, the leaf spring member 85 is placed in tension and will cause the shaft 79 to move counterclockwise with respect to the housing 75 to cause the deflector 81 to move downwardly out of blocking relation with the nozzle outlet 95*b*. On the other hand, as the balance housing 75 moves to the right of the vertical centerline due to an unbalanced load in the cylinder or drum 19, the leaf spring member 85 is compressed between the shaft 79 and the clamping surfaces 100*a* and 105*a* of the frame and rod members 100 and 105, respectively. This compressing action tends to somewhat buckle or bend the leaf spring member 85, however, the leaf spring member 85 is effective to rotate the shaft 79 in a clockwise direction to cause the deflector to move upwardly, although as noted, the upward deflector movement is not sufficient to permit the introduction of water into the balance tanks which would add to the unbalanced load.

The interrupter or deflector member 81 moves approximately an equal amount in opposite directions from its neutral or properly indexed position and in exact phase with the drum and casing assembly deflection by originally establishing the proper relationship between the flat portion of the recessed section 79*a* in the shaft means 79 and the deflector member 81. To accomplish this, the sleeve member 77 when installed in the balance housing 75 is positioned so that the cut-out portion 77*a* of the sleeve 77 allows the shaft recess portion 79*a* to operate in its proper dimensional position. After the drive member 85, washer means 84 and cam member 83 are positioned on the shaft recess portion 79*a* and the interaction between cam surface 83*b* and the roller follower 86 as driven by spring 89 has placed the flat portion of the shaft recess 79*a* in its proper neutral position, the de-

flector member 81 is screwed by means 80 into the shaft. A particular dimension is established for this purpose as a result of test investigations, and this dimension locates the top of the deflector or interrupter member 81 with respect to the outlet 95*b* of the nozzle assembly 95. This establishes the proper phase relationship between the position of the off-balance load in the drum 19 and the movement of the deflector 81 to allow the balancing fluid to pass into the collector segments 70.

After this exact dimension has been found, the deflector is locked in this dimensional position with respect to the balance nozzle outlet 95*b*. Thereafter, the bleed-off valve 91 is adjusted in the balance housing 75 to give a proper dimensional distance of the valve stem 91*a* from flange portion 87*a* when the cam follower 86 is centered on the cam surface 83*b* of the cam member 83 as controlled by the spring 89 with leaf spring member 85 unlocked. This dimension assures that the bleed-off for clutch slippage will occur at a deflection slightly greater than the deflection necessary to initiate water balancing for the purpose earlier indicated of maintaining the drum rotative speed at that which caused the off-balance condition to produce the necessary water balancing initiation deflections. With the discussed adjustments made, which can be a bench assembly operation, the entire assembly is ready to be installed on the front wall 18*a* of the casing 18.

It may now be seen that as each unbalanced load is counterbalanced, the casing and drum assembly deflection, and thus the interrupter member deflection, return to where zero deflection exists. As other unbalanced loads appear and begin to produce a casing and drum assembly deflection, the deflector member 81 will also begin to oscillate in phase with the casing and drum deflection, so that the proper relationship between the two deflections will exist and counterbalancing of the new unbalanced load will take place.

It is also possible that while one unbalanced load is being counterbalanced, a different unbalanced load may appear in a different part of the drum 19. Depending on the magnitude of each of the unbalanced loads, an effective resultant unbalanced load will appear. The exact point of the cylinder on which such resultant unbalanced load is directed will then become the part of the cylinder or drum that will produce the maximum deflections. The interrupter member or flag 81 moves exactly in phase with such resultant unbalanced load that produces the maximum deflections and thus the water balance system of the present invention will counterbalance such resultant unbalanced load. In this manner, all unbalanced loads that appear within the drum 19 of the present invention are rapidly and effectively counterbalanced.

It will be understood that the operation of the system of the present invention has been explained with regard to an "in phase condition" of the relationship between the unbalanced load and the deflection it produces. In practice, the expected top operating spin speed of the cylinder or drum is sufficiently below the critical frequency of the rigid casing and drum assembly so that the phase shift existing between the unbalanced load and its resulting casing and drum assembly deflection is small. To accommodate phase shifting whereby the unbalanced load angularly leads the deflection it produces, the structure of the present invention requires only that the relationship of the inlet segment and its corresponding balance pocket be modified so the leading edge of the inlet segment will be in some position less than 120° from the centerline of the corresponding balance tank. Such changed relation thus allows the balancing fluid to enter the balance tank sooner than in the "in phase condition" described hereinabove.

In any event, by the present invention an off-balance condition is rapidly and effectively overcome, and as well, by provision of the bleed-off system, precise control is maintained over the acceleration of the drum or cylinder 19 so that the drum not only does not rotate at a speed any considerable degree faster than that which caused the off-balance condition to produce the necessary water balancing initiation deflections, but also by not actuating the bleed-off system at the same deflection resulting from the off-balance load, the drum rotative speed is not reduced to a value such that water balancing system would be rendered ineffective. Further, as has been described, there is also provided a "zero locking system" of either a mechanical or electrical form to assure that after machine movements the deflector member 81 and cam member 83 are restored to the original pre-set indexed or zero position for effective water balancing and acceleration control.

Various modifications have been described hereinabove, and it is of course appreciated that these and other changes can be effected in the structure disclosed without departing from the novel concepts of the instant invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for counter-balancing a rotating receptacle comprising a base, support means on said base including bearings for journalling said receptacle, a receptacle journalled in said bearings, counterbalancing means on said receptacle including a plurality of circumferentially positioned pockets for receiving liquid, and means for introducing liquid into said pockets selectively comprising conduit means having a nozzle for directing a stream of liquid towards said pockets, and a movable baffle interposed between said nozzle and said pockets, a shaft connected to said baffle and rotatable about its own axis to pivotally move said baffle for alternately interrupting and introducing the flow of liquid into certain of said pockets, means on said support means supporting and journalling said shaft for rotation, a thin leaf spring forming a reaction member having one end connected to said shaft radially outwardly of its axis, said reaction member extending transversely relative to said axis, and means connecting the other end of said reaction member to said base, whereby relative movement of said support means and said base induced by rotation of unbalanced loads in said receptacle will alternately place said reaction member in tension and compression so the resulting flexing and buckling thereof will oscillate said shaft to control the pivotal movement of said baffle.

2. Apparatus for counterbalancing a rotatable receptacle comprising, a casing, a rotatable receptacle in said casing and means for driving said receptacle, a base frame having connections with said casing sufficiently rigid to confine said casing for limited movement when unsymmetrical centrifugal forces are generated during rotation of said receptacle, a plurality of fluid receiving pockets mounted on said receptacle for receiving counterbalancing fluid, and control means controlling the addition of fluid to said pockets to effect counterbalancing during rotation of unbalanced loads within said receptacle, said control means including a shaft journalled for rotation on the casing and having a coupling portion formed thereon, a thin leaf spring member clamped at one end to said coupling portion of said shaft, and means clamping the other end of said thin leaf spring member to said base frame, and means including means regulated by said shaft for fluid balancing unsymmetrical centrifugal forces generated during rotation of said receptacle to which movements of said casing are responsive, oscillation of said casing during rotation of unbalanced loads in said receptacle operating to place said leaf spring member alternately in tension and compression so that resulting flexing and buckling of the leaf spring member will oscillate said shaft to control water balancing.

3. Apparatus as defined in claim 1, and further characterized by said means connecting the other end of said reaction member to said base comprising a release means,

said release means including a pivotally movable clamping member to selectively clamp said reaction member for connection to said base during rotation of the receptacle, but releasable for pivotal movement to release the reaction member for shipment.

4. Apparatus as defined in claim 1, and further characterized by said means connecting the other end of said reaction member to said base including a means for selectively releasing clamping engagement with said reaction member, and means resisting oscillation of said shaft by said reaction member and effective when said clamping engagement is released to return said baffle to an original pre-set position.

5. Apparatus as defined in claim 1, further characterized by drive means for rotatably driving said receptacle and control means including valve means supported on said support means and connected to said drive means for controlling the rotative speed of said receptacle in response to said relative movement of said support means in said base in phase with the movement of said baffle.

6. Apparatus as defined in claim 1, further characterized by resiliently urged cam means connected to said shaft and resisting pivotal movement of said shaft by said reaction member, thereby tending to maintain said baffle at a pre-set position.

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