

Jan. 28, 1964 **W. K. COMPANS** **3,119,773**
PIVOTING DEFLECTOR WATER BALANCE SYSTEM
FOR CENTRIFUGAL EXTRACTOR APPARATUS
Filed Oct. 10, 1960 4 Sheets-Sheet 1

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FIG. 1

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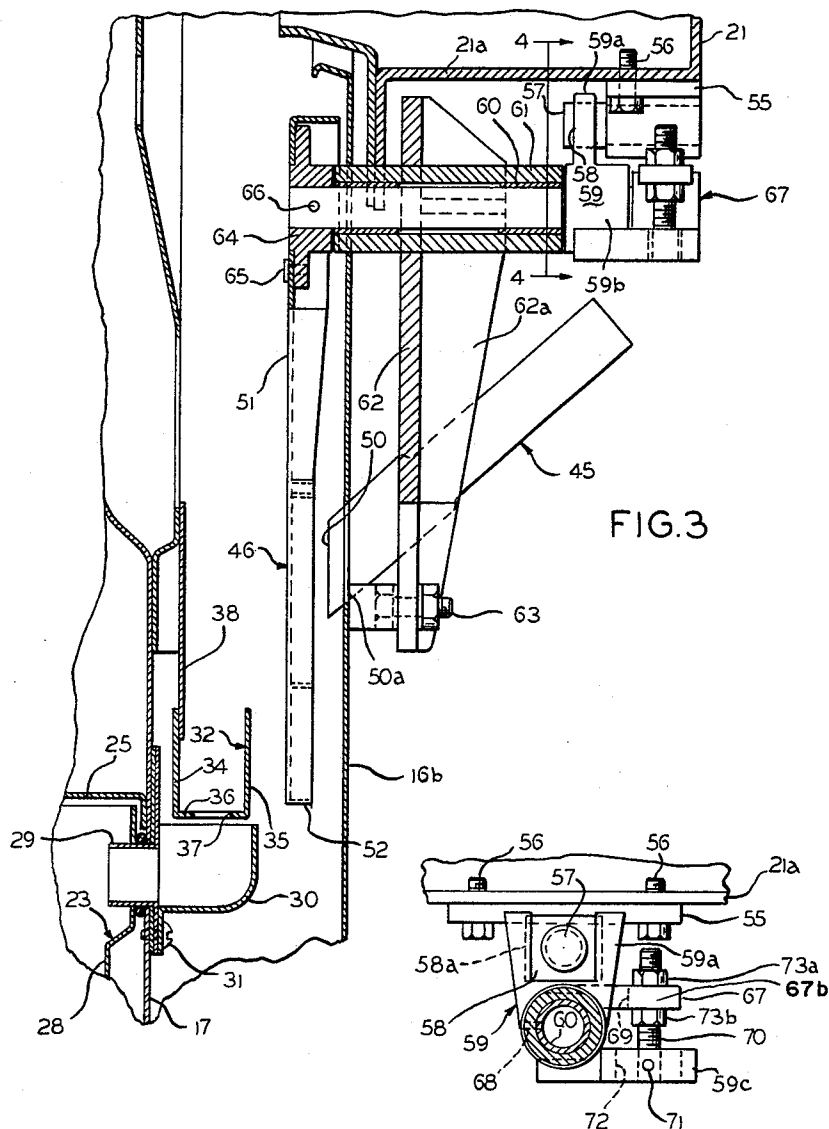


FIG. 4

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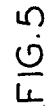
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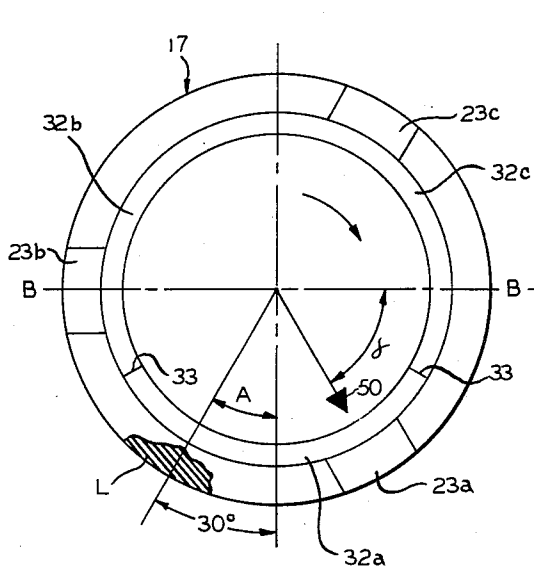


FIG. 6

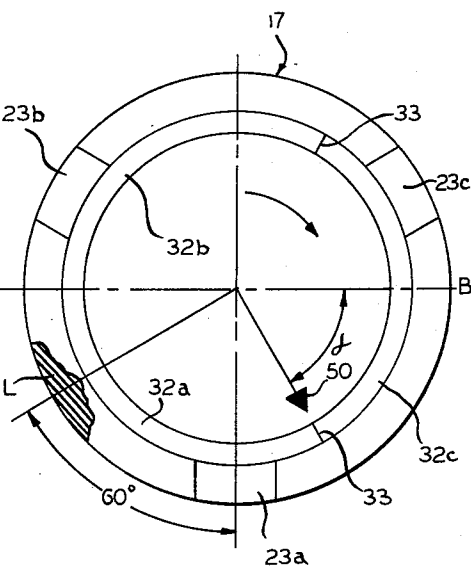


FIG. 7

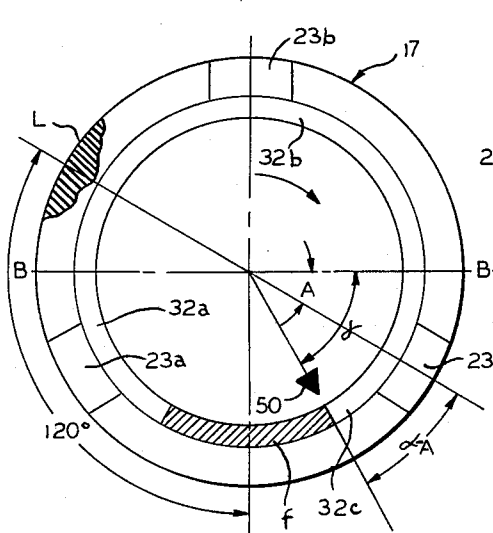


FIG. 8

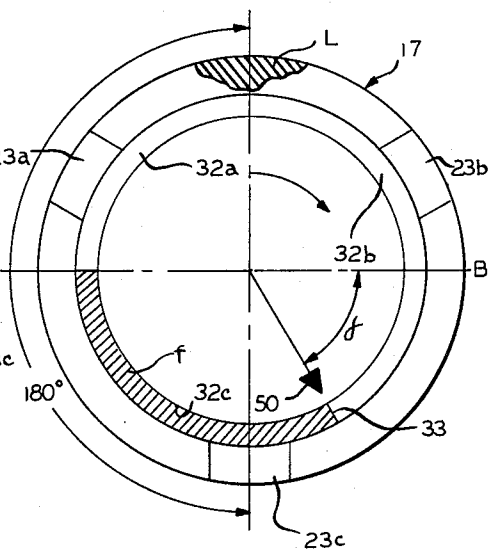


FIG. 9

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PIVOTING DEFLECTOR WATER BALANCE SYSTEM FOR CENTRIFUGAL EXTRACTOR APPARATUS

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

The principles of the present invention are generally applicable to any balancing system and method 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 and method, the invention is described and illustrated in connection with a specific laundry machine and method associated with domestic utilization such as a typical home laundry appliance.

From the point of view of a housewife 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 the 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 power consumption 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 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 power consumption rate savings of approximately 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

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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 weight 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 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 the diameter of the clothes cylinder must be reduced, where cabinet size is a factor, to the point where the capacity of the cylinder becomes impractical if wrinkle free drying is to be maintained.

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 casing is rigidly supported by a base frame and within the casing a drum is mounted for rotation and for vibratory movement relative to the base frame. A flow regulator or deflector is mechanically connected to the means which mounts the drum for rotation within the casing, and the deflector moves in phase with a deflection

produced by an off-balance load being rotated, and desirably the deflector or flow regulator pivots to either interrupt or allow a flow of balancing liquid from a nozzle to be introduced into certain of a plurality of liquid balance pockets disposed on the periphery of the drum; thereby effectively counterbalancing the off-balance load.

By virtue of this novel arrangement of parts, the situs of the unbalance is automatically determined and only as much counterbalancing liquid as is required is added to the rotating system of the machine.

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

Another object of this invention lies in the provision of a balancing system for a rotating receptacle which 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 counterbalancing system wherein a deflector member is mounted for pivotal movement by mounting structure which vibrates relative to casing supporting means, the deflector being interposed in a path of fluid flow from a stationary nozzle member and moving in phase with a deflection produced by an off-balance load being rotated in an extractor drum such that the pivoting deflector either interrupts or allows a flow of balancing liquid from the nozzle to be discharged into the drum to counterbalance unsymmetrically distributed centrifugal forces therein.

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 side elevational view, with parts removed and with parts taken in section, to more clearly illustrate the counterbalancing system of this invention;

FIGURE 2 is an end elevational view, with parts removed and with parts taken in section, showing in further detail a laundry machine embodying the balancing system of the present invention;

FIGURE 3 is a fragmentary sectional view of the deflector mounting means and injection intake segment which connects with a liquid balance pocket to receive balancing liquid from the illustrated nozzle when an off-balance condition is present;

FIGURE 4 is a vertical sectional view taken substantially along the line 4—4 of FIGURE 3, and showing certain details of the pivotal mounting for the deflector;

FIGURE 5 is a fragmentary end elevational view of the pivoting deflector and mounting means therefor which interrupts or permits liquid flow from the illustrated nozzle into certain of a plurality of the liquid balance pockets; and

FIGURES 6 to 9 are more or less diagrammatic illustrations showing in part a preferred nozzle position and relationship between an off-balance load and the angle between said load and the deflection produced thereby during a complete revolution of the extractor drum.

Referring now first to FIGURES 1 and 2, there is shown and designated generally by the numeral 10 a domestic laundry appliance which may take the form of a so-called combination washer-dryer. Certain structural portions of the laundry appliance have been omitted in the interest of clarity of illustration and since such portions are not essential to the present invention.

In the exemplary structural organization shown, the machine 10 is provided with a base plate or support structure indicated at 11. An enclosing cabinet (not shown) having side, front, and back walls plus a top wall is

attached to the upright sides of the base plate 11. The front wall provides access at 12 by means of which a batch of materials to be laundered may be placed in or withdrawn from a treatment zone formed within the machine 10.

The cabinet is supported upon front and rear legs 13 and 14 which are mounted on the base plate or support structure 11, and upon the base plate 11 there is fixedly mounted a drum mounting structure designated at 15, and which may take the form of a pair of spaced uprights 15a and 15b. The base portion of the cabinet 11 further fixedly supports, as shown in FIGURE 1, a casing 16 spaced within the cabinet and shaped along its lower portion as indicated in FIGURE 2 by the numeral 16a to provide a sump.

Mounted for rotation within the casing 16 and for vibratory movement relative to the casing 16 and base plate 11 is a perforated drum or cylinder 17 having a passaged front wall 17a and closed rear wall 17b connecting generally centrally thereof with shaft means 18 received at its opposite end in relatively fixed bearing means 19. The bearing means 19 is attached in any suitable manner to a generally horizontal support or pylon member 21 connected at its opposite ends to the upright members 15a and 15b, and constituting the herein provided means for mounting the drum 17 for rotation within the casing 16 and for vibratory movement relative to the casing 16 and base plate 11. As will be later described in further detail, rotation of the drum 17 with an unbalanced load therein causes the pylon member 21 to vibrate in opposed horizontal directions as indicated by the arrows 22, and in the absence of the application of counterbalancing forces, such vibration may be sufficient to cause the machine 10 to actually "walk" upon the floor. This situation can exist whether or not a supporting structure of the character indicated at 15 is employed, and it can accordingly be appreciated that the supporting means 15 can take the form of an A frame or any other basket or drum mounting arrangements.

The drum or basket 17 is provided with recess means at a plurality of circumferentially spaced points on its periphery to accommodate mounting in such recesses a liquid balancing receptacle, of which three are provided in the illustrative embodiment shown and designated therein by the numerals 23a-c. Each balancing receptacle is of essentially identical construction and comprises a generally trough-shaped tray member having a wall 24 spaced radially outwardly of an imperforate wall portion 25 formed on the drum 17 at the recessed area. Each receptacle 23a-c further includes side walls 26, and in the generally diagrammatic showing of FIGURE 1, front and rear walls 27 and 28. The front walls 27 desirably have drain openings of minimal dimension adjacent the perforate wall portion 25 (not shown) to afford draining after the drying cycle.

Illustratively, the receptacles 23a-c and injection intake structure therefor may take the form shown in FIGURE 3, to which reference is now made. The rear wall 28 of each receptacle 23 and rear wall 17b of the drum 17 may be passaged to receive a connector member 29 communicating with an annular fluid guide member 30 secured as at 31 to the drum rear wall 17b. The trough-like guide ring 30 is mounted to be in fluid receiving communication with an inlet assembly generally designated by the numeral 32, and desirably provided by a generally U-shaped ring member divided at 33 (FIGURE 2) to provide three inlet segments 32a-c extending through 120° of arc on the rear wall 17b of the drum 17. Three 120° segments have been found advantageous in practice, and the specific reasons therefor will be discussed hereinafter.

As appears in FIGURE 3, the injection intake ring 32 has a pair of spaced wall portions 34 and 35 connected by a radial wall 36 apertured at 37 at circumferentially spaced locations to communicate the inlet segments 32a-c with a particular balance receptacle 23a-c during the

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counter-balancing action. As also appears in FIGURE 3, the injection intake member 32 is welded or otherwise secured along its wall portion 34 to a plate portion 38 connected to the drum rear wall 17b.

The drum 17 is rotatively driven within the casing 16 in any desired manner, and illustratively there may be provided motor means 39 provided with a shaft 40 mounting pulley means 41 about which is trained a belt 42 also wrapping a pulley 43 on the drum drive shaft 18. Desirably, the motor means 39 connects with transmission means having low and high speed capabilities, and shifting or clutching means preferably form a part of the transmission means in order that continued acceleration of the basket or drum 17 can be terminated during counter-balancing. This, however, forms no part of the instant invention and the details thereof are accordingly not illustrated.

It has been earlier noted that in the balancing systems of the prior art it has been proposed to inactivate the spin mechanism in response to excessive motion in the laundry apparatus, to suspend the entire laundry machine along with an additional mass producing dead weight within the enclosing cabinet on a complex spring system, or to sense and located eccentric motions of the rotating body by relatively complex mechanisms which control the addition or subtraction of weights from the rotating components of the machine. Some of the numerous disadvantages of these systems have been referred to hereinabove.

The mechanism provided in accordance with the principles of this invention and which eliminates the noted deficiencies of the prior art comprises first a nozzle assembly generally designated by the numeral 45 and deflector means or flow regulator means designated in its entirety by the numeral 46. The nozzle assembly 45 includes a conduit portion 47, as shown in FIGURE 1, communicating with a liquid source, which desirably is the laundry liquid in the sump 16a in order that liquid or water be supplied to the nozzle assembly at uniform pressures. Liquid flow from the sump 16a is of course under control of pump means (not shown) in the manner known to the art.

The nozzle assembly 45 further includes a nozzle 48 connected to the conduit or hose portion 47 by a clamping member 49. As appears in FIGURE 5, the nozzle assembly 45 is characterized by a narrow elongated nozzle outlet 50 registering with a slotted opening 50a (FIGURE 3) in rear wall 16b of the casing 16. The nozzle assembly 45, and particularly the nozzle 48, as shown in FIGURE 1, thereof, is stationarily mounted to casing structure and this can be accomplished in any desired manner.

The deflector or interruptor member 46 is generally flat and more or less paddle-shaped, and is formed to provide a main body portion 51 and end portion 52 which is provided with a relatively narrow elongated slot 53 to register with the opening 50 in the nozzle 48 during the counterbalancing action. Of course, the deflector member 46 need not be slotted, and instead the end portion 52 thereof could be of reduced width to permit liquid discharge on the proper side of the end portion during counterbalancing.

The pivotal mounting for the deflector of interruptor member 46 is illustrated in FIGURES 3, 4 and 5, and as appears therein bracket means 55 is bolted or otherwise secured at 56 to lower wall portion 21a of the pylon member 21. The bracket means 55 is formed with a dependent apertured tongue portion 55a (FIGURE 5) and press fit or otherwise tightly carried in the aperture in the tongue portion 55a is pin means 57. The pin means or pivot shaft 57 receives thereon an apertured bearing member 58, which as appears in FIGURE 4, is grooved at its opposite ends to provide spaced track portions 58a engageable with an upstanding generally U-shaped portion 59a on bracket means 59. In this manner, during assembly the bearing member 58 is slid into

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engagement with the U-shaped portion 59a on the bracket member 59.

The bracket means or bottom adjustment bracket 59 is provided with a hub portion 59b (FIGURE 3) which is freely rotatable upon shaft means 60 which in turn is freely received in sleeve means 61 having bearing means all of which are rigidly supported by a plate member 62 provided with strengthening ribs 62a and attached at 63 to the casing rear wall 16b.

The shaft means 60 co-rotatably mounts a hub member 64 to which by screw means or the like 65 the leg portion 51 of the deflector member 46 is connected at one end. If desired, the hub portion 64 and end portion of the deflector leg 51 may be provided with mating screw receiving openings, and the means for attachment of the hub member to the shaft 60 may be pin means as indicated at 66.

The pivotal mounting arrangement for the deflector member 46 further includes bracket means 67 (FIGURE 5) shaped to provide a hub or shaft receiving portion 67a and an outwardly extending arm portion 67b. The bracket hub portion 67a is rigidly connected to the shaft means 60, as indicated in FIGURE 4 at 68, and the bracket arm portion 67b is slotted as at 69 in the same view to receive adjustment bolt means 70. The bolt means 70 is rigidly connected to leg portion 59c of the bracket member 59, as at 71 and the bolt registers with a slot portion 72 of leg portions 59c as shown in FIGURE 4. The leg portion 59c of the bracket member 59 is integral with the bracket 59 and the hub portion 59b thereof. Threadably received upon the bolt means 70 and bearing against opposite faces of the arm portion 67b of the bracket means 67 is a pair of nut means 73a and 73b, which function in a manner to be described in detail hereinafter to adjust the position of the deflector member 46 so that the nozzle opening 50 injects liquid through the deflector slot 53 at the proper times.

It may now be seen that by the pivotal mounting arrangement described that when the pylon member 21 vibrates in either of the directions indicated by the arrows 22 thereon in FIGURE 2, caused by the presence of an unbalanced load in the rotatable drum 17, the bracket member 59 pivots or swings to cause corresponding movements of the bracket member 67, which by its rigid connection to the shaft means 60, rotates the shaft and pivots or swings the connecting deflector member 46.

Thus, the pivoting deflector means for controlling the flow of liquid between the nozzle 48 and the pockets 23a-c have, in effect, a linkage provided by the bracket members 59, 55 and 67 so that such bracket members may be referred to herein as first, second and third linkage means, respectively.

Prior to describing the manner of coordinating the deflector position with a particular balance receptacle 23 during rotation of an unbalanced load in the drum or cylinder 17, it is desired to note that in FIGURE 2 there is shown safety means to arrest the acceleration of the cylinder when severe unbalanced loads are encountered. Such means may comprise a leg member 75 connected to and depending from the pylon member 21 to move therewith and correspondingly vibrate. The leg member 75 may mount at its lower end pin means 76 for engagement with pin means 77 of switch means 78 mounted on the base plate 11. The switch 78 desirably is of the time delay type, and through suitable electrical circuitry connects with the motor means 39 to stop the acceleration of the cylinder when switch 78 is opened due to the presence of a severe unbalanced load. The time delay allows the cylinder to return to tumble speed so the load will be redistributed. After the time delay period, switch 78 will reclose and the cylinder will again accelerate.

As was stated, motion of the interrupter or deflector member 46 must be timed in a manner to permit the flow of balancing liquid into the segment or segments 32 which supply the balancing compartment or compartments 23

located diametrically opposite the off-balance load, designated in FIGURE 2 as L. Applied to this same view is the designation B—B identifying the horizontal centerline of the machine or the line of structure motion, and in investigations which have been conducted it has been found that as the off-balance load L passes the line B—B on one side of the machine, the deflection of the pylon member 21 on this same side of the machine is not at its maximum value. This difference is referred to herein as the lag angle between the off-balance load and the deflection produced thereby. The lag angle is partly determinative of the angular relationship between a balance compartment and its corresponding inlet segment.

By measurement under test conditions, there can be determined the mean total angle of lag over the balancing speed range, or otherwise stated, the average value of the lag angle from the speed at which the centrifugal force of the load in the drum or cylinder overcomes gravity to the maximum cylinder speed. This value when there is then added thereto the angle of advance of the center of a particular segment 32 in relation to the center of its respective compartment 23 must equal an angle, identified in FIGURE 2 as alpha and which lies between the horizontal centerline B—B and the indicated radial line C—C extending from the center of the drum 17 and passing through the center of the nozzle opening 50. This is more thoroughly explained in conjunction with the explanation of FIGURES 6-9.

It may be observed from FIGURE 2, and as was earlier described, three inlet segments 32a-c and a corresponding number of balancing compartments 23a-c are employed. Such an arrangement has been found advantageous in order to initiate the counterbalancing action in the early phases of pylon deflection, while still not providing large inlet segments. To explain, it is of course desirable to use as small a volume of liquid for balancing purposes as is possible, and to direct this relatively small volume of liquid into the correct balancing compartments as rapidly as possible. As well, as the volume of the balance compartments increases, there is then less volume within the cylinder 17 for the load.

Since the direction of cylinder rotation in FIGURE 2 is clockwise, and since obviously because of gravity conditions the balancing liquid should be delivered to the cylinder 17 beneath the horizontal centerline B—B, the nozzle 48 is positioned in the lower righthand corner of the cylinder circumference, as shown, or generally between a three o'clock and six o'clock position. Accordingly, balancing will take place only when the pylon member 21 deflects to the left of the vertical centerline. If a zero lag angle is assumed, it can be seen that when the off-balance load L in clockwise rotation passes the vertical centerline beneath the horizontal centerline B—B, deflection of the pylon member to the left begins. Now, if inlet segments 90° in arcuate length were employed, the injection of liquid into the inlet segments would not begin until the off-balance load had rotated 45°. According to the laws of simple harmonic motion, a 45° rotation of the off-balance load from the vertical centerline corresponds to a pylon deflection of about 67% of the maximum value achievable with an off-balance load. It is thus apparent that with four 90° inlet segments and a corresponding number of balancing compartments, balancing could not begin until 67% of maximum pylon deflection had been achieved, and such a relatively high percentage of maximum deflection would obviously be undesirable.

However, when three balance compartments 23a-c are employed, balancing begins after the off-balance load L has traveled only 30° from the vertical centerline, again assuming a zero lag angle. A 30° travel of the off-balance load corresponds to only 50% of the maximum deflection of the pylon member 21 due to that off-balance load. Accordingly, three balance tanks 23a-c provide an optimum compromise between pylon pre-travel before

balancing begins and the required balance tank liquid capacity.

An important angular relationship exists between each balance tank and its respective inlet segment. This can probably be best understood by reference to FIGURES 6 to 9, in each of which the legend alpha designates the location of the nozzle 48 beneath the horizontal centerline and the radial line from the center of the cylinder passing through the center of the nozzle. In FIGURES 6 and 8 there is as well identified by the legend A the average lag angle by which, for this example, the unbalanced load leads the deflection it produces. In addition, it may be observed that like numerals from the preceding views have been employed to designate the drum or cylinder 17, balance compartments 23a-c, inlet segments 32a-c, nozzle opening 50 and unbalanced load L.

In the discussion now to follow, the exemplary conditions employed include injection of liquid from the nozzle opening 50 on pylon motion to the left only, a nozzle location at the angle alpha of 60° from the horizontal centerline B—B, an arc of injection of 120°, and an angle A of 30° by which the off-balance load L leads the deflection caused thereby. As well, for purposes of illustration, the off-balance load is shown as located between the balance compartments 23a and 23b, although of course effective counterbalancing is provided regardless of the load position. Since the balance compartment 23c is diametrically opposite the off-balance load L, the objective achieved by this invention is to direct the smallest volume of water in the shortest period of time to the balance tank 23c.

In FIGURE 6 the conditions existing are zero pylon motion, and with the stated lag conditions, the off-balance load L is at an angle A of 30° from the vertical centerline. In this position the deflector or interrupter member 46 is disposed in fluid blocking relation to the nozzle opening 50, essentially as shown in FIGURES 2 and 3.

In FIGURE 7 it may be seen that the off-balance load L has rotated 30° from the position of FIGURE 6, and in order to limit the injection to the desired 120° arc, injection is now initiated. Since it is also desirable that all of the balancing fluid be directed to balancing compartment 23c, the divider 33 between the inlet segments 32a and 32c must be directly beneath the nozzle opening 50. This is shown in FIGURE 7, and at this point in the counterbalancing cycle the deflection of the pylon member 21 is at 50% of its maximum value. Injection begins into inlet segment 32c.

Maximum pylon deflection to the left is present in the illustrative presentation of FIGURE 8, and this occurs when the off-balance load L is approximately 30° above the horizontal centerline B—B. At this point the deflector slot 53 is precisely aligned with the nozzle opening 50 for maximum injection, and the inlet segment 32c has been receiving counterbalancing fluid for 60° of drum rotation, as indicated in FIGURE 8 by the legend F. The centerline of inlet segment 32c is on line with the nozzle opening.

During the next 60° of cylinder rotation essentially the same action takes place as described, with the exception that the motion of the pylon member 21 is to the right in FIGURE 2. FIGURE 9 is illustrative of the conditions when approximately 150° of cylinder rotation has occurred, or 120° of injection. The baffle or divider 33 separating the inlet segments 32c and 32b is of course at this time directly beneath the injector nozzle 50. Injection of counterbalancing fluid then terminates as the pylon member 21 continues movement to the right, to place the deflector end portion 52 in fluid blocking relation with the nozzle opening 50.

It is to be observed from an examination of FIGURES 6 to 9 that all of the liquid injected during the 120° arc of rotation is confined to the inlet segment 32c, so that all balancing fluid is introduced into the balancing

compartment 23c, which as earlier stated, is the correct compartment for effective counterbalancing of an off-balance load when located as originally assumed in connection with FIGURE 6. This shows that for this example, counterbalancing has been achieved in an efficient manner by using a minimum of counterbalancing fluid.

It is apparent from FIGURE 8 that to accomplish the most efficient counterbalancing under the illustrative conditions indicated, the centerline of the inlet segment must be located at an angle of $\alpha-A$ ahead of or leading the centerline of the corresponding compartment into which counterbalancing fluid is to be introduced. This is the case regardless of the values of the true angles. If there was no lag angle in the system, the centerline of the balance tank or compartment 23c and the trailing edge of the corresponding inlet segment would coincide. Of course, if the nozzle opening was targeted in a direction other than directly downwardly, as is indicated in FIGURES 6 to 9, compensation would be necessary for the different target angle.

The adjustment means 70 is provided so that the deflector 46 can be adjusted so that slot 53 indexes in front of nozzle 50 at the precise instance as indicated in the explanation of FIGURES 6-9.

For purposes of simplicity in FIGURES 6-9 the unbalanced load L was positioned so that with a 120° arc of injection all of the counterbalancing fluid would go into compartment 23c. If it is desired for illustrative purposes, to place the unbalanced load L in a different location, it will be found that the same inlet segment-compartment relationship will allow the newly positioned unbalanced load to be balanced using a minimum of counterbalancing fluid. Of course, for any position of the unbalanced load other than midway between two balancing compartments the same set up would assure the proper proportioning of counterbalancing fluid to the two compartments necessary for proper balancing.

It is believed now apparent from the preceding discussion that there is herein provided a counterbalancing system of rapid and accurate response which is reliably phased by means of relatively simple adjustments in the pivotal mounting for the deflector structure. It was noted that the deflector need not be slotted, and of course, other modifications and variations can be effected without departing from the novel concepts of this invention.

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

1. Centrifugal extractor apparatus comprising, supporting means, a receptacle,

means mounting said receptacle for rotation in said supporting means on a substantially horizontal axis, drive means for rotatably driving the receptacle, a plurality of balancing pockets on said receptacle, means including a nozzle for directing balancing liquid into the pockets,

said supporting means including a horizontal member capable of horizontal vibrational movement, and means for controlling the flow of liquid between said nozzle and said pockets comprising,

a shaft journaled on said supporting means, a deflector for interrupting the flow of liquid from the nozzle and connected to said shaft,

a first linkage means freely rotatable on said shaft, a second linkage means rigidly connected to said horizontal member,

means including a bearing interconnecting said first and second linkage means,

a third linkage means corotatably connected to said shaft,

and adjustable connection means between said first and third linkage means,

whereby said third linkage means swings with said first linkage means upon vibrational movement of the horizontal member to rotate the shaft and swing said deflector relative to said nozzle.

2. Centrifugal extractor apparatus as defined in claim 1, said deflector comprising a generally flat main body portion connected to said shaft and having an end portion extending from said body portion to register with said nozzle.

3. Centrifugal extractor apparatus as defined in claim 2, said deflector end portion having a narrow elongated slot formed therein through which balancing liquid is directed when in register with said nozzle.

4. Centrifugal extractor apparatus as defined in claim 1, said adjustable connection means comprising arm portions on said first and third linkage means, bolt means operatively connecting said arm portions,

and nut means to lock said arm portions at selected positions of adjustment,

thereby to index the deflector relative to said nozzle.

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2,603,982	Davis et al.	July 22, 1952
2,760,383	De Moss	Aug. 28, 1956
3,080,059	Scott et al.	Mar. 5, 1963