Dec. 19, 1950 L. M. KAHN 2,534,267

WASHING MACHINE CYLINDER BALANCING APPARATUS

Filed Oct. 3, 1945 6 Sheets-Sheet 1

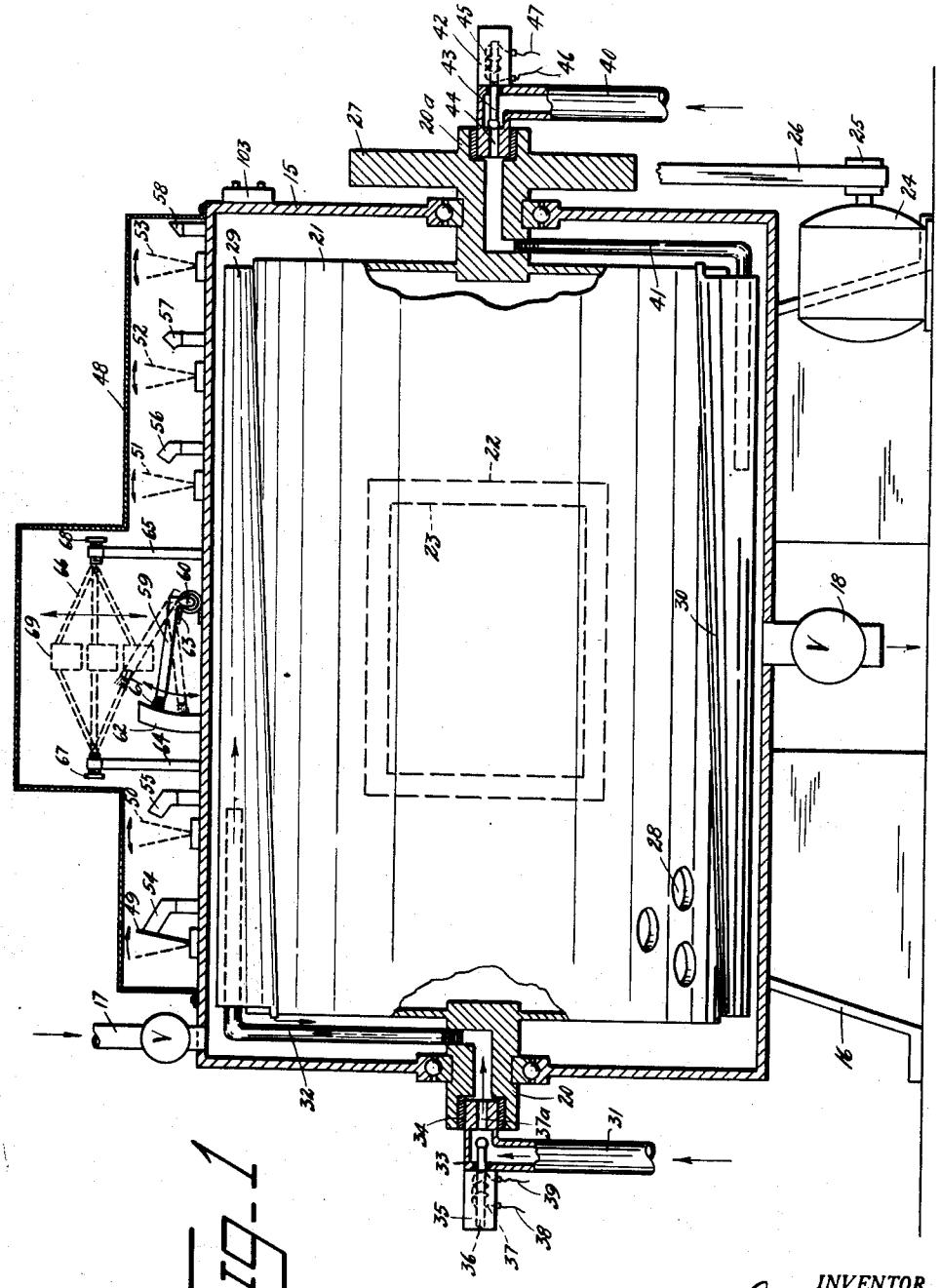


FIG. 1

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WASHING MACHINE CYLINDER BALANCING APPARATUS

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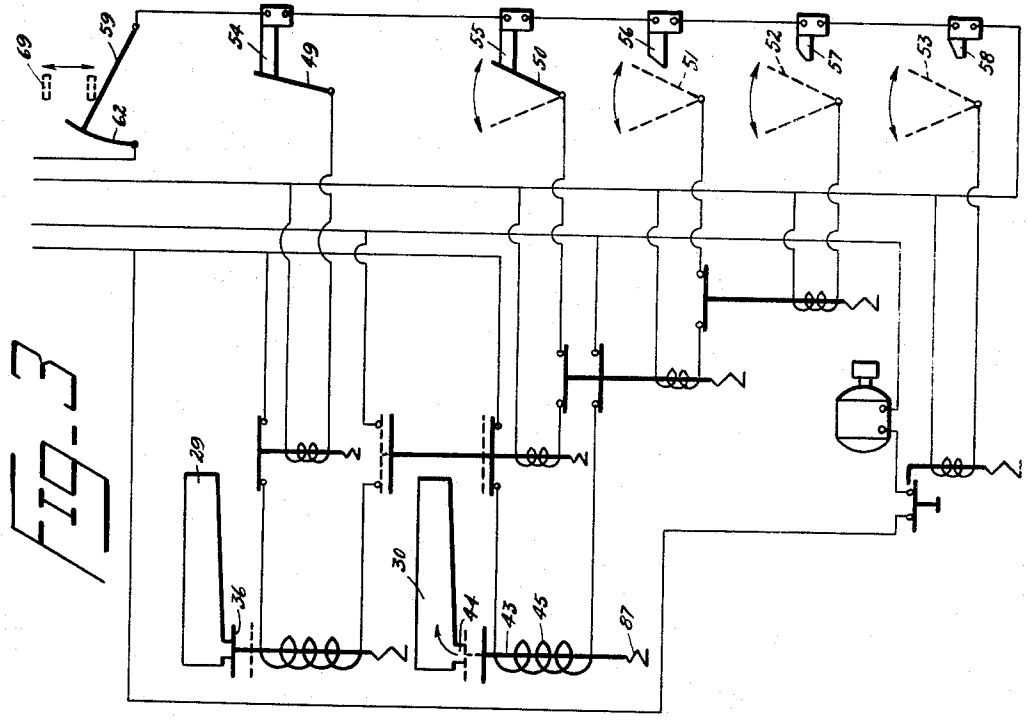


FIG. 3

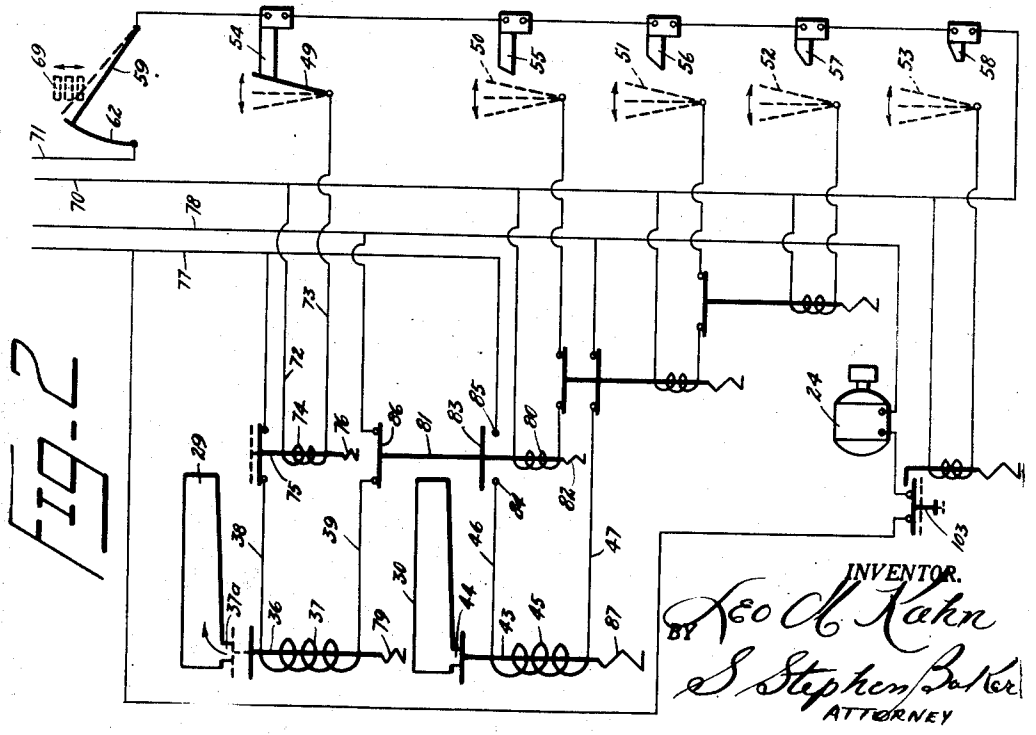


FIG. 2

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WASHING MACHINE CYLINDER BALANCING APPARATUS

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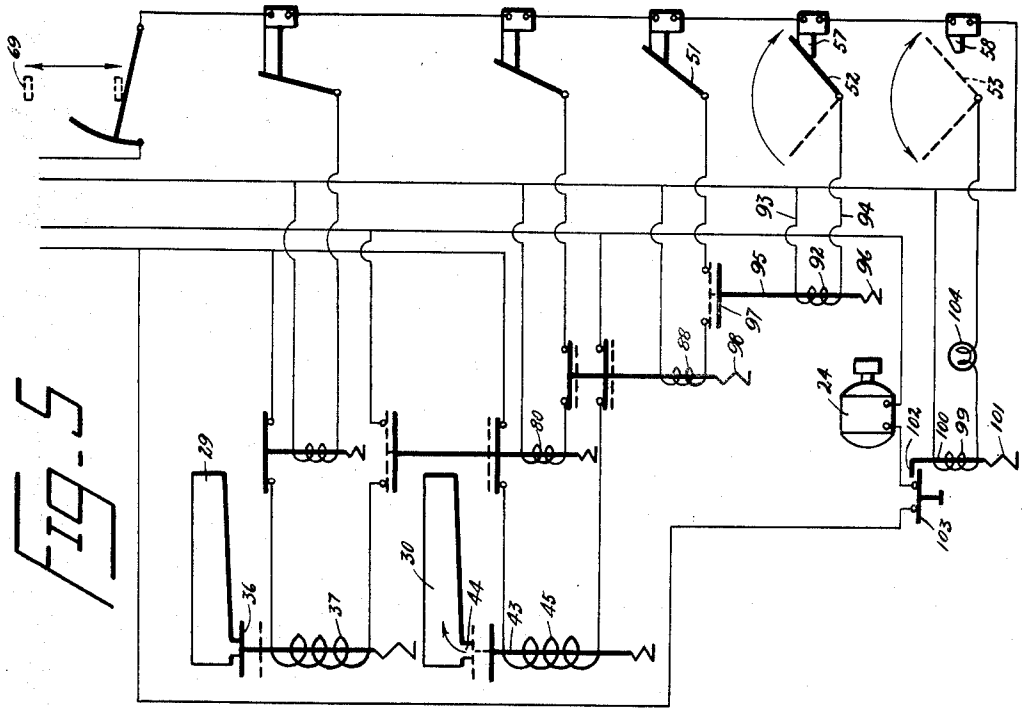


FIG. 5

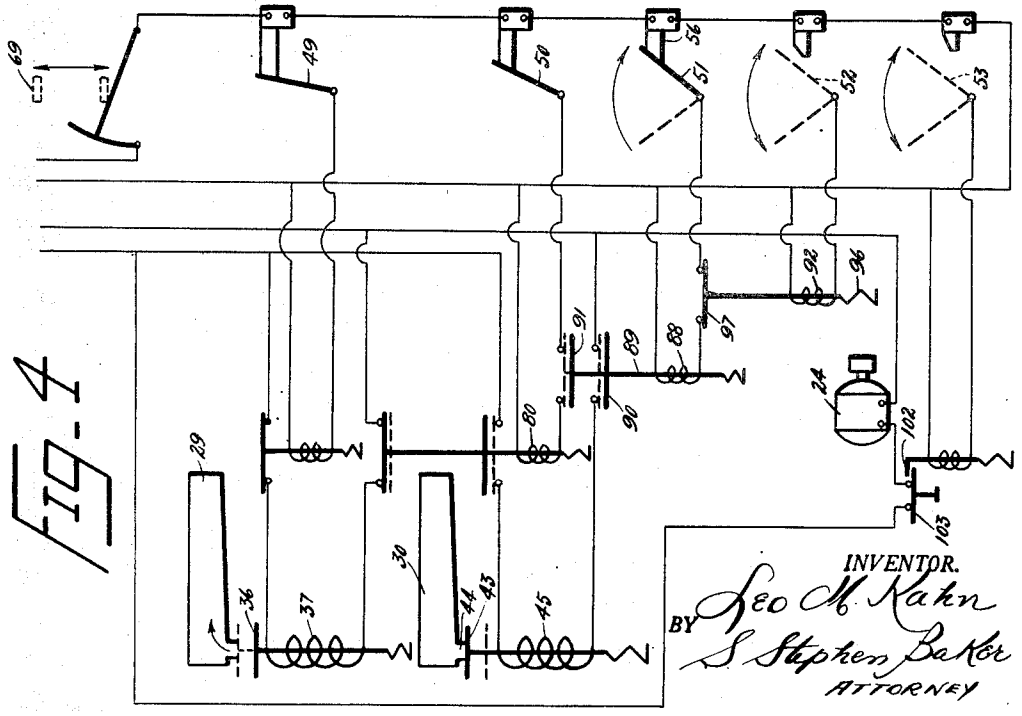


FIG. 4

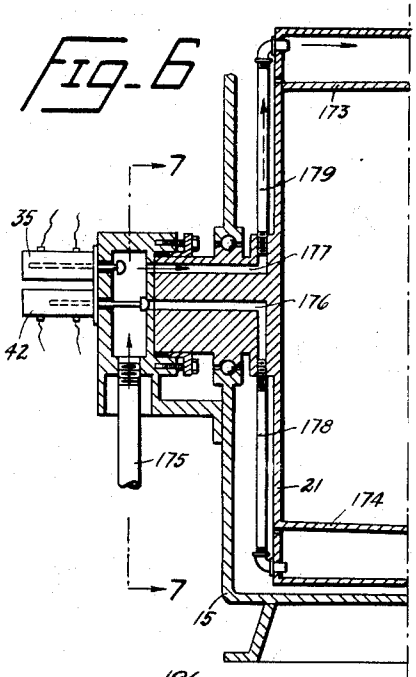
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Dec. 19, 1950 L. M. KAHN 2,534,267

WASHING MACHINE CYLINDER BALANCING APPARATUS

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FIG. 6



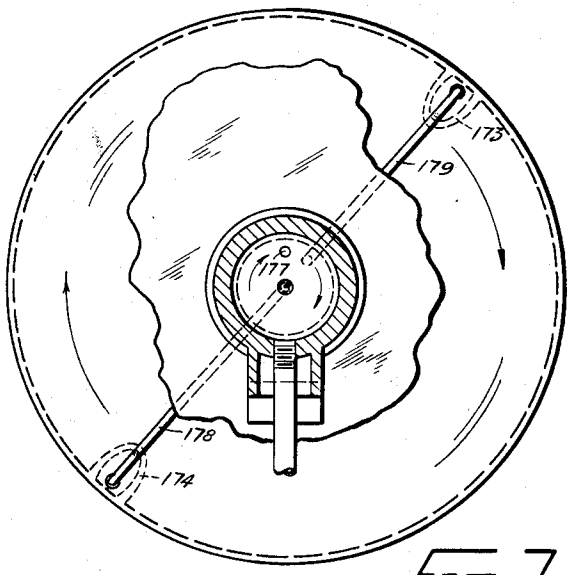
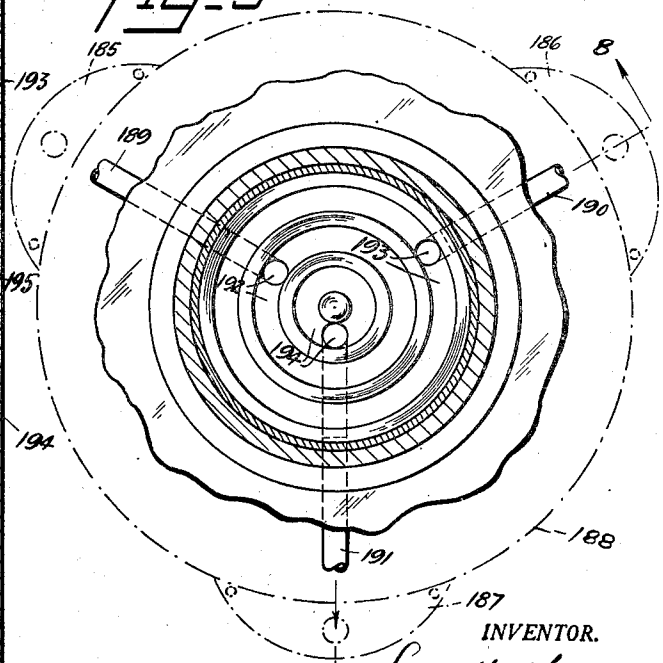


FIG. 7

FIG. 9



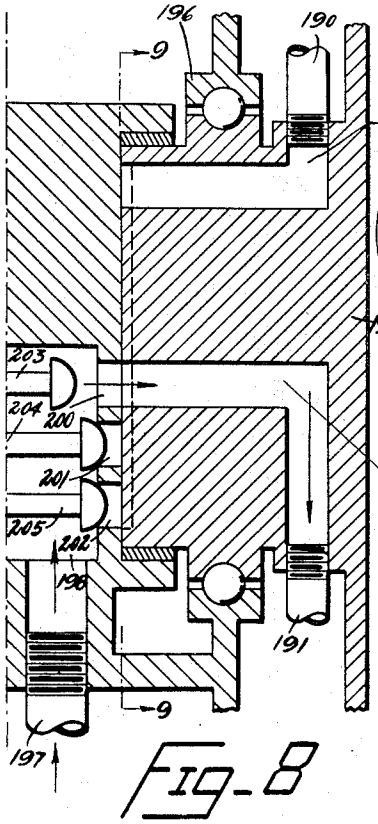


FIG. 8

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Dec. 19, 1950 L. M. KAHN 2,534,267

WASHING MACHINE CYLINDER BALANCING APPARATUS

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FIG-11

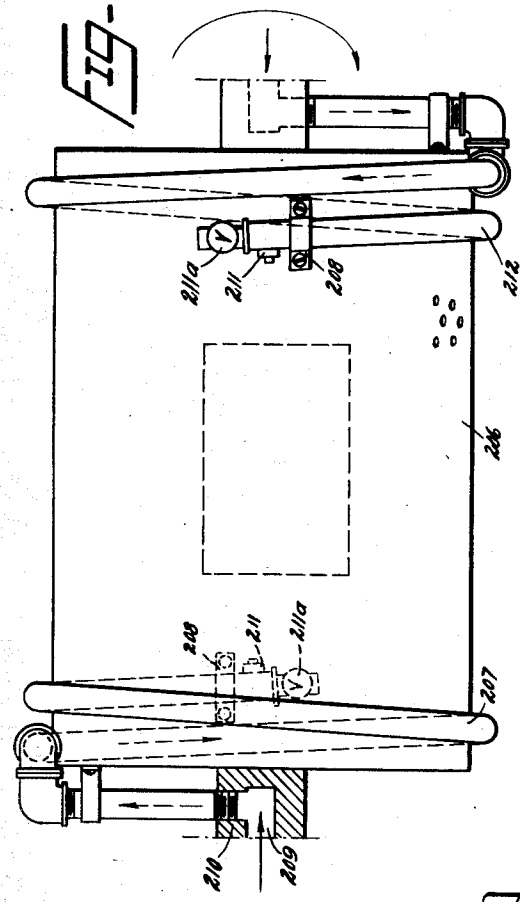


FIG-13

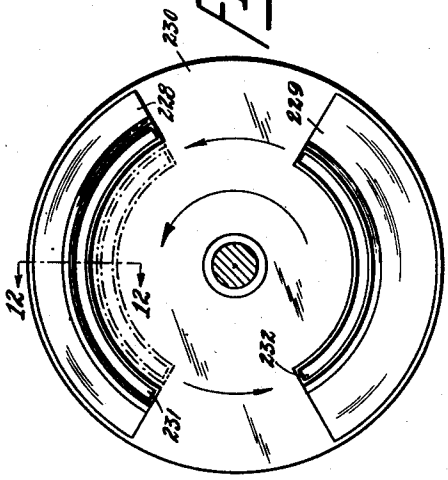


FIG-12

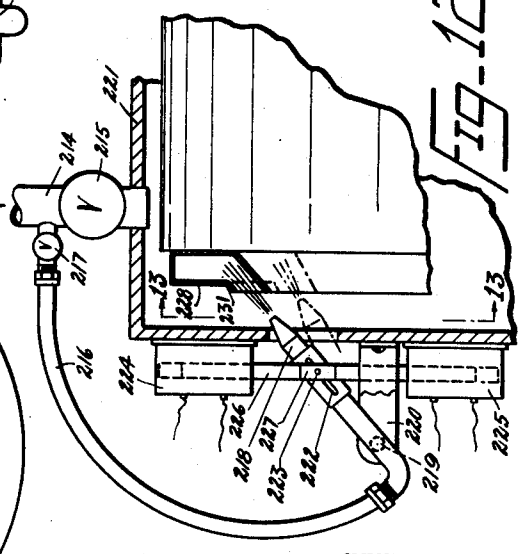
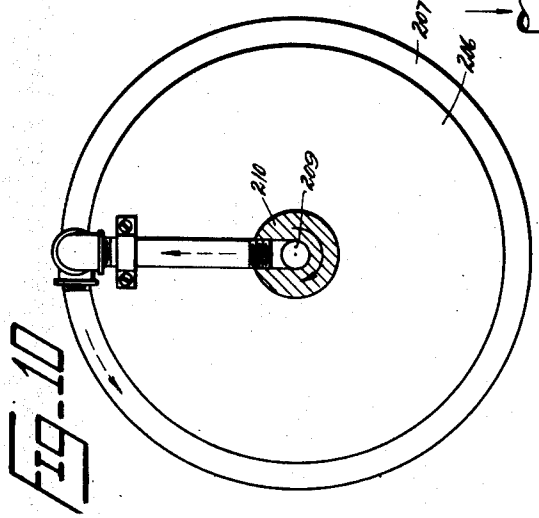


FIG-10



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Dec. 19, 1950 L. M. KAHN 2,534,267

WASHING MACHINE CYLINDER BALANCING APPARATUS

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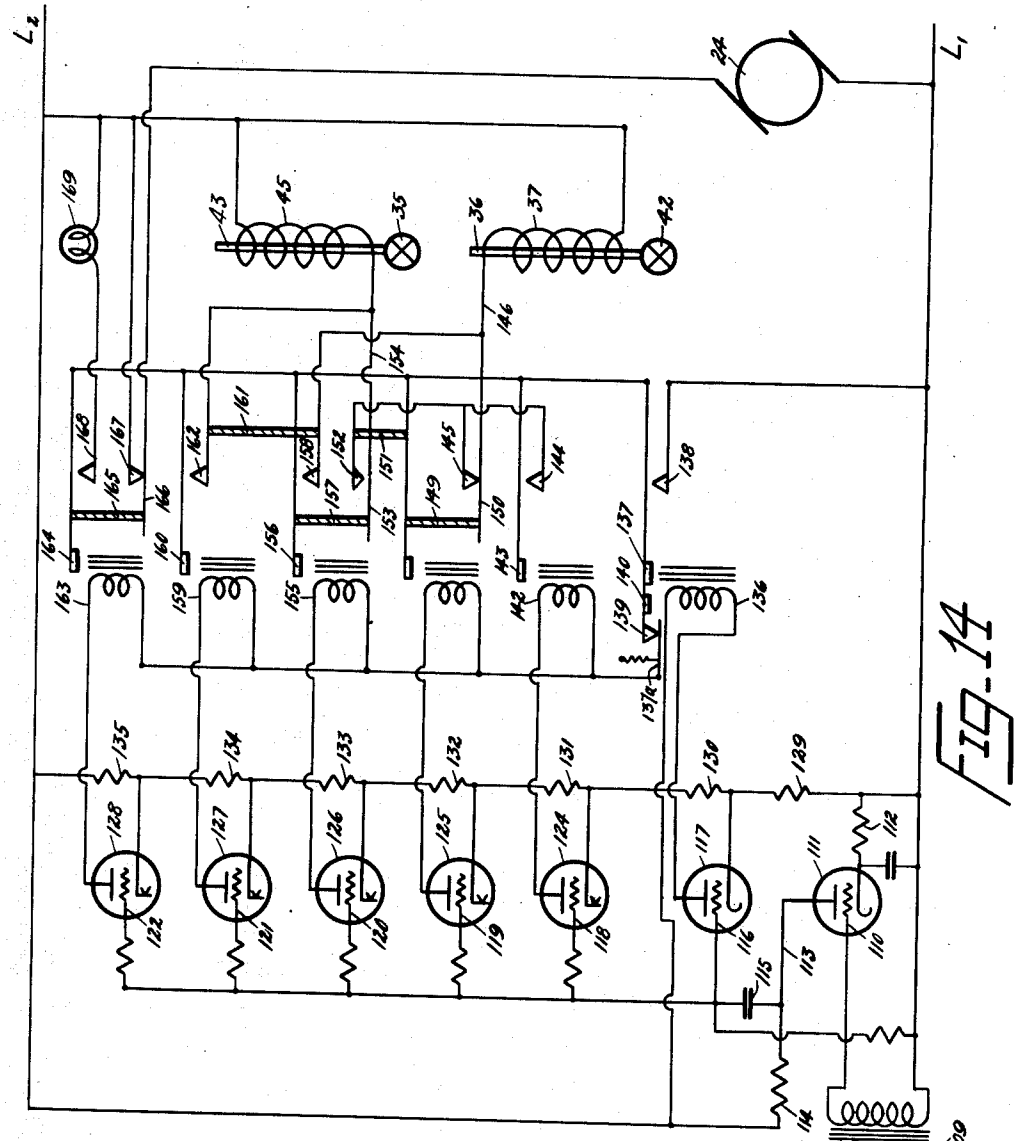


FIG-14

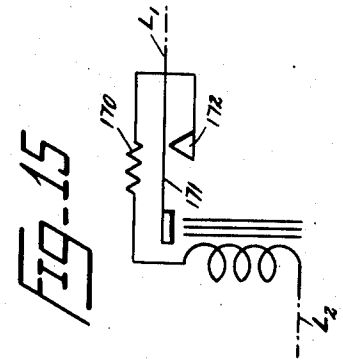


FIG-15

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Patented Dec. 19, 1950

2,534,267

UNITED STATES PATENT OFFICE

2,534,267

WASHING MACHINE CYLINDER BALANCING APPARATUS

Leo M. Kahn, Island Park, N. Y.

Application October 3, 1945, Serial No. 620,038

25 Claims. (Cl. 74—573)

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This invention relates to laundry machines wherein extraction of washing fluid from the washed clothing is effected through high speed rotation of a perforated cylinder.

Washing or drying machines of this type depend upon centrifugal force generated by such high speed rotation for ejection of the wash water through the perforations of the cylinder. However, the generally unsymmetrical distribution of the clothes in the cylinder produces objectionable vibration which limits the speed of rotation and affects thereby the degree and time of drying. Considerable efforts have been directed toward systems for balancing the rotating cylinder during its high speed rotation. The trend of corrective measures regarding deviations from balance or symmetry, has been toward the re-orientation of the cylinder axis to comply with and compensate for the unbalanced mass, or the application of some form of compensating means to a specific portion of the cylinder or associated with a particular portion of its periphery and determined by the eccentric rotation of the cylinder caused by its unbalance.

Bearing the foregoing in mind, it is an object of this invention to provide an efficient, electrically operated control apparatus for correcting unbalance in a cylinder loaded with wash clothes to be dried by the centrifugal extraction of water.

Another object of this invention is to provide an apparatus for adding weight at various portions of the cylinder and determining the reaction of the cylinder to such additions. Thus, a sensing or "feeler" system is provided wherein compensating weights are added at various portions of the cylinder selectively, and means are provided to determine whether such weights have been correctly disposed. The last named means comprises a system of injecting compensating weights according to indications or contra-indications of weights previously added. The system locates the site of compensation by empirical means and continues in operation until all vibration has been reduced to a pre-determined level whereupon compensation ceases and the cylinder continues vibrationless rotation or may be caused to shift to a higher speed with safety. The detection or sensing system might then resume activity if the higher speed produced further vibration although by that time the extent of vibration would have been minimized.

Another object of this invention is to inject or alter opposing weights selectively at spaced points around the periphery of a washing cylinder and to provide automatic reaction to determine which of the opposed or altered weights more effectively balances the rotating cylinder.

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Another object of my invention is to provide means for balancing a washing cylinder or extractor not only in respect to its longitudinal axis but also in respect to a transverse axis. Thus, it may be considered that both dynamic and static unbalance of the cylinder is treated.

Another object of this invention as found in a modified form thereof is to provide means to insure that unbalance of the washing cylinder is attributable to weight disposed at a particular portion of the washing cylinder so that the injection of the counter weight in the opposite portion of the cylinder must be correct. In this manner an element of uncertainty as to the source of unbalance is eliminated inasmuch as it will be known where the objectionable weight is located and the only remaining problem therefore is to determine the quantity of compensating weight to be applied. This problem is treated automatically and inherently in the system.

A further object of this invention is to provide a master control which serves to determine not only whether or not weight should be added to the rotating cylinder, but determines further, whether weight added pursuant to its control has been effective in achieving the desired cylinder balance.

Still another object of this invention is to insure against damage to a washing machine through excessive vibration of its components by automatically cutting off the operation of a machine in which a large degree of unbalance exists. Allied with this object is the provision of a device which may control the application of compensating weight to a poorly balanced cylinder, but wherein operation is discontinued if such weight has been improperly applied to such an extent that further rotation is dangerous.

Other objects of my invention will be apparent from the following description, it being understood that the above general statements of the objects of my invention are intended to describe and not to limit it in any manner.

Referring to the drawings:

Fig. 1 is a side view in elevation of a preferred embodiment of my invention.

Fig. 2 is a schematic view of the electrical system for controlling the application of weights to an unbalanced cylinder, the said figure illustrating the position of the controls during a mild condition of unbalance.

Fig. 3 is a schematic view similar to Fig. 2, and

illustrating the condition of the electrical controls when the vibration or unbalance of the cylinder has increased.

Fig. 4 is a view similar to Figs. 2 and 3 and illustrating a higher state of unbalance.

Fig. 5 is a view similar to these preceding figures and indicating a still higher state of unbalance.

Fig. 6 is a fragmentary cross-sectional view, illustrating a modification of the weight injecting apparatus shown in Fig. 1.

Fig. 7 is a section along the line 7—7 of Fig. 6.

Fig. 8 illustrates a second modification of the weight injecting apparatus, and taken on the line 8—8 of Fig. 9.

Fig. 9 is a section on the line 9—9 of Fig. 8.

Fig. 10 is an end view in elevation of a washing machine cylinder embodying another type of weight injecting system, viewed on line 10—10 of Fig. 11.

Fig. 11 is a side view in elevation of the cylinder illustrated in Fig. 10, and viewed on line 11—11 thereof.

Fig. 12 is a fragmentary view, partly in cross section, illustrating a further modification of compensating weight injection means, as viewed on line 12—12 of Fig. 11.

Fig. 13 is a view along the lines 13—13 of Fig. 12. Fig. 14 is an electronic circuit for accomplishing the functions of the vibrating reed circuit. Fig. 15 illustrates a fragmentary modification of the electronic circuit of Fig. 14.

The apparatus comprises an outer shell 15 supported by base 16 and having the usual water inlet valve 17 and water outlet or dump valve 18. Within central openings formed in the end walls of shell 15 are disposed anti-friction bearings 19 rotatively supporting trunnions 20 and 20*a* of the washing cylinder 21.

Washing cylinder 21 is of generally conventional form and is adapted to contain the clothing to be washed and damp dried through the centrifugal extraction of water. Suitable doors 22 and 23, respectively formed in the shell 15 and washing cylinder 21, are arranged to register with each other so as to permit the introduction or withdrawal of articles from the washing cylinder 21.

Rotating motion is imparted to cylinder 21 by the variable speed electric motor 24, the pulley 25 of which drives a belt 26 so as to actuate the pulley 27 connected to the trunnion 20*a*. As is conventional in apparatus of this type, motor 24 serves to rotate the cylinder 21 at a slow or washing speed so that the clothing is tumbled about the cylinder and becomes washed. The cylinder is provided with the usual ribs, not shown, for agitation or tumbling of the clothes. After washing, and one or more stages of rinsing, the rotating speed of cylinder 21 is increased so that the resulting centrifugal force is applied to the wet clothes and ejects the water therefrom whereupon the water flows through the open dump 18 by means of the cylinder perforations 28. Means for thus varying the speed of rotation can be provided in the form of a variable speed motor or by separate motors as shown in my co-pending application Serial No. 610,035, now Patent #2,528,594, filed August 10th, 1945. As will appear hereinafter, however, it may be desirable in some instances to provide not only a washing speed and an extracting speed, but in addition to provide an intermediate balance testing speed. Thus, motor 24 being of the variable speed type, may serve this function.

After the clothes have been washed at the slow washing speed and the rotation of the cylinder has been increased for water extracting purposes, any unbalanced distribution of the clothes in the cylinder will be manifested by vibration of the cylinder and shell. It will be apparent to those skilled in the art that lack of symmetry or deviations from uniformity of distribution of the clothing in respect to the longitudinal axis of the cylinder will generate a centrifugal force of considerable magnitude in the direction of increased weight so as to cause the cylinder to vibrate in its bearings. Accordingly, means are provided to inject compensating weight on either side of the cylinder 21 so as to equalize the distribution of weight in respect to the longitudinal axis of the cylinder. As will be seen hereinafter, the addition of weight is made arbitrarily in order to ascertain the reaction of the added weight and to proceed according to the nature of such reaction. By the term "arbitrary" I mean that the initial added weight is applied to the cylinder without regard to the source or site of unbalance.

Such weight compensating means takes the form of hollow tubes 29 and 30 which are secured as by rivets, welding, or any other suitable means of connection, to the periphery of cylinder 21 and at diametrically opposite portions thereof. However, the function of hollow tubes 29 and 30 may be served by means of hollows in the usual washing ribs which are conventionally disposed within the washing cylinder 21.

Means are provided to inject water into the tubes 29 and 30 according to the indications of the control system to be hereinafter described. Water pipe 31 serves to introduce water under suitable pressure through trunnion 20 of the cylinder 21 so as to inject the water into tube 29 by means of the pipe 32. Water pipe 31 may be provided with an offset end member 33 which enters the trunnion 20 and is spaced therefrom by bushing 34 which is of an anti-friction character. Valve 35 is disposed adjacent to end member 33, the valve stem 36 serving to control the opening 37*a* in end member 33. Valve stem 36 takes the form of an armature of a solenoid 37, energization of solenoid 37 being effected by means of electrical wires 38 and 39. Since water under pressure is adapted to be supplied to water pipe 31, tube 29 will have such water introduced therein if valve stem 36 permits access through opening 37*a* of end member 33. Electrical leads 46 and 47 serve to apply the operating electricity for winding 45 so as to control the flow of water to tube 30.

A control apparatus for selectively operating either valve 35 or valve 42 is provided in a control box 48 mounted on the shell 15. Control box 48 houses a plurality of vibrator reeds 49, 50, 51, 52, and 53 to which are transmitted any vibrations of the cylinder 21 through the shell 15. Associated respectively with each vibrating reed are the electro-magnetic devices 54, 55, 56, 57, and 58. Electromagnetic devices 54 to 58 comprise the usual energizing windings and cores, the drawings herein illustrating the cores thereof which provide a path for the magnetic flux generated by the electromagnetic winding so as to form an area of magnetic attraction adjacent the ends of the cores. The intensity of this area of magnetic attraction may be varied by regulating the voltage applied to the electromagnets.

A master control is provided in the form of a metallic arm 59 which is mounted for swinging

movement at the pivot 60. Arm 59 is provided with a flexible metallic contact member at its free end which may take the form of a wire brush 61. An arcuate electrical contact member 62 is disposed adjacent to arm 59 so that brush 61 thereof makes electrical contact with arcuate member 62 when arm 59 is depressed into contacting relationship. A spring member 63 serves to maintain arm 59 in an upward position so as to be out of contact with member 62. Means are provided, however, to depress arm 59 against the action of spring 63, such depression means being operative in response to vibration of the washing cylinder 21.

The depression means are mounted on rods 64 and 65 secured to the shell 15 and comprise a strip of elastic rubber 66 secured to threaded bolts 67 and 68 in the rods 64 and 65. Bolts 67 and 68 are threaded so as to adjust the tension of rubber strip 66 and to thereby vary the sensitivity of the control apparatus as will be hereinafter described. A weight 69 is maintained centrally of rubber strip 66 so as to travel in a longitudinal path the extent of which is dictated by the amplitude of vibration of the machine.

It will be observed in Fig. 1 that vibration of the rubber strip 66 causes the weight 69 to periodically depress arm 59 so as to make contact with member 62 whenever the amplitude of vibration is such that the weight 69, bearing against the arm 59, forces it downwardly to a predetermined extent. During objectionable vibration electrical contact between member 62 and arm 59 is not broken by the action of spring 63 in spite of the fact that the influence of weight 69 is periodically removed, since the frictional contact of brush 61 with member 62 causes the arm 59 to move upwardly slowly so that before the circuit is broken the weight 69 again strikes the arm 59 and thus maintains the necessary electrical contact.

It will be observed that electromagnetic structures 54 to 58 are arranged to have their areas of magnetic attraction progressively removed from the vibrating reeds and that the reeds have a normal position wherein they are suitably spaced therefrom. The proximity of each electromagnetic structure to its associated vibrating reed determines the sensitivity of each such combination. In the specific embodiment shown, all the vibrating reeds will have the same fundamental frequency and amplitude of vibration in response to the vibration of cylinder 21. However, the voltage applied to each electromagnetic structure is such as to create an area of weak magnetic attraction so that contact between each vibrating reed and its associated electromagnetic structure depends upon the physical distance between the vibrating reed and the electromagnet core. It will be apparent that comparatively slight vibration will bring reed 49 into an area of magnetic attraction so as to be attracted to and retained by core 54. On the other hand, a very high degree of vibration is required to bring reed 53 into a position where it can be acted upon so as to be retained by core 58. The intermediate reeds 50, 51, and 52 require varying degrees of vibration in order to be attracted to and retained by the respective cores 55, 56, and 57. Instead of the progressive spacing shown, the reeds may be of progressively varying lengths so as to vary the amplitudes of their vibrations. As will appear hereinafter, the electromagnetic structures 54 to 58 function as holding relays for maintaining the valves in set position after the proper site of compensation has been found. Thus, although the degree of vibration decreases as compensation is correctly applied, such decrease of vibration does not shift the valve controls during the compensation.

Referring to the schematic representations of the electric circuit involved, Fig. 2 illustrates the electrical series arrangement of electromagnets 54 to 58 which are energized through electrical leads 70 and 71 through arcuate member 62 and contact arm 59. The voltage applied through the leads 70 and 71 may be relatively small and should be varibale so as to control the sensitivity of the electromagnetic structures as will be hereinafter described. Referring to a state of vibration such as would produce the conditions illustrated in Fig. 2, the vibration is of such mild character that only reed 49 has been attracted to electromagnet 54 so as to be retained thereby. It will be apparent that this state of unbalance, although mild, is sufficient to have actuated the weight 69 to such a degree that arm 59 had closed the reed attracting electromagnetic circuit. Accordingly, corrective measures are set in action. The attraction of reed 49 to electromagnet 54 closes an electrical circuit comprising leads 72 and 73, and electromagnet 74. Consequent energization of electromagnet 74 pulls inwardly its armature 75 against the action of the spring 76 so as to close an electrical circuit fed by the electrical lead wires 77 and 78 from which branch off the leads 38 and 39. The energization of electromagnet 74, therefore, serves to further energize electromagnet 37 so as to open the water inlet opening 37*a* as shown in Fig. 1 since the valve stem 36 is thereby retracted against the action of spring 79, from its normal closing position. It will be seen, therefore, that the actuation of reed 49 has caused the opening of valve 37 so as to introduce water into tube 29 and apply a corresponding weight to that portion of the cylinder 21.

The introduction of the water into tube 29 will either correct the unbalance or aggravate it. In the event that by chance that portion of the cylinder had required the additional weight which was supplied by the above action, the master control contact arm 59 would cease to make contact with member 62 because the weight 69 would no longer have such amplitude of vibration as to depress the arm 59 into electrical contacting relationship. Accordingly, reed 49 would be released so that water would stop flowing to the tube 29 by virtue of the restoration of valve stem 36 of valve 35 to its normal position. It will be evident that just so much water will be added to correct the defect, assuming that it has been applied to the proper side of the cylinder.

Assuming now that the cause of vibration was unbalance due to weight initially existing at that side of the cylinder, the addition of more water would further aggravate the degree of unbalance. Accordingly, the vibration will increase to such an extent that reed 50 will now be caused to enter the zone of attraction of electromagnet 55 so as to close a circuit which includes electromagnet 80.

The energization of electromagnet 80 through lead wires 70 and 71 and through reed 50 pulls armature 81 inwardly against the action of spring 82 so as to cause bridging contact 83 to bridge the contacts 84 and 85 so as to close a circuit in parallel relationship to that controlled by reed 49. The attraction of armature 81, however, withdraws bridging member 86 from the electrical circuit which energizes winding 37 so

that valve stem 36 is restored to normal position wherein the valve opening 37a leading to tube 29 is shut. By this electrical action, the circuit which includes reed 49 is opened while that circuit which includes reed 50 is closed. This condition is illustrated in Fig. 3 of the drawings herein, the energizing circuit for winding 45 as controlled by reed 50, serving to withdraw valve stem 43 against the action of spring 57 so as to permit the ingress of water to the opening 44. Hence the compensating effect of added water is now diverted to tube 30 while water for this purpose is cut off from the tube 29. Since the introduction of water to tube 29 aggravated the unbalanced condition and the consequent vibration, the addition of the water to tube 30 will relieve the vibration inasmuch as tube 30 is disposed diametrically opposite tube 29. Accordingly, water will continue to flow into tube 30 until the vibration is reduced to the point where weight 69 no longer has sufficient amplitude of vibration to effect contact between arm 59 and member 62 whereupon electrical current will be cut off from the electromagnet structures so that both electromagnet circuits controlling the respective valves 35 and 42 will be inoperative and no additional water will flow into either of the tubes 29 and 30. It can be seen, therefore, that when a desired state of balance has been achieved the introduction of water is automatically stopped. It will further be noted that whereas the initial application of compensating weight is arbitrary, the reaction to such weight determines the course to be pursued. Thus, if the arbitrarily added weight indicates that the compensation was properly made vibration ceases, whereas should the indications be otherwise the compensation will be immediately applied to the opposite side whereupon the vibrations will be decreased and the compensation will be continued until the weight 69 is no longer actuated and cuts off the electromagnetic structures so as to close both valves. For the sake of clarity in the drawings, the cylinder 21 has been shown as having two hollow tubes 29 and 30, although it will be understood that more such tubes may be added, if four such tubes are used, they may be disposed around the cylinder and spaced 90 degrees apart. In the illustrated embodiment the compensating weight is applied to tube 29 and then to tube 30 simultaneously being cut off from the tube 29. In a structure wherein three or four tubes are used, the second tube control will shift the compensation to the third tube, and the circuit will simultaneously cut off the compensation to the second tube, etc. The last control which may affect either tube, may always be arranged to return the compensation to the first tube in the event equilibrium has not been attained when said last control initially introduces weight to the last tube.

Whereas in Fig. 2 and Fig. 3 the conditions of the circuit are shown when the progression of the state of unbalance is such as to cause the actuation to creep up to the reed 50 circuit and to gradually eliminate vibration when the proper site therefor has been established, in Figs. 3 and 4 are illustrated the circuit conditions when the initial state of unbalance was such as to have exceeded the vibration required to close the circuit of reed 50 and to have closed the electrical circuit which includes reed 51. As noted in Fig. 4, the vibration of reed 51 has been of such amplitude, as indicated by the arrow adjacent thereto, as to have caused it to enter the area of effectiveness of electromagnet 56. This is further illustrated by the indicated amplitude of vibration of the weight 69. Such attraction of the reed 51 will energize the electromagnet 88 which will attract armature 89 so as to cause the bridging contact 90 to open the circuit energizing winding 45 and causing the bridging contact 91 to simultaneously open the electrical circuit which includes electromagnet 88 whereby armature 91 is released to its normal position. Accordingly, the electrical circuit energizing winding 37 will be restored so as to unblock opening 37a and admit water into tube 29. It will be seen, therefore, that in a more severe condition of vibration, reed 51 assumes the function of reed 49 and arbitrarily applies the compensating water to tube 29 so as to similarly determine the reaction of such compensation. Assuming that the application of compensation to tube 29 was correct, vibration would gradually decrease as water is introduced therein while the holding electromagnetic structure retain the controls in the correct setting.

However, should such arbitrary application of weight be incorrect, vibration would increase to such a high degree as to develop the condition illustrated in Fig. 5 wherein reed 52 is held by electromagnet 57. Accordingly, electromagnet 92 will be energized through wires 93 and 94 so as to attract armature 95 against the action of spring 93 and to open the circuit of reed 51 by withdrawing briding contact 97. The consequent de-energization of electromagnet 88 would restore the effectiveness of the circuit energizing electromagnet 45 so as to open the valve 42 and admit water through the opening. Simultaneously, electromagnet 88 would be energized once more since the normal action of the spring 98 is to close its circuit. Energization of electromagnet 88 opens the electrical circuit energizing electromagnet 37 so that water is cut off from tube 29 simultaneously with its application to tube 30. The site of compensation having been found through empirical means, water continues to flow into tube 30 during the decrease of vibration until weight 69 is no longer actuated. Thus, when the proper site has been found, the controls are set in this position during compensation. Upon the initial application of high speed rotation of cylinder 21, should the distribution of the clothes be so unusual and the consequent unbalance be so great as to cause the reeds up to reed 52 to be held by the holding electromagnets, the circuits would be established so that weight would be arbitrarily applied to tube 30. Should this be correct satisfactory balance would gradually be restored. However, should it be incorrect, the extent of vibration might exceed that indicated by the weight 69 in Fig. 5. Continued operation under such circumstances is inadvisable in order to avoid damage to the machine. The attraction of reed 53 to electromagnet 58 in consequence of such severe vibration serves to energize electromagnet 99 which attracts the armature 100 against the action of spring 101 so that finger 102 removes bridging contact 103 from the wires supplying motor 24. Accordingly, rotation of the cylinder 21 ceases while lamp 104 glows to indicate this condition. The operator may then open and examine the cylinder to remove the causes for such unbalance or he may re-distribute the articles therein.

In Fig. 14 is illustrated an electronic circuit for accomplishing the above. In place of the

rubber strip supporting the vibrating weight 69, a magnet 105 is secured to the shell 15. An armature 106 having a weight 107 is arranged to pivot at the magnet 105 so as to vary the magnetic field and induce currents in a coil 108 enclosed by the magnet 105. However, any type of magnetic vibration tester or magnetic pick-up device may be employed. A step up transformer 109 is arranged to feed the grid 110 of tube 111 which is so biased by resistor 112 that progressive negative excitation at the grid 110 produces successively positive voltages at the plate 113, the tube being operated along a linear portion of its characteristic curve for these operations.

These positive voltages developed across plate load resistor 114 are transferred through coupling capacitor 115 to the grid 116 of tube 117 as well as to the grids 118, 119, 120, 121, and 122, of the Thyratron or gas triode tubes 124, 125, 126, 127 and 128. The Thyratron tubes as well as master control tube 117 are successively biased by resistors 129, 130, 131, 132, 133, 134 and 135 so that each tube is normally cut off and responds to successively higher positive voltages applied to the respective grids. Thus, a comparatively slight voltage will cause tube 117 to conduct so as to energize solenoid 136 and attract arm 137. The attraction of arm 137 will cause it to meet contact 138 and apply the voltage from main current line L1 to the succeeding contacts whereby windings 37 and 45 may be alternately energized for the above described weight compensating and balancing system. Tube 117 also acts as a priming device the contact 139 being supported through insulation 140 by arm 137 and serving to apply plate voltage from the plate 141 of tube 117 to the plates of the Thyratrons through spring biased contact arm 137a. It will be observed that the plates of the tubes are thus supplied through high voltage line L2. The Thyratrons, however, will not conduct at this time unless the amplitude of vibration is sufficient to generate the voltage necessary to overcome the bias on each tube. While the bias shown is of the cathode type, it is apparent that a separate source of potential may be applied between the grid and cathode. If the vibration is such as to cause tube 124 to conduct, solenoid 142 will attract arm 143 so that it meets contact 144 whereupon the circuit for energizing winding 37 will include contact 145, and wire 146 to winding 37 and back to line L2.

Should the vibration increase pursuant to compensating weight thus added, tube 125 will conduct so as to energize solenoid 147 and attract arm 148. Insulating post 149 will thereupon break the circuit of winding 37 by depressing floor 150 so that contact 145 no longer meets it. Insulating post 151, however, brings contact 152 to the floor 153 of wire 154 so as to simultaneously energize winding 45 as winding 37 is deenergized.

If the vibration were of such extent as to have caused tube 126 to conduct initially, solenoid 155 would be energized so as to attract arm 156. Insulating post 157 would then depress the floor 153 away from contact 152 and arm 156 would meet contact 158 so as to energize winding 37. If the vibration were to increase in consequences of the added weight, tube 127 would conduct so as to energize solenoid 159. Arm 160 would be attracted so that insulating post 161 removes contact 158 from arm 156 and arm 160 simultaneously meets contact 162 so as to energize winding 45 while de-energizing winding 37.

Assuming that in any of the foregoing operations, the vibration declined while either valve was open, water would continue to flow into the proper tube notwithstanding the progressive decrease of voltage at the grids of the Thyratrons. This results from the gas triodes well known characteristic of being practically impervious to changes of grid voltage after the current starts flowing in the tube. Thus the tube acts inherently as a holding relay to maintain compensation to the proper site once established. As will be described hereinafter, means for accomplishing this function with ordinary vacuum tubes is also provided in a modification of the electronic circuit. When the vibration decreases to the point where tube 117 is no longer conductive, arm 140 is released so as to cut off the plate voltage of the Thyratrons and close both compensation valves.

If vibration were so severe that the grid voltage magnitude was sufficient to overcome the bias of tube 128, solenoid 163 would be energized so as to attract arm 164. Insulating post 165 then serves to depress floor 166 away from contact 167 whereupon operating current to motor 24 is removed and rotation of the cylinder ceases. Simultaneously, contact 168 is met in order to energize lamp 169 and indicate the reason for cessation of operation.

It will be observed that the electronic circuit described substantially duplicates the function of the electrical circuit first described, the master control of the first circuit finding a counterpart in tube 117.

Instead of Thyratrons, ordinary vacuum tubes may be used. In this event, a holding relay such as illustrated in Fig. 15 may be used and plate voltage to the tubes need not be interrupted by arm 140 but may be constant. The function of resistor 170 which is disposed across the main lines by the meeting of the arm 171 and contact 172 is well known to those skilled in the art. Briefly, it serves to supply just enough voltage to the solenoid to hold the arm 140 regardless of whether the grid voltage of the tube were to decrease. Such a holding relay would be used in each tube stage after the master control tube 117.

As illustrated in Fig. 1, the tubes 29 and 30 have sloping floors. The purpose thereof is to permit the compensating water to flow out of the tubes between operations. During operations centrifugal force will maintain the water in the tubes. As water flows out, it avoids the perforations 28.

In Fig. 6 is illustrated a modification of the compensation water inlet structure, both valves 35 and 42 being disposed at one end of the cylinder and the tubes being formed in the agitating or tumbling ribs 173 and 174 of the cylinder 21. A water inlet pipe 175 supplies the compensating water to either opening 176 or opening 177 which openings communicate respectively with the pipes 178 and 179 feeding the respective ribs 173 and 174. It will be observed in Fig. 7 that opening 176 will communicate with pipe 178 continuously whereas communication between opening 177 and pipe 179 will be intermittent depending upon the rotation of the device. However, the results will be the same, although the tube or rib 173 will take a longer time to fill unless the opening 177 and pipe 179 are made larger to offset the periodic cessation of communication or a circular channel is provided in the trunnion to feed water into opening 177 continuously.

In Figs. 8 and 9, a modified version thereof is

provided wherein three tubes are utilized for compensation purposes, such an arrangement requiring two additional reeds or electronic tubes in the circuits described above. The compensating water holding tubes 185, 186 and 187 are shown connected to the outer periphery of a washing machine cylinder 188. The tubes 185, 186 and 187 are spaced 120 degrees apart around the cylinder and pipes 189, 190 and 191 are arranged to feed water into the tubes. Three concentrically arranged and substantially L-shaped channels or troughs 192, 193 and 194 are formed in the trunnion 195 which rotates in antifriction bearing 196, each said channel communicating with one of said pipes as illustrated in Fig. 8. Water inlet pipe 197 supplies water to the chamber 198 formed in the stationary block 199.

Water chamber 198 has 3 openings 200, 201, and 202 formed therein and adapted to register respectively with the concentric channels. It will be apparent that where any of said openings are unblocked, water will be fed continuously to the channel communicating with said opening notwithstanding the rotation of the cylinder. Valves 203, 204 and 205 are arranged to control the blocking of said openings so that water is selectively applied to one of the tubes in accordance with the actuation of the valves. Such actuation of the valves will be selectively determined by the empirical or sensing system described above, any required modification thereof in the form of increased electronic tube stages commensurate with the increased compensation sites, being apparent to those skilled in the art.

The thus modified circuit would inject the water progressively into tubes 185, 186 and 187 while increased vibration after injection into tube 187 would return the water to tube 185. Thus, the system is identical with that above described and a cut-off stage may similarly follow two complete cycles of water injection such as described. After balance has been achieved by the instant system, it is feasible to increase the speed of rotation so that both a testing speed and an operating speed may be employed. If objectionable vibration reoccurs due to the higher speed, the system will resume activity and effect a new balance.

In Figs. 10 and 11 is illustrated a washing cylinder where water may be applied at either end of the cylinder so as to balance the weight distribution in respect to a transverse plane passing through the center of the cylinder. In addition, means are provided to inject weight laterally in respect to the longitudinal axis of the cylinder. The cylinder 206 is provided with substantially a single turn of tubing 207 at one end thereof, suitable clamps 208 serving to retain the tubing. A water inlet opening 209 in the trunnion 210 supplies the weight compensating water to the cylinder. If it is desirable to permit the escape of air from the tubing 207 as water is forced in, a conventional valve 211 of the air vent type may be provided. A water outlet valve 211a may be manually controlled to drain off the water after each complete washing and extracting operation.

The opposite end of cylinder 206 is similarly constructed, the tubing 212 serving to receive water for that end. The control system may be the same as that illustrated in Fig. 1 and either the electrical or the electronic circuit may be employed. It will be apparent that a system of this type will be effective when particular washing conditions might produce wide variations of weight along the longitudinal axis of the machine. Referring, for example, to my co-pending application Serial No. 610,035 filed August 10, 1945, where washed clothes are concentrated at the respective ends of a machine to overcome the serious problem of non-uniformity of circumferential distribution of the clothes, any appreciable difference in the weight of the clothes concentrated at each end would be reflected in unbalance in respect to a medial transverse axis. This condition may also be found in ordinary washing machine operations particularly where large as well as small articles are accommodated. The expedient, therefore, of selectively applying weight to the respective ends of the cylinder serves to balance lack of uniformity in longitudinal distribution.

In Figs. 12 and 13 is shown a weight compensation system having a single injection source. The wash water inlet pipe 214 serves also as the water inlet although valve 215 is closed when compensation water is injected. A pipe 216 and valve 217 supplies the water to a nozzle 218. Nozzle 218 is pivotally connected at 219 to a bracket 220 connected to the shell 221 of the machine. Means are provided to vary the directivity of nozzle 218 so that the fluid can be directed as desired. Accordingly, a slot 222 is formed in nozzle 218 and a pin 223 is disposed in the slot. It will be evident that longitudinal actuation of the pin 223 will cause nozzle 218 to pivot correspondingly and vary the direction of the injected fluid.

Electromagnets 224 and 225 are oppositely arranged upon an end wall of the shell 221 and have an armature 226 common to both the electromagnets. If desired, a portion 227 of the armature may be of non-magnetic material to avoid undue interaction between the electromagnets. The pin 223 is integral with the portion 227. Electromagnets 224 and 225 are similar in function to the windings 37 and 45 of Fig. 1 and they may be incorporated in either electrical or the electronic circuit in place of said windings. Accordingly, nozzle 218 will be directed in response to the control system described, the full lines of the nozzle indicating one position while the broken lines indicate another position. Weight balancing means may take the form of receptacles 228 and 229 oppositely disposed in respect to the longitudinal axis of the washing cylinder 230. While the receptacles are shown as disposed endwise of the cylinder it will be apparent that they may include an extension running parallel to the longitudinal axis after the manner of the tubes 29 and 30 of Fig. 1. The receptacles may be formed with offset scoops 231 and 232 which are directed so as to receive the injected water. Receptacle 229 is wider than receptacle 228 and its scoop 232 is disposed further inward radially than scoop 231 so that the alternate positions of the nozzle serve to apply the water selectively to either of the receptacles. Thus, energization of electromagnet 224 pivots the nozzle 218 upwardly so as to apply the water to receptacle 228 as shown in the full lines of Fig. 12 while energization of electromagnet 225 pivots it slightly downwardly to avert receptacle 228 while applying the water to receptacle 229 in the broken line position. It will be noted that after water has been applied, centrifugal force will maintain it against draining from the receptacles until the cylinder stops rotating whereupon the water is automatically discharged through the scoops.

In an alternative procedure, receptacle 228 may be arbitrarily filled to full capacity regardless of whether or not the unbalance is attributable to weight at that side. This expedient will, for all practical purposes, assure the predominance of weight at that side so that the compensation can

be applied to receptacle 229 with assurance that corrective action is being taken. This application of weight can be continued until the master control or other vibration responsive device indicates the achievement of a suitably low level, or virtual absence, of objectionable vibration. Of course, the sensing components of the circuit can be eliminated since this alternative procedure fixes the source of unbalance. Inasmuch as the greater weight of the clothes may originally have been on the same side of the cylinder as receptacle 228, receptacle 229 is made of larger volume than receptacle 228 to compensate not only for such greater weight, but also for the arbitrarily injected water. It will also be noted that receptacle 228 may be solid so as to represent an unbalancing weight without the application of water so that the water may be initially injected into receptacle 229. In this manner, as previously, the only uncertainty then resides in the amount of compensation to be applied.

When balance has been achieved the valve 217 is closed to cut off the supply of water. This closing of valve 217 may be manual and depend upon the judgment of the operator or it may be effected by a master control such as shown in Fig. 1 which, in combination with reed 49 serves to maintain the valve stem away from its normal closing position while objectionable vibration is present.

It can be seen from the above that there has been provided a compensation system which overcomes unbalance without the use of non-rigid or flexible bearings and without requiring the reorientation of the cylinder axis.

I have shown a preferred embodiment of my invention but it is obvious that numerous changes and omissions may be made without departing from its spirit. For example, while I have illustrated the invention as directed to a horizontal type washer, its principles may be applied to the vertical type of machine. Any suitable means of injection can be used such as, for example, water applied from the top end of the cylinder during rotation. In addition, while I have described the compensation as taking the form of water, mercury or similar material may be used. It is also within the scope of the invention to compensate for unbalance by supplying a force which serves to equalize the centrifugal force created by the unbalance.

I claim:

1. Vibration control means for a rotating cylinder comprising vibration pick-up means, a plurality of weight receptacles disposed at the periphery of the cylinder and means automatically responsive to reactions of said vibration pick-up means for introducing weights to certain of said weight receptacles.

2. Vibration control means for a rotating cylinder comprising in combination vibration indicating means, a centrifugal force compensating device for the application of counterforces for balancing unsymmetrical centrifugal forces in said rotating cylinder, means in said compensating system automatically responsive to said indicating means for applying a counterforce to said cylinder and means responsive to said indicating means for cutting off the application of said counterforce when balance has been attained.

3. Vibration control means for a rotating cylinder comprising in combination, vibration pick-up means, a plurality of weight receiving members radially spaced in relation to the longitudinal axis of said cylinder, control means responsive to said vibration pick-up means for applying a weight to one of said members during the rotation of said cylinder, said control means being further responsive to said pick-up means for shifting the application of weight to a different member if the vibration increases during said first application of weight.

4. Vibration control means for a rotating cylinder comprising in combination, pick-up means continuously operable during rotation of the cylinder to responses which vary as a function of the degree of vibration of said cylinder, a plurality of weight receptacles arranged axially off-set in said cylinder, a plurality of control means each respectively controlling the application of weight to said weight receptacles, a source of weight applications, said control means being selectively operative pursuant to graduated higher values of responses of said pick-up means whereby weight is selectively applied to said weight receptacles as the degree of vibration increases and means to maintain one of said controls operative when the degree of vibration decreases.

5. Vibration control means for a rotating cylinder comprising in combination pick-up means operable to produce responses which vary as a function of the degree of vibration of said cylinder, a plurality of weight receptacles symmetrically arranged at the periphery of said cylinder, control means operative upon a pre-determined response of said pick-up means to inject a liquid into one of said receptacles and operative during a period of increasing vibration to shift the injection to another of said receptacles and means to render said control means insensitive to varying responses of said pick-up means during a period of decreasing vibration.

6. Vibration control means for a rotating cylinder comprising in combination pick-up means adapted to produce a series of graduated responses according to the extent of the vibration of said cylinder, a plurality of weight receptacles peripherally disposed in symmetrical relationship on said cylinder, a source of fluid unbalance correcting material, each of said responses of said series being adapted to apply said fluid into one of said weight receptacles during a period of increasing vibration, the application of fluid to said weight receptacles being controlled by the last of said series of responses during said period of increasing vibration and means to maintain said control of said last response during a period of decreasing vibration.

7. Vibration control means for a rotating cylinder comprising in combination, a master vibration responsive member for controlling the application of compensating material to said cylinder, a series of control members adapted to be activated by the vibration of said cylinder, each of said series being adapted to produce a response according to the degree of vibration of said cylinder, a source of fluid unbalance correcting material, a plurality of fluid receptacles peripherally disposed about said cylinder, each of said control members being adapted to shift the admission of fluid successively to said receptacles so as to produce a decrease of vibration when the fluid is applied to a weight deficient portion of said cylinder and means to maintain the admission of fluid to a specific receptacle when said decrease is produced, said master vibration responsive member being operative to deactivate said control members at a pre-determined low level of vibration whereby no fluid is admitted into any of said receptacles when said low level is reached.

8. Vibration control means according to claim 7 wherein said control members comprise vibrating reeds, electromagnetic means co-acting with said reeds and valves controlled by said reeds, and said electromagnetic means for admitting said fluid to said receptacles.

9. Vibration control means according to claim 7 wherein said control members comprise electronic tube stages each biased to respond to successively higher degrees of vibration, valves controlling the admission of fluid to said receptacles, electromagnetic means incorporated in said tube stages for controlling the actuation of said valves prior to said decrease of vibration and means to maintain said electromagnetic means energized during said decrease of vibration.

10. Vibration control means for a rotating cylinder comprising in combination, a master vibration responsive member for controlling the application of unbalance compensating material to said cylinder, a series of control members each adapted to be successively actuated during a period of increasing vibration, a source of liquid unbalance compensating material, at least one pair of receptacles for said liquid disposed peripherally of said cylinder and in diametrically opposite relationship thereon, said control members being operative to shift the admission of said liquid alternately from one to the other of said receptacles during an ascending state of vibration, means to interrupt said shifting when vibration ceases said ascension so as to maintain said admission of liquid into one of said receptacles, said master vibration responsive member being operative to deactivate said control members at a predetermined low level of vibration whereby the application of said liquid is suspended when said low level is reached.

11. Vibration control means for a rotating cylinder comprising in combination. a master vibration responsive member for controlling the application of unbalance compensating material to said cylinder, a series of control members each adapted to be successively activated during a period of increasing vibration of said cylinder, a source of fluid unbalance compensating material, a pair of receptacles for said fluid disposed peripherally of said cylinder and diametrically opposite each other, each of said control members being operative when activated to successively admit said fluid into one of said pair of receptacles and to deactivate a previously activated control member whereby the admission of fluid is shifted from one to the other of said receptacles during said period of increasing vibration and only the last control member to be activated is operative to admit said fluid, electrical holding means for maintaining the deactivated control members in the deactivated state after a succeeding control member has been activated whereby the application of said fluid is confined to a specific receptacle when the vibration declines during the application to said specific receptacle, said master vibration responsive member being adapted to deactivate all of said control members at a pre-determined low level of vibration whereby the application of said fluid is suspended when said low level is reached.

12. A method of correcting unbalance in a rotating cylinder subject to weight differences on both sides thereof which comprises arbitrarily overloading one side of said cylinder to an extent greater than weight variations likely to be encountered and gradually applying a fluid to the other side of said cylinder while the cylinder is rotating until the weights on both said sides are substantially equal.

13. The method of correcting a state of unbalance in a constantly rotating cylinder which is subject to weight differences at various points about the periphery of the cylinder, which method comprises arbitrarily overloading one of said points to an extent greater than weight variations likely to be encountered, and thereafter gradually applying weighty liquids to other points about said cylinder while the cylinder is rotating until the weights about the cylinder are substantially equally distributed.

14. Vibration correction means for a rotating cylinder adapted to have loose articles therewithin comprising a plurality of receptacles, each said receptacles being off-set in respect to an axis of said cylinder, a source of weight compensating material, means to fill one of said receptacles with said material so as to unbalance said cylinder in the area of said one receptacle and means to apply said material to another of said receptacles until the weight of said initially applied material plus any differences due to the disposition of said loose articles are balanced.

15. Vibration correction means for a rotative cylinder adapted to have one or more loose articles therein comprising a pair of weight members oppositely off-set in respect to the longitudinal axis of the cylinder, one of said weight members having a normally fixed excess of weight in respect to the other weight member, and means to apply a counterweight to said other weight member so as to overcome said excess, plus or minus weight variations due to the distribution of said loose articles in respect to said weight members.

16. Vibration correction means for a rotating cylinder adapted to have one or more loose articles therein comprising a pair of weight members oppositely off-set in respect to the longitudinal axis of the cylinder, one of said weight members having a normally fixed excess of weight in respect to the other weight member, a source of weight compensating fluid, and means to supply said fluid to said other weight member so as to overcome said excess, plus or minus weight variation due to the distribution of said loose articles in respect to said weight members. cylinder adapted to have one or more loose ar-

17. Vibration correction means for a rotating cylinder adapted to have one or more loose articles therein, comprising vibration measuring means, a pair of weight members oppositely offset in respect to the longitudinal axis of the cylinder, one of said weight members having a normally fixed excess of weight in respect to the other weight member, a source of weight compensating fluid, means to apply said fluid to said other weight member and means automatically responsive to the reactions of said vibration measuring means for interrupting said application of fluid.

18. Vibration correcting means for a rotating cylinder, comprising vibration responsive means, a plurality of fluid weight receptacles disposed peripherally of said cylinder, means to arbitrarily vary the fluid contents of said receptacles so as to alter the response of said vibration responsive means, means controlled by said response for selecting a particular weight receptacle for variation of its contents and for discontinuing said variation when a satisfactory low level of vibration is achieved and means to restore said

receptacles to a normal condition in preparation for succeeding operation.

19. In a washing machine, vibration control means for a rotating cylinder comprising in combination, a plurality of radially spaced hollow ribs disposed about the periphery of said cylinder, vibration responsive means associated with said cylinder and actuated by vibrations thereof, a centrifugal force compensating apparatus for the application of counter forces for balancing unsymmetrical centrifugal forces in said rotating cylinder, means in said compensating apparatus controlled by said vibration responsive means for applying a counter force when unsymmetrical centrifugal forces cause vibration of said cylinder so as to actuate said vibration responsive means, said application being discontinued by said vibration responsive means when balance has been attained, said counter forces comprising streams of liquid injected into selected ribs of said cylinder, the ribs being selected by the action of said vibration responsive means.

20. A laundry machine comprising a horizontal housing, a perforated horizontal cylinder rotatably mounted in said housing, trunnion means for effecting said rotatable mounting, vibration responsive means associated with the housing and means on said rotatable cylinder for balancing unsymmetrical centrifugal forces generated during rotation of said cylinder, said balancing means comprising liquid receiving portions on said cylinder for the reception of liquid so as to create a counter-acting weight for balancing said unsymmetrical centrifugal forces, and means to introduce said liquid from a source external of said housing through said trunnion means during the rotation of said cylinder into certain of said liquid receiving portions under the control of the vibration responsive means.

21. A laundry machine according to claim 20 in which the vibration responsive means are associated with said housing and actuated by vibrations thereof, and including means controlled by said vibration responsive means for introducing said liquid through said trunnion means to selected liquid receiving portions on said cylinder, said liquid receiving portions being spaced around the periphery of said cylinder whereby counter action weights are applied to said cylinder as determined by the response of said vibration responsive means.

22. A laundry machine comprising a housing, a perforated cylinder rotatably mounted in said housing and having its longitudinal axis horizontally disposed, rigid bearing means on each end of said cylinder for effecting said rotation, vibration responsive means associated with the housing and means on said rotatable cylinder to balance unsymmetrical centrifugal forces generated during rotation of said cylinder, said balancing means comprising liquid receiving receptacles peripherally disposed on said cylinder for the reception of liquid so as to create a counter-acting weight for balancing said unsymmetrical centrifugal forces and means to introduce said liquid to said receptacles during the rotation of said cylinder, said means to introduce water comprising a water channel formed in at least one of said rigid bearing means whereby water from a source external to said housing may be introduced through said channel and into said water receptacles during the rotation of said cylinder under the control of the vibration responsive means.

23. A laundry machine comprising a horizontal housing, a perforated cylinder rotatably mounted in said housing, rigid bearing means for effecting said rotation, vibration responsive means associated with the housing and means on said rotatable cylinder for balancing unsymmetrical centrifugal forces generated during rotation of said cylinder, said balancing means comprising liquid receiving portions on said cylinder for the reception of liquid to create a counter-acting weight for balancing said unsymmetrical centrifugal forces, means controlled by the vibration responsive means to introduce said liquid to said liquid receiving portions during the rotation of said cylinder, and means operative during rotation of said cylinder for discharging liquid from said portions in preparation for a succeeding operation.

24. A laundry machine comprising a housing, a perforated cylinder rotatably mounted in said housing, and means on said cylinder for balancing unsymmetrical centrifugal forces generated during rotation of said cylinder, said balancing means comprising liquid receiving portions mutually spaced from each other on said cylinder for the reception of liquid so as to create a counter-acting weight for balancing said unsymmetrical centrifugal forces, means to introduce a stream of liquid to said liquid receiving portions during the rotation of said cylinder, and means to vary the directivity of said stream so as to introduce said liquid to said spaced liquid receiving portions selectively.

25. A laundry machine according to claim 24 wherein said means to shift the directivity of said stream comprises vibration responsive means operatively connected to said rotating cylinder and a stream shifting mechanism controlled by said vibration responsive means.

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