PIVOTING NOZZLE WATER BALANCE SYSTEM FOR A LAUNDRY EXTRACTOR

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The present invention relates broadly to apparatus for countervailing 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 wherein it is desired to countervail 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 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 a 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 drive 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, the 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 entrainment 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 parralels an optimum spinning 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 clothes 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 gyrotory 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 unsymmetrical 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 vibratory movements rotate the base frame. A pivotal structure is connected to the means which mounts the drum for rotation within the casing and this structure
supports a nozzle assembly which moves in phase with a deflection produced by an off-balance load being rotated. The nozzle assembly thereby pivots to either inject balancing fluid into the sump provided by the casing, or to discharge the liquid into certain of a plurality of liquid balance pockets on the periphery of the drum, thereby effectively counterbalancing the off-balance load. By virtue of this novel arrangement of parts, the status of the unbalance is automatically determined and only as much counterbalancing liquid as is required is added to the rotating system of the machine.

An extremely important part of the present invention is 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 fluid 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 nozzle assembly is mounted for pivotal movement by mounting structure which vibrates relative to casing supporting means, the nozzle assembly moving in phase with a deflection produced by an off-balance load being rotated in an extractor drum such that the nozzle outlet injects balancing fluid either away from or into peripherally disposed liquid balance pockets on 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 a rear elevational view, with parts taken in section and with parts removed, showing in further detail a laundry machine embodying the balancing system of the present invention;

FIGURE 3 is a fragmentary sectional view of the nozzle mounting means, and showing further an injection intake segment and communicating liquid balance pocket to receive the balancing fluid from the nozzle when the nozzle pivots in the presence of an off-balance load in the drum or cylinder;

FIGURE 4 is a fragmentary rear elevational view providing an enlarged and more detailed presentation of the arrangement of FIGURE 2;

FIGURE 5 is a vertical sectional view taken substantially along the line V—V of FIGURE 4, and showing certain details of the pivotal mounting for the nozzle assembly; 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 therein by the numeral 10 a domestic laundry appliance which may take the form of a conventional combination washer-dryer. Certain structural portions of the laundry appliance have been omitted in the interests of clarity of illustration, and for the further reason that such portions are not essential to a complete understanding of 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 movements relative to the casing 16 and base plate 11 is a perforated cylinder or drum 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 movements relative to the casing 16 and base plate 11.

As will be later described in greater detail, rotation of the drum 17 with an unbalanced load therein (indicated at L in FIGURE 2) causes the pylon member 21 to vibrate in opposed generally horizontal directions as indicated by the arrows 22 applied to the pylon member. In the absence of the application of counterbalancing forces, such vibrations 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 17 is rotatably 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 (not shown) having low and high speed capabilities, and shifting or clutching means preferably forms a part of the transmission means in order that continued acceleration of the basket or drum 17 can be terminated during counterbalancing. This, however, forms no part of the instant invention, and the details thereof are accordingly not illustrated.

The laundry machine 10, in the manner known to the art, is equipped with means (not shown) for heating and circulating air through the drum 17 to assist in the clothes drying operation. As shown in FIGURE 2, member 47 mounts at one end flange means 47a, and actuated by the flange means is switch means 48 carried by a dependent leg member 49 supported at one end by the pylon member 21. The switch 48 desirably is of the time delay type, and through suitable electrical circuitry connects with the motor means 39 or transmission means to return the drum 17 to tumble speed in the event a very serious off balance load exists in the drum 17. The switch means 48 thus acts as a safety device and the time delay allows the load to be tumbled and re-distributed in the drum 17 to eliminate the severe off balance load that caused switch means 48 to be actuated.

The drum or basket 17 is further 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 pro-
vided 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 radial wall 23b extending 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, each receptacle is shaped to provide front and rear walls 27 and 28. Additionally, 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 a fluid guide member 30 secured as at 31 to the rear wall 17b. The fluid guide member 30 is mounted to be in fluid receiving communication with an inlet assembly or injection intake structure, 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 each extending through 120° of arc on the rear wall 17b of the drum 17. Three 120° arc 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 counterbalancing action. As also appears in FIGURE 3, the injection intake member 32 may have its wall portion 34 extended at 34a to 34b to provide means for welding or otherwise securing the intake ring 32 to the drum rear wall structure.

It has been earlier noted that in the prior art balancing systems proposals have been made to either inactivate the spin mechanism in response to excessive motion in the hydraulic apparatus, or to entirely remove the entire hydraulic machine along with an additional means for producing dead weight within the enclosing cabinet on a complex spring system, or to sense and locate 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. Certain of the many disadvantages of these systems have been referred to hereinbefore.

The mechanism provided in accordance with the principles of this invention, and which effectively eliminates the noted deficiencies of the prior art, comprises first a nozzle assembly generally designated by the numeral 45, as mounting means 46 for the nozzle assembly responsive to vibrations of the pylon member 21 to swing or pivot the nozzle assembly outlet portion into and out of fluid communication with the inlet ring 32. As appears best in FIGURE 4, the nozzle assembly 45 includes a flexible conduit portion 47 communicating with a liquid source, which desirably is the hydraulic fluid 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 relatively rigid and horizontally swingable portion 48 received in the flexible conduit portion 47, and connected to the portion 48 is an angularly downwardly disposed nozzle member 49 having a narrow elongated nozzle outlet 50 (FIGURE 5) to communicate balancing fluid with the inlet ring 32 during the counter-balancing action. Of course, the coupling portion 48 and nozzle member 49 may be of integral construction, but in any event, the casing rear wall 16b is provided with an aperture of sufficient dimensions to accommodate swinging action of the nozzle member 49.

The means 46 for pivotally shifting the nozzle portions 48 and 49 in response to deflections of the pylon member 21 comprises bracket means 51 secured by screws or the like 51a (FIGURE 4) to lower wall portion 21a of the pylon member 21. The bracket means 51 is formed with a tip dependent pin portion 52 tightly received in a slide block member 53 located in a mating slot 54 in leg portion 55a of a pivot arm member 55.

Referring now particularly to FIGURE 3, there is rigidly attached to the casing rear wall 16b by fastening means 56 a plate member 57 of generally triangular configuration and provided therein the hub portion 57a having a vertical passage therethrough receiving bushing means 58 (FIGURE 5). The bushing means in the plate hub portion 57a receives therethrough shaft means 59 restrained against rotation relative to the pivot arm 55 by set screw means or the like 60. The shaft means 59 passes through the leg portion 55a of the pivot arm 55, as well as through a reduced length leg portion 55b on the pivot arm 55.

It is to be observed at this point that when the pylon member 21 vibrates in either of the directions indicated by the arrows 22 in FIGURE 2, caused by the presence of unbalanced loads in the pylon, the vibratory movements are sensed by the bracket means 51 and dependent pin portion 52 thereon to pivotally swing the pivot arm member 55 through limited rotation of the shaft means 59 within the bushing or bearing 58 in the plate member hub portion 57a. The means for translating the pivotal action of the arm member 55 into corresponding pivotal movement of the nozzle portions 48 and 49 will now be described.

Mounted upon the hub portion 57a of the stationary plate member 57, as well as upon the leg portion 55b of the pivot arm 55, is a generally A-shaped nozzle support member 62 as shown in FIGURE 4. The member 62 is provided with an upper cross arm portion 63 shown in FIGURE 3 as being seated upon the plate member hub portion 57a, and in this same view it may be observed that the nozzle support member 62 is further provided with a lower cross arm portion 64 positioned between the reduced length arm portion 55b on the pivot arm member 55 and hub portion 57a. The cross arm portions 63 and 64 of the nozzle support 62 are passaged to receive therethrough the shaft means 59.

Formed upon the generally A-shaped nozzle support member 62 is a pair of ear portions 65 and 66 (FIGURE 4), and threadably received in the ear portion 65 is adjusting means 67 bearing against the pivot arm member 55. The ear portion 66, on the other hand, provides a bearing or contact surface for adjusting means 68 threadably received in the pivot arm member 55. It may accordingly now be seen that by threadable adjustment of the screw means 67 and 68, the positions of the pivot arm member 55 and nozzle support member 62 relative to one another can be changed, so as to properly locate the nozzle outlet opening 60 with respect to the inlet ring 32.

Leg portions 62a and 62b of the nozzle support member 62, and upon which the ear portions 65 and 66 are formed, connect to a pair of clamping means 70 and 71 supporting the nozzle portion 48. The clamping means 70 and 71 threadably receive adjusting means 72, which may take the form of the illustrated bolt means.

It may now be seen that by the pivotal mounting described, when the pylon member 21 vibrates in the respective directions indicated by the arrows 22 thereon in FIGURE 2, caused by the presence of unbalanced load in the rotatable drum 17, the bracket member 51 correspondingly vibrates to pivot the arm member 55 and shaft 59 fixed thereto within the bearing 58 in the hub portion 57a of the stationary plate member 57, which is connected as described to the casing rear wall 16b. Since the shaft means 59 passes through the nozzle support member 62, and the member 62 and pivot arm member
55 are connected through the ear portions 65 and 66 and the adjusting means 67 and 68 acting thereagainst, pivotal movement of the pivot arm member 55 causes corresponding movement of the nozzle support member 62, thereby swinging the nozzle portion 48 and nozzle segment 32 which supply the balancing compartment or compartments 23 located diametally opposite the off-balance load, designated in FIGURE 2 by the legend L. Of course, it is appreciated that during high spin speeds at which unsymmetrically distributed centrifugal forces are present in the rotating body 17, the nozzle assembly is continuously discharging balancing liquid, either into the sump 16a or into the inlet ring 32. Continuous fluid flow in this manner can readily be accomplished by connecting electric valve means for the fluid pump means into the machine timing circuitry, in a manner well known to the art.

Applied to FIGURE 2 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 to date 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 23a—c and a corresponding number of balancing compartments 23c—e 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 unduly 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, as is evident by the configuration of the drum, the nozzle outlet 59 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, the liquid 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 23c—e 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 23c—e provide an optimum compromise between pylon 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 FIGURE 9, in each of which the legend angle 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. As FIGURES 6 and 8 are there 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 23c—e, inlet segments 33c—e, 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 23c 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 effective 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 nozzle member 49 and particularly the opening 58 therein is in a neutral position and fluid is being discharged into the sump 16a, as indicated in FIGURE 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 59. This is shown in FIGURE 7, and at this point the counterbalancing cycle of 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 nozzle
member opening 59 is precisely aligned with the inlet segment 32c for maximum injection, and this segment has been receiving countercountercurrent fluid for 60° of drum rotation, as indicated in FIGURE 8 by the legend F. The centerline of inlet segment 32c coincides with the nozzle opening 59 at this time.

During the next 60° of cylinder rotation essentially the same action takes place as described, with the exception that the motion of the pylons 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 opening 59. Injection of countercurrent fluid to the inlet ring 32 then terminates by the nozzle member 49 and the outlet 50 swinging to a neutral position to discharge the countercurrent fluid into the sump 16a.

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 countercurrent mixing. This angle of injection when located as originally assumed in connection with FIGURE 6. This shows that for this example, countercurrent has been achieved in an efficient manner by using a minimum of countercurrent fluid.

It is apparent from FIGURE 8 that to accomplish countercurrent under the illustrative conditions indicated, the centerline of the inlet segment must be located at an angle of alpha—4° ahead of or leading the centerline of the corresponding balance compartment. 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 balancing compartment 23c and the true edge of the corresponding inlet segment would coincide. Of course, if the nozzle opening was targeted in a direction other than directly downward, as is indicated in FIGURES 6 to 9, compensation would be necessary for the different target angle.

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 countercurrent 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 arrangement may be used and an off-balanced load to be balanced using a minimum of countercurrent-balancing 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 countercurrent fluid to the two compartments necessary for proper balancing and still use a minimum amount of countercurrent fluid.

It is believed now apparent from the preceding description that there is herein provided a countercurrent system of rapid and accurate response, which is reliably phased by means of relatively simple adjustments in the pivotal mounting for the nozzle assembly. The pivotal mounting disclosed produces highly effective results, however, it is believed readily apparent that variations may be practiced therein, and as well, other changes and modifications in other portions of the apparatus can be effected without departing from the novel concepts of the present invention.

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

1. A laundry extractor comprising, a casing, supporting means for said casing, an extractor drum, means mounting said drum for rotation within said casing and for vibratory movement relative to said supporting means during rotation of unbalanced loads in said drum, drive means for rotating said drum to effect the extraction of fluids from wet fabrics within said drum, a plurality of pockets carried on said drum for receiving fluid to counterbalance unbalanced loads within said drum, fluid directing means comprising a movable nozzle for directing fluid into said pockets to effect a countercurrenting of such unbalanced loads during rotation of said drum to reduce the amplitude of vibrations of said drum relative to said supporting means, bracket means connected to said mounting means, a pivot arm connected to said bracket means and shiftable about a substantially vertical axis by said bracket means in response to vibratory movements of said mounting means, and means supporting said nozzle and connected to said pivot arm for pivoting said nozzle through interaction of said pivot arm and said bracket means when the amplitudes of vibrations of said mounting means exceed a predetermined level to pivot said nozzle into fluid communication with said pockets for countercurrenting action.

2. A laundry extractor comprising, a casing, supporting means for said casing, an extractor drum, means mounting said drum for rotation within said casing and for vibratory movement relative to said supporting means during rotation of unbalanced loads in said drum, drive means for rotating said drum to effect the extraction of fluids from wet fabrics within said drum, a plurality of pockets carried on said drum for receiving fluid to counterbalance unbalanced loads within said drum, means for directing fluid into said pockets to effect a countercurrenting of such unbalanced loads during rotation of said drum to reduce the amplitude of vibrations of said drum relative to said supporting means, bracket means connected to said mounting means, a pivot arm connected to said bracket means, means attached to said casing and mounting a passaged hub portion, shaft means received in said hub portion and connected to said pivot arm, and a bracket member receiving said shaft means and connected to said pivot arm, said bracket member supporting said fluid directing means and pivoting said fluid directing means into fluid communication with said pockets for countercurrenting action through interaction of said pivot arm and said bracket means when the amplitudes of vibrations of said mounting means exceed a predetermined level.

3. A structure as defined in claim 2, in which adjusting means connect said pivot arm and said bracket member for adjusting the position of said fluid directing means relative to said fluid receiving pockets.

4. A relationship as defined in claim 2, comprising, a casing, supporting means for said casing, an extractor drum, means mounting said drum for rotation within said casing and for vibratory movement relative to said supporting means during rotation of unbalanced loads in said drum, drive means for rotating said drum to effect the extraction of fluids from wet fabrics within said drum, a plurality of pockets carried on said drum for receiving fluid to counterbalance unbalanced loads within said drum, fluid directing means comprising a movable nozzle for directing fluid into said pockets to effect a countercurrenting of such unbalanced loads during rotation of said drum to reduce the amplitude of vibrations of said drum relative to said supporting means, pivot arm having a connection to said mounting means for shifting movement about a pivot axis in response to vibratory movements of said mounting means, and means supporting said nozzle and connected to said pivot arm for pivoting said nozzle through interaction of said pivot arm and said bracket means when the amplitudes of vibrations of said mounting means exceed a predetermined level to pivot said nozzle into fluid communication with said pockets for countercurrenting action.

5. A laundry extractor comprising, a casing, supporting means for said casing, an extractor drum, means mounting said drum for rotation within said casing and for vibratory movement relative to said supporting means during rotation of unbalanced loads in said drum, drive means for rotating said drum to effect the extraction of
fluid from wet fabrics within said drum, a plurality of pockets carried on said drum for receiving fluid to counterbalance unbalanced loads within said drum, a movable nozzle to direct liquid into said pockets, bracket means connected to said mounting means, a pivot arm connected to said bracket means, means attached to said casing and mounting a passaged hub portion, shaft means received in said hub portion and connected to said pivot arm, and a bracket member receiving said shaft means and connected to said pivot arm, said bracket member supporting said nozzle and pivoting said nozzle into fluid communication with said pockets for counterbalancing action through interaction of said pivot arm and said bracket means when the amplitudes of vibrations of said mounting means exceed a predetermined level.

6. A laundry extractor comprising, a casing, supporting means for said casing, an extractor drum, means mounting said drum for rotation within said casing and for vibratory movement relative to said supporting means during rotation of unbalanced loads in said drum, drive means for rotating said drum to effect extraction of fluid from wet fabrics within said drum, a plurality of pockets carried on said drum for receiving fluid to counterbalance unbalanced loads within said drum, fluid directing means comprising an inlet ring of generally U-shaped configuration and having internal partitions to divide the interior of the ring into as many equal angular segments as there are pockets on said drum, each corresponding segment being in fluid communication with a corresponding pocket, said fluid directing means further comprising a movable nozzle for directing fluid into said inlet ring to effect a counterbalancing of such unbalanced loads during rotation of said drum to reduce the amplitude of vibrations of said drum relative to said supporting means, a pivot arm having a connection for effecting shifting movement of said pivot arm about a pivot axis in response to vibratory movements of said mounting means, and means supporting said nozzle and connected to said pivot arm for pivoting said nozzle through interaction of said pivot arm and said connection when the amplitudes of vibrations of said mounting means exceed a predetermined level to pivot said nozzle into fluid communication with said inlet ring for counterbalancing action.

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<td>2,760,383</td>
<td>De Moss</td>
<td>Aug. 28, 1956</td>
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<td>3,086,099</td>
<td>Scott et al.</td>
<td>Mar. 5, 1963</td>
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