April 26, 1955 H. C. A. MEYER 2,706,899

LAUNDRY MACHINES

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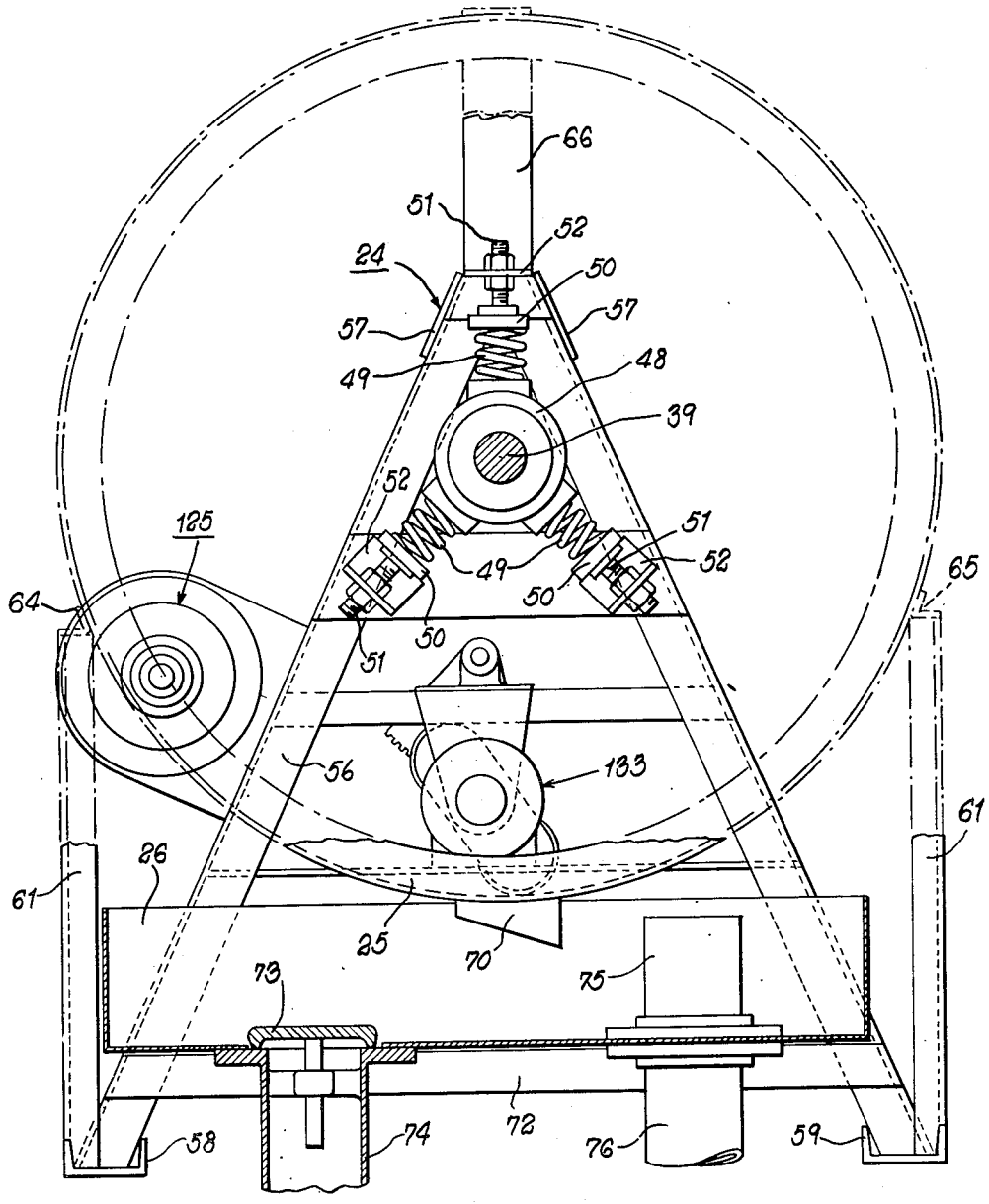

Fig. 3.

INVENTOR.
HENRY C. A. MEYER
BY Kenyon & Kenyon
HIS ATTORNEYS

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LAUNDRY MACHINES

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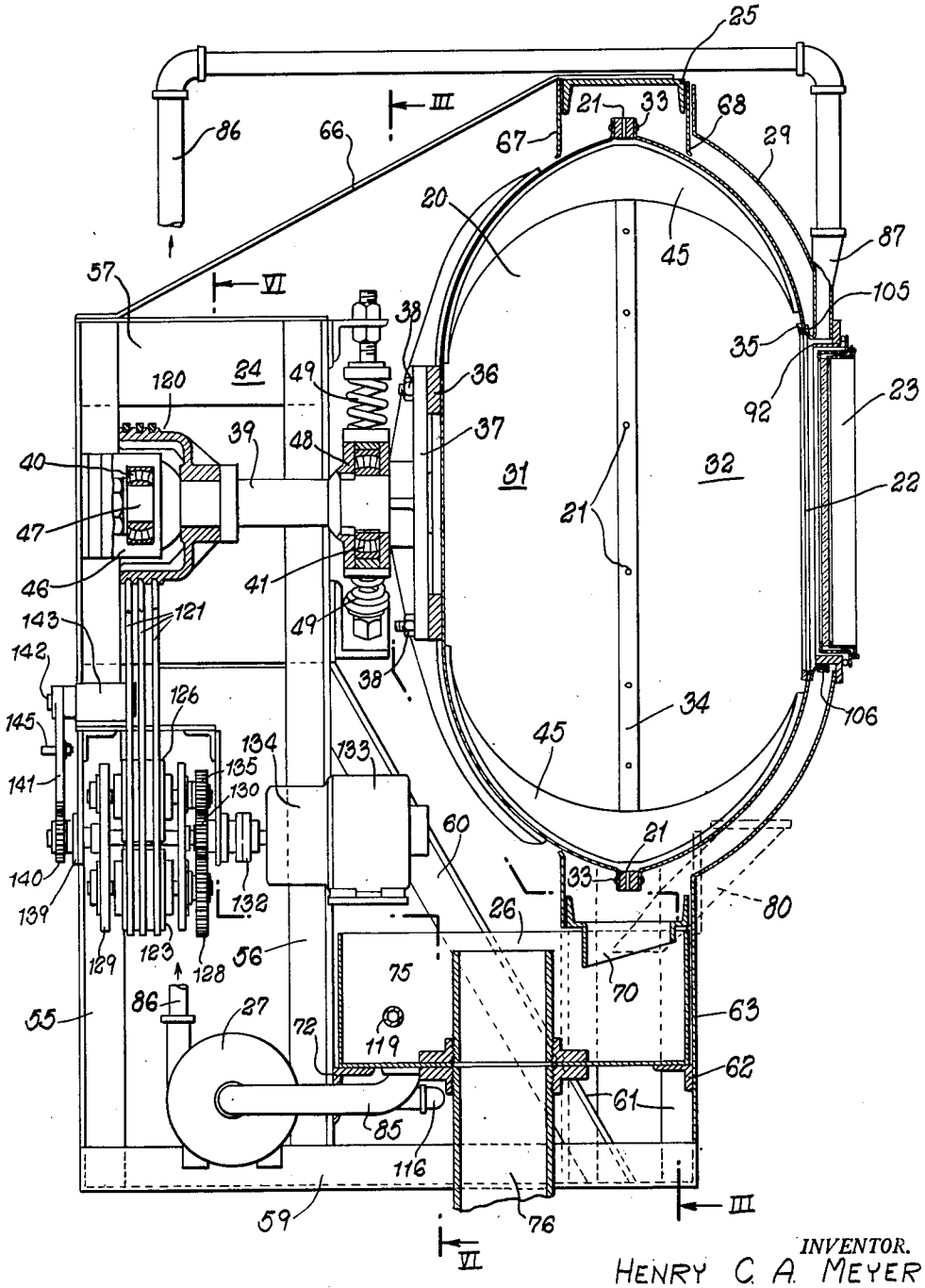

Fig. 1.

INVENTOR.
HENRY C. A. MEYER
BY Kenyon & Kenyon
HIS ATTORNEYS

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LAUNDRY MACHINES

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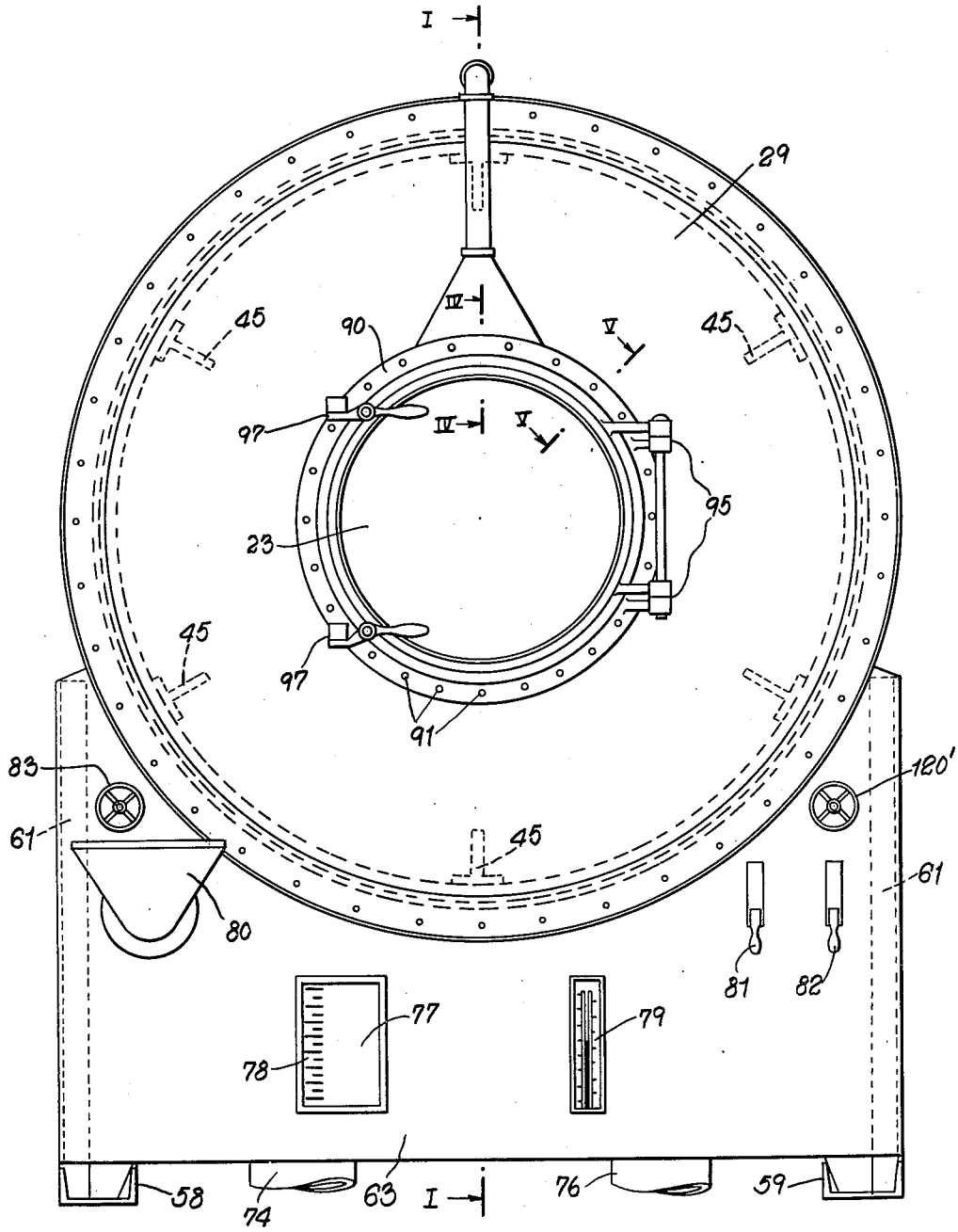

Fig. 2.

INVENTOR.
HENRY C. A. MEYER
BY Kenyon & Kenyon
HIS ATTORNEYS

April 26, 1955 H. C. A. MEYER 2,706,899

LAUNDRY MACHINES

Filed Dec. 4, 1950 8 Sheets-Sheet 4

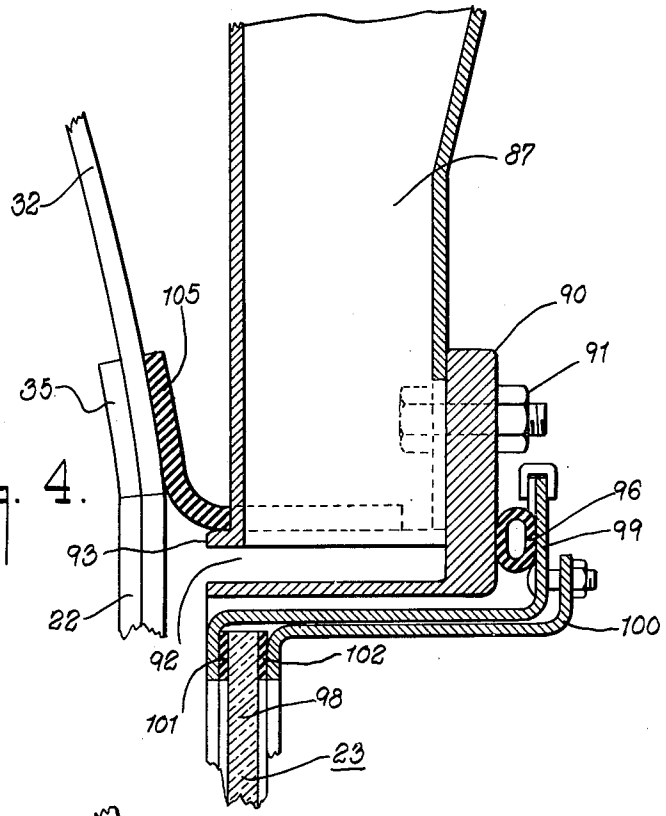

Fig. 4.

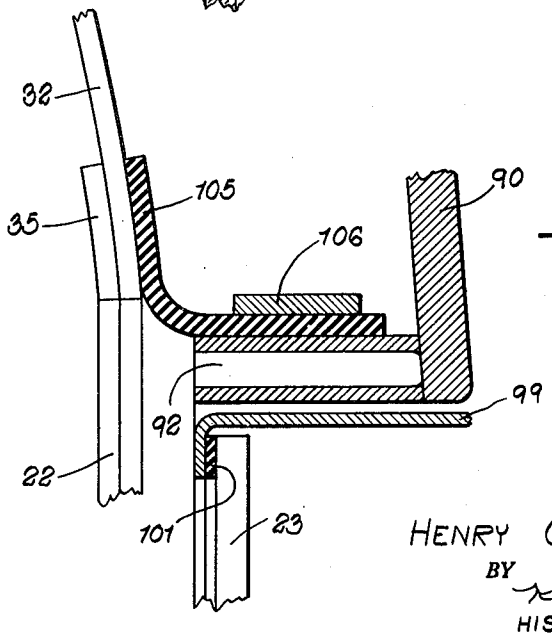

Fig. 5.

INVENTOR.
HENRY C. A. MEYER
BY Kenyon & Kenyon
HIS ATTORNEYS

April 26, 1955 H. C. A. MEYER 2,706,899

LAUNDRY MACHINES

Filed Dec. 4, 1950 8 Sheets-Sheet 5

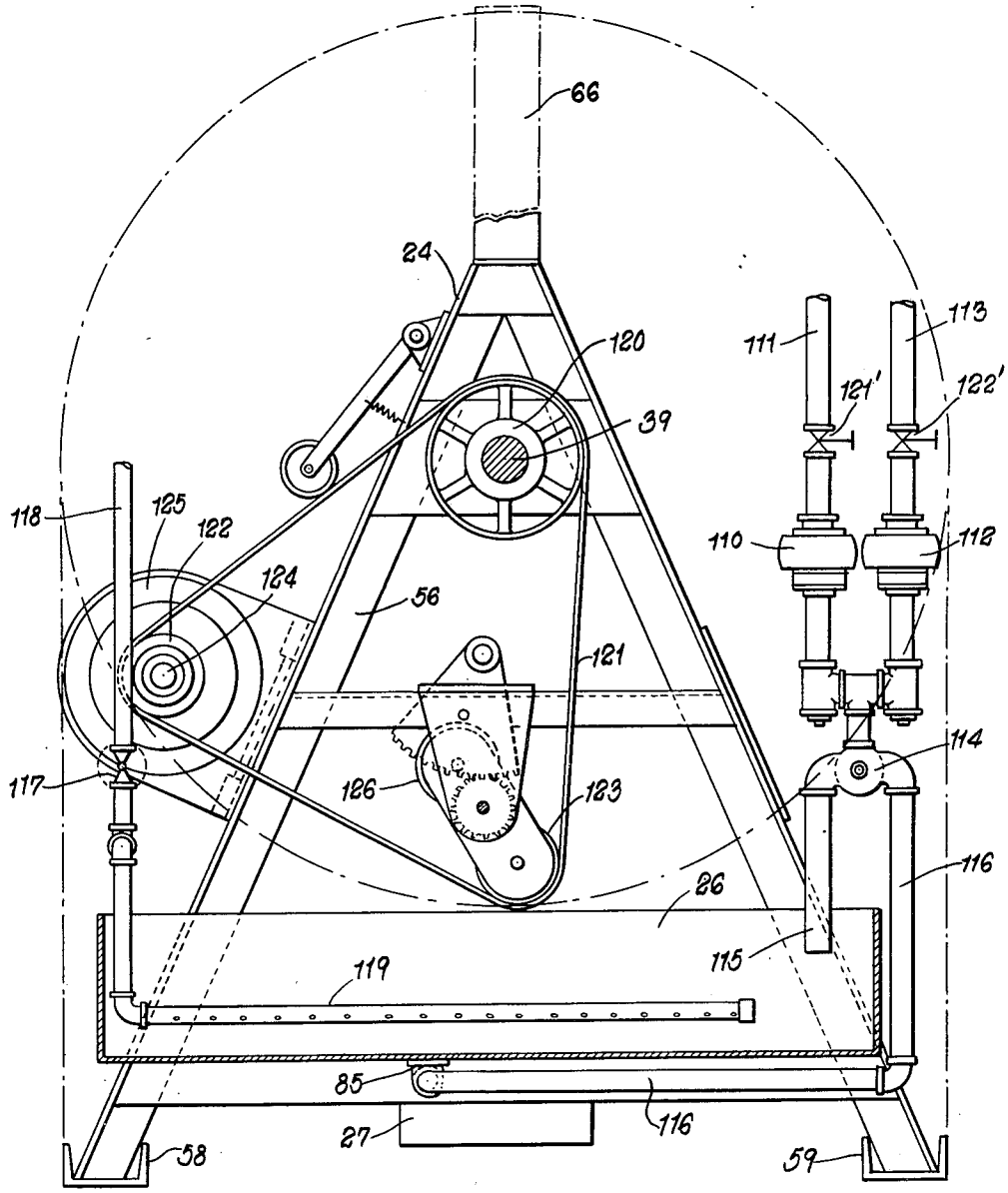

Fig. 6.

INVENTOR.
HENRY C. A. MEYER
BY Kenyon & Kenyon
HIS ATTORNEYS

April 26, 1955 H. C. A. MEYER 2,706,899

LAUNDRY MACHINES

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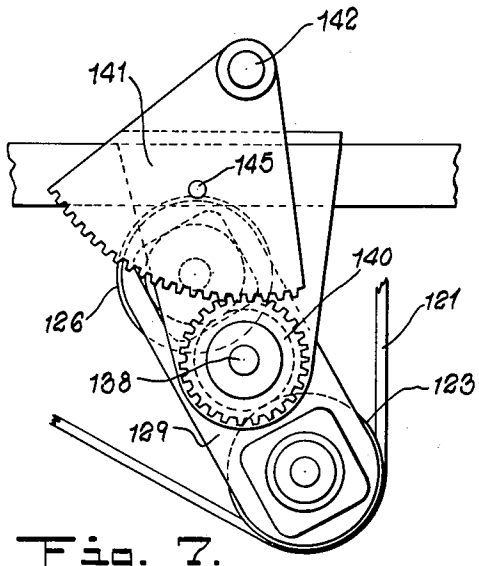

Fig. 7.

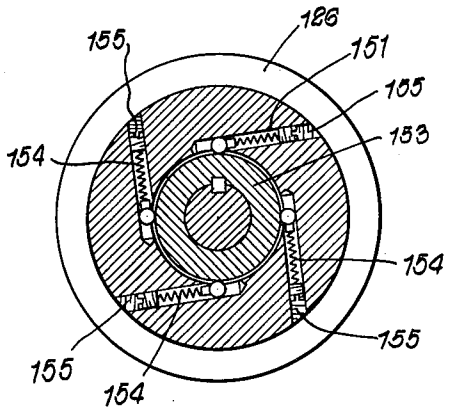

Fig. 9.

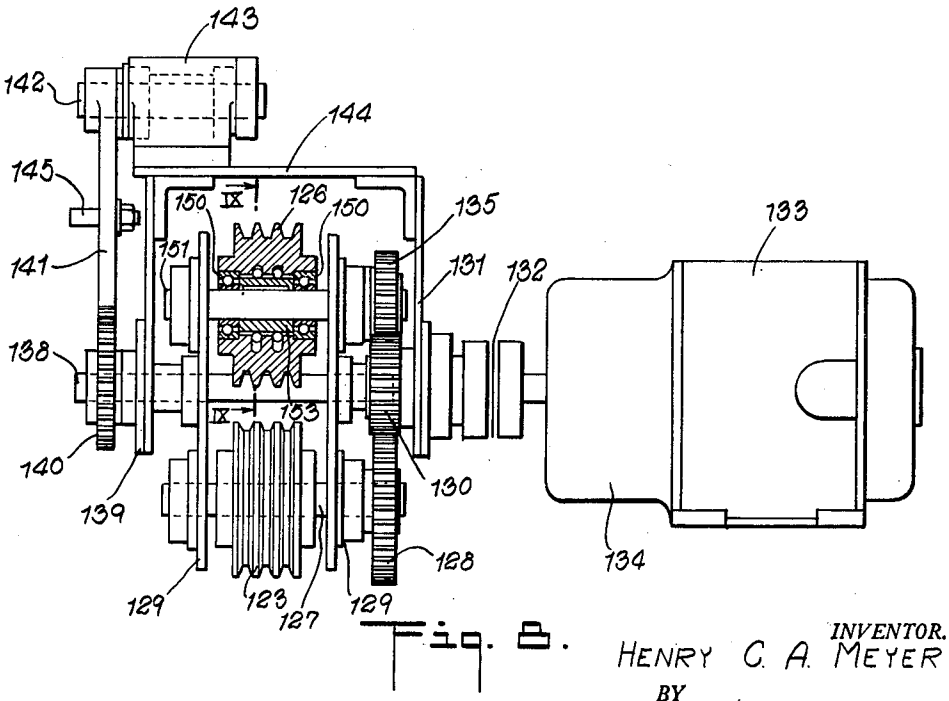

Fig. 8.

INVENTOR.
HENRY C. A. MEYER
BY
Kenyon & Kenyon
HIS ATTORNEYS

April 26, 1955 H. C. A. MEYER 2,706,899

LAUNDRY MACHINES

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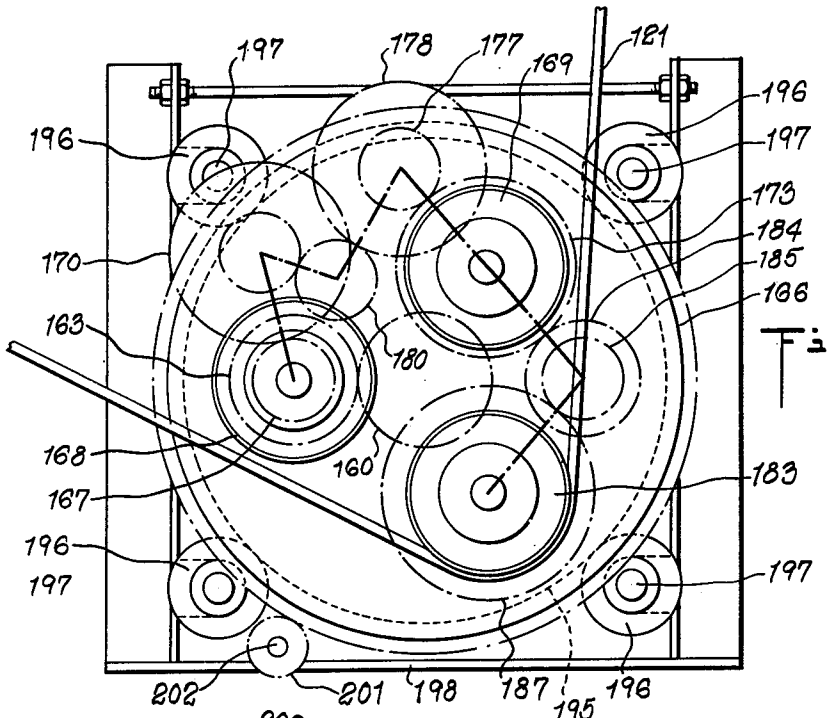

Fig. 10.

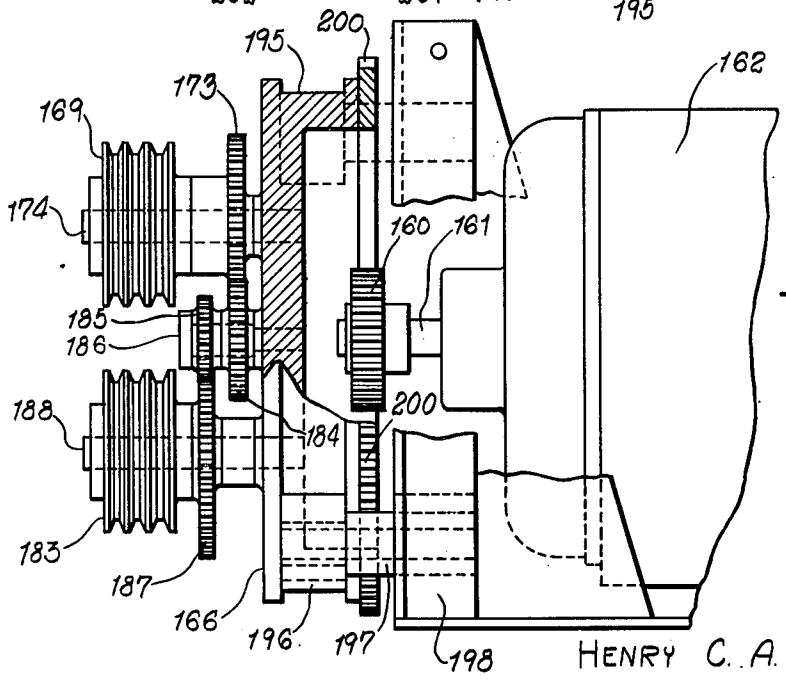

Fig. 11.

INVENTOR.
HENRY C. A. MEYER
BY Kenyon & Kenyon
HIS ATTORNEYS

April 26, 1955 H. C. A. MEYER 2,706,899

LAUNDRY MACHINES

Filed Dec. 4, 1950 8 Sheets-Sheet 8

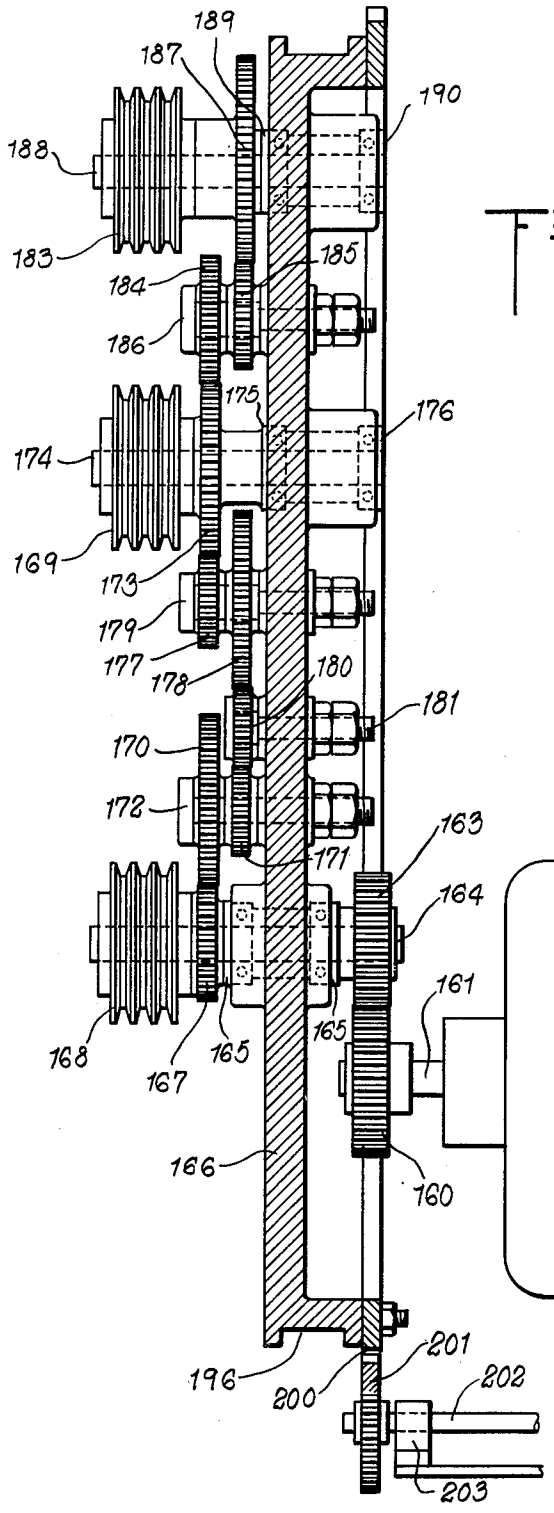

Fig. 12.

INVENTOR.
HENRY C. A. MEYER
BY Kenyon & Kenyon
HIS ATTORNEYS

United States Patent Office 2,706,899 Patented Apr. 26, 1955

2,706,899

LAUNDRY MACHINES

Henry C. A. Meyer, Syracuse, N. Y.

Application December 4, 1950, Serial No. 199,105

7 Claims. (Cl. 68—24)

This invention relates to laundry machines which both wash and extract the washing fluid from the load after the washing process is completed, and also to a method of cleansing fabric materials which may be practiced with such machines.

One object of my invention is to provide an improved laundry machine which performs the separate operations of washing and extracting in a single machine instead of separate machines, as conventionally required.

Another object of my invention is to provide such a laundry machine which performs the operations of washing and extracting with less supplies and less water per pound of load processed in less time than is possible with machines and processes of the present art.

Another object of my invention is to provide a method of cleansing fabric materials which may be practiced with such a machine or other machines and which achieves the process of rinsing in a superior manner, by displacement of the cleansing fluid by the rinse fluid rather than by mere dilution as in conventional practice. By the term "rinsing" as used here and hereinafter in the specification and claims is meant the process of freeing the material being washed from the soap, suds, detergents and/or cleansing fluid used in washing.

Another object of my invention is to provide a method of reducing "wobble" of a rotating container containing a compactable material, as in a laundry machine, by utilizing centrifugal force.

Still another object of my invention is to provide a new and novel type of drive mechanism for such a laundry machine for rotating the container thereof at the necessary relatively low washing speed, the higher rinsing speed, and the still higher and relatively high fluid-extracting speed.

A further object of my invention is to provide such a drive mechanism which is simple and foolproof in operation and yet insures that the speed of the container cannot drop below the rinsing speed during the shift from rinsing to fluid-extraction speeds.

Still a further object of my invention is to provide such a laundry machine including a container of such shape that the load tends to be concentrated in a single plane perpendicular to the axis of rotation of the container during operation so as to prevent or reduce to an irreducible minimum "wobble" of the container.

This last object can be achieved with various forms or shapes of rotating containers, including spheres, demi-spheres, cones, double cones placed base to base, rhombohedrons, pyramids, double pyramids placed base to base, or lenticular shapes, all rotated about an axis of symmetry, although not all of these shapes are equally efficacious. All such shapes when rotated about an axis of symmetry thereof tend to concentrate a contained load in a single plane perpendicular to the axis of symmetry when the container is rotated about that axis, which eliminates or reduces to an irreducible minimum those force couples which cause "wobble" or vibration difficulties when the container is revolved at elevated speeds with a load therein.

For purposes of illustration, I have shown and described a preferred form of my invention in which the container is of generally lenticular shape or elliptical cross-section rotatably supported on the minor axis of its cross-section by a shaft intended to be substantially horizontally-positioned in normal use, but this is by way of illustration only and I do not intend to be limited to this particular shape. This preferred form of container

comprises two dished halves joined at their peripheries by a ring lying in the major axis of the elliptical cross-section or lenticular container. This ring is provided with a number of radial orifices or perforations for reasons which will be explained hereinafter.

The reasons for making my preferred container substantially lenticular or elliptical in cross section are multifold. This shape is symmetrical and has a cross-section wherein those adjacent opposed walls extending away from the axis of symmetry converge toward and abut at an apex lying in a plane perpendicular to the symmetrical axis. This plane, which is the plane of the major axis of the elliptical cross-section, is, of course, the single plane referred to above in which the contained load tends to be concentrated when the container is rotated so that those force couples which cause "wobble" or vibration difficulties are eliminated or at least reduced to an irreducible minimum.

In addition, this shape allows simpler means and less material to be employed for overcoming the stresses and strains incident to centrifuging loads at high speeds. Also, experiments have demonstrated that if the major axis/minor axis ratio of the elliptical cross-section is at least 1.32:1 there is more stability when the container is revolved at elevated speeds and the load tends to be concentrated in the plane of the major axis of the elliptical cross-section.

A further reason for utilizing this shape is that the adjacent opposed walls extending away from the axis of symmetry may be made to converge in such a manner as to compensate for the progressive increase in circumference from the symmetrical axis to the periphery of the container. Thus, going radially outward from the axis of symmetry, successive differential rings or elements of equal radial thickness are of the same volume, thereby maintaining a constant cross-sectional area through which the fluid in the container passes in its radial passage toward the peripheral orifices. This factor is important in my laundry machine since it aids in maintaining an "interface" between the cleansing fluid and the rinse fluid during my novel rinsing operation. In any event, the cross-sectional area of radial passage of the fluid should not be allowed to increase substantially, and, alternatively, an overcompensation may be achieved, particularly near the periphery of the container, so that the cross-sectional area of radial passage of the fluid progressively decreases. Preferably, I shape my lenticular container to approximately achieve this compensation for producing the constant cross-sectional area of radial passage, at least beyond the radius R_1 at which each discrete element of material contained in the container will be acted upon by a force of at least 1 G (1 gravity) at the predetermined speed of rotation of the container for the rinsing cycle.

Furthermore, this lenticular shape, in combination with the radial perforations, facilitates the release of the free washing liquids during the processes of washing, rinsing, and centrifuging from a narrow annulus lying substantially on the major axis of the container. By limiting the number of these perforations in relation to the flow of washing fluid or liquid provided, provision is made for maintaining a volume of the fluid within the container during the washing cycle while providing a continuous circulation of the fluid, if desired. While, as will be seen hereinafter, in my preferred embodiment the perforations are not valved, if a continuous circulation of the washing fluid is not desired during the washing cycle, centrifugal valves may be provided for each perforation, such valves being normally closed at the speed at which the container revolves during the washing cycle and opening automatically when a higher speed is reached, as during the rinsing and extracting cycles.

My construction also avoids the necessity and expense of providing a shell, as in some conventional washing machines, which surrounds the spinner or basket and in which the latter rotates. As will be pointed out hereinafter, this conventional construction is wasteful of both the washing fluid, the washing supplies, such as detergents or soaps, and the time required for the operations of washing and rinsing because of the time required to fill and drain this additional space of the washing fluid. My construction also avoids the "double door" operation re-

quired in conventional horizontal-axis cylinders, and thus avoids the attendant undesirable procedure of aligning the inner door with the outer door when the contained load is to be removed. Furthermore, my construction facilitates unloading—only one door need be opened—and my construction basically reduces the reach for the extracted load by one-half over conventional home-type vertical-axis or commercial-type horizontal-axis cylindrical drum washing machines.

My invention accomplishes my objective of washing with less supplies and less water per pound of load processed in less time because of five factors. First, it eliminates the water and supplies therefor which are required to fill the annulus between the cylinder or basket and shell in conventional horizontal-axis washers. The importance of this is readily understood when it is realized that in the case of a two-inch wide annulus surrounding a 42-inch diameter cylinder with five inches of water in the cylinder, 40% of the total water is in the annulus, and 70% of this unused or inactive fluid may be considered to be hot water by normal standards when the washing fluid is water.

Secondly, my construction is more economical in that it eliminates the use of an equivalent amount of supplies, i. e., 40% for a given concentration of the supplies in the washing fluid.

Thirdly, my construction facilitates initial saturation of the load by a solution of the water and supplies rather than than the water alone, and maintains this solution absolutely uniform throughout the entire load. This is virtually impossible with conventional washers, and is important because, as is well known in the art, it is much easier to remove dirt from fabric or the like if a solution of the supplies and water is applied initially rather than the material first being wetted by the water and the supplies then added separately.

Fourthly, my construction avoids rinsing by dilution and instead effects rinsing by displacement, which is a vastly superior and quicker process. The usual steps in a conventional rinsing procedure are: (1) draining the suds; (2) refilling with clean fluid to the proper level and going through the rinsing operation; (3) draining this rinsing fluid; (4) again refilling with clean fluid to the proper level and again going through the rinsing operation; (5) draining this second rinsing fluid; (6) still again refilling with rinsing fluid to the proper level and still again going through the rinsing process; and (7) draining this third rinsing fluid. Conventionally, there are three or four such rinses in a normal rinsing cycle in a conventional washer, this filling, rinsing, and draining routine being repeated until the residual concentration of the supplies remaining in the clothes of the load is as low as desired. This conventional process is, of course, one of reducing the residual concentration by repeated dilution. The importance of avoiding, if possible, these repeated rinsing procedures is apparent when it is realized that a conventional washer with some 16 inches of water in a 42-inch diameter cylinder within a 46-inch diameter shell (thus providing a two-inch wide annulus around the shell) requires about 32 gallons per foot or 0.64 gallon per pound per rinse—a very considerable amount of fluid.

In my construction rinsing is effected by displacement instead of dilution, since the container is continuously rotated during the rinsing cycle to force out the residual content through the perforations ahead of the displacing fresh water provided. This effects a very substantial reduction in both hot and cold water required with attendant economies and also, of course, reduces the time required for rinsing. This is particularly important, since each conventional rinsing routine requires about five minutes.

Fifthly, my construction eliminates both the time and labor involved in conventional washers of the type having separate extractors in the operations of removing the wet, heavy, and soggy load from the washer and placing this load into the separate extractor basket, either with or without an intermediary transporting container depending upon the relative placement of the extractor and washer in the particular installation.

In general, it may be said that my construction provides at least a 50% reduction in time required for extracting, rinsing, and washing over that of conventional washers, at least a 50% reduction in the amount of hot water required and at least a 40% reduction in the amount of supplies, such as detergents or soaps, required.

Other and further advantages of my invention will be apparent from the detailed description given hereinafter, when taken with the accompanying drawings, in which:

Fig. 1 shows a partially cut-away cross-sectional side elevational view of the preferred embodiment of my laundry machine;

Fig. 2 shows a front view of the extractor-washer of Fig. 1;

Fig. 3 is a cross-sectional view taken along the section line III—III of Fig. 1, illustrating more clearly the tripod suspension of the container shaft bearing and the tank;

Fig. 4 is a cross-sectional view through the frame construction at the top of the door, taken along the plane IV—IV of Fig. 2.

Fig. 5 is a cross-sectional view showing the frame-to-door seal construction, taken along the plane V—V of Fig. 2;

Fig. 6 is a cross-sectional view taken along the section line VI—VI of Fig. 1, and illustrating particularly the belting arrangement with the three-speed drive provided and the hot and cold water and steam supply piping;

Fig. 7 is a detailed end view of the two-speed drive portion of Fig. 6;

Fig. 8 is a cross-sectional view of the two-speed drive shown in Figs. 6 and 7;

Fig. 9 is a cross-sectional view taken along plane IX—IX of Fig. 8, illustrating the over-running drive construction utilized;

Fig. 10 is a view generally similar to that of Fig. 7 of an alternative unitary three-speed drive system;

Fig. 11 is a cross-sectional view of the three-speed drive system of Fig. 10; and

Fig. 12 is a developed sectional elevation of the three-speed drive system of Fig. 11.

Referring now to the drawings, it will be seen that my construction includes eight main elements: a container **20** of generally elliptical cross-section or lenticular shape provided with one or more radial peripheral orifices or perforations **21** and a side opening **22**; a loading and unloading door **23** for the opening **22**; a supporting A-shaped frame **24**; a collecting channel **25** surrounding the major axis of container **20** and in which the perforations **21** discharge the washing fluid when the structure is revolved; a tank **26** disposed below the collecting channel **25**; a pump **27** for supplying and circulating the washing fluid; and a drive mechanism **28** for rotating container **20** and including one or more motors and a system of gearing, pulleys, and belt transmission.

While not essential, in my preferred embodiment a sheet cover **29** is provided on the front of my laundry machine joining the door frame with the collecting channel **25** and supporting the former from the latter. If desired, this cover **29** may, of course, be replaced by any suitable supporting means between collecting channel **25** and the frame of door **23**, e. g., a plurality of strap members could be employed.

As shown in Fig. 1, container **20** is formed of two dished halves or heads **31** and **32** secured, as by means of rivets **33**, at their peripheries to an annular member **34**. The limited number of radially-disposed orifices or perforations **21** are provided as shown in this annular member **34**. The front half or head **32** is provided with the central opening **22** and a stiffening ring **35** surrounds opening **22** and is preferably secured to the inner surface of dished half **32**. A centrally-disposed heavy stiffening ring **36** is secured to the back dished half **31**, preferably on the outer surface thereof, and is machined and finished to fit hub **37**, to which it, and hence container **20**, are secured by means of a plurality of stud and nut connections **38**. Hub **37** is supported by and mounted on the end of shaft **39**, which in turn is mounted within bearings **40** and **41**, shown cut-away for clarity.

One or more ribs **45** are provided and secured to the inner periphery of container **20** for the dual purpose of adding rigidity to the lenticular structure and for assisting in lifting the load during the rotation of the container **20**, as is well known by those skilled in the art. While these ribs **45** are shown as being of T-shaped cross-section in Fig. 2, this is not imperative, and any suitable shape, as for example a U-shaped member, may be utilized for this purpose.

Bearing **40**, of the spherical-roller self-aligning type, is disposed within a housing **46** and allows the shaft **39**, bearing **41**, and container **20** to rotate with a sufficient degree of latitude of angular oscillation about the center point **47** of bearing **40**. Bearing **41**, housed within chamber **48**, is also of the spherical-roller self-aligning type permitting oscillation of the rotating shaft **39**. Chamber **48** is supported by three helical springs **49**, as shown best in Fig. 3, disposed radially in a tripod arrangement. The ends of each spring **49** are disposed in respective cavities in housing **48** and spring-supporting block **50**, being held in compression between the two supporting members, and the back of each block **50** abuts an adjusting screw **51** supported by angle clips **52** secured to supporting frame **24**.

The supporting frame structure **24** is formed of two main A-shaped elements **55** and **56** held together rigidly at the top by cross members **57** and at the bottom by inverted heavy channel base members **58** and **59**. As will be seen from the drawings, various other connecting members between the A-shaped elements **55** and **56**, including the motor-supporting plates, belt transmission supports, etc., add to the rigidity of the frame structure **24**. Two bracing members **60** (only one is shown in Fig. 1) connect the respective legs of front A-shaped element **56** to base members **58** and **59**, respectively, and also serve to add stability to the supporting structure. Corner angle posts **61** are supported at their lower ends by base members **58** and **59**, and the front corner angle post **61** in turn supports a horizontally-disposed connecting frame member **62** and front plate **63**. Collecting channel **25** is supported from corner posts **61** by means of brackets **64** and **65**, as indicated in dotted lines in Fig. 3, and brace **66** connects the top of collecting channel **25** to the top of the back inverted V-element **55** of frame **24**.

Circumferential tough resilient rings **67** and **68** are disposed on either side of collecting channel **25**, as best shown in Fig. 1, to act as splash guards. The front splash guard ring **68** may be omitted, if desired, when the front circumferentially-complete sheet cover **29** is utilized, as in this preferred embodiment. A large aperture fitted with a pipe **70** is provided in the lowermost point of collecting channel **25**, and immediately below pipe **70** is disposed the open-topped tank **26**, supported by frame **24**, as by means of front horizontal member **62** and a corresponding back horizontally-disposed connecting frame member **72**. This tank **26** is equipped with a dump valve **73** operable manually by suitable linkage (not shown) to allow the fluid contained in the tank **26** to be discharged to a drain rapidly when desired through conduit **74**. An overflow **75** is also provided in tank **26** to limit the level to which the tank may be filled, any excess spilling over the upper edge of the overflow **75** and discharging through conduit **76** to a suitable drain. As best shown in Fig. 2, tank **26** is also provided with a transparent wall section **77** to facilitate viewing the liquid level within the tank and the condition of the contained liquid, this transparent wall section **77** preferably being provided with indicia **78** as shown to indicate the exact amount of contained liquid. An indicating thermometer **79** is also preferably provided to indicate the temperature of the liquid.

Supplies, such as soap, detergents, bluing, etc., required during any given cycle of the machine operation are delivered through supply chute **80** (Figs. 1 and 2) to the tank **26**, where they are mixed with the washing liquid, usually a mixture of hot and cold water. The admission of this hot and cold water is controlled by means of respective valve-operated levers **81** and **82** (Fig. 2), and the admission of steam to tank **26** is controlled by valve wheel **83** (Fig. 2) when it is required in the judgment of the operator. The detail of the water and steam piping is shown in Fig. 6 and will be described more in detail in connection with the description of that figure.

The suction of pump **27** is drawn from the bottom of tank **26** by means of conduit **85**, as shown in Fig. 1, or from the cold or hot water supply lines through conduits **116** and **85**, as will be described more fully hereinafter in connection with the detailed description of Fig. 6. The discharge from pump **27** is directed through conduit **86** to admission chamber **87** located above door **23** and connecting with the interior of container **20** through opening **22** thereof, as shown in detail in Fig. 4.

Referring now particularly to Figs. 2 and 4, it will be noted that door frame **90** is secured to front cover **29**, as by means of bolts **91**. Door frame **90** is provided with a washing fluid annular admission segment **92** formed by annular bar **93** secured to frame **90**. This annulus **92**, conecting with and supplied from admission chamber **87**, is only semi-circular and is open to the washing fluids only around the upper half of the door, this shape thus causing the discharged fluid to describe a pattern of a continuous semi-circular arc over the lower interior half of the lenticularly shaped container **20**. Hinges **95** (Fig. 2) are provided between door frame **90** and door **23**, and a resilient sealing gasket **96** (Fig. 4) is provided between door **23** and frame **90**. One or more door latches **97** are also provided, as shown in Fig. 2, between frame **90** and door **23** to hold the door tightly shut and compressing the resilient gasket **96** when the washing machine is in use. Preferably, my door **23** is formed with a transparent glass **98** held in place between members **99** and **100** but separated therefrom by means of ring gaskets **101** and **102**, respectively. A circumferential sealing member **105** (as shown in Figs. 1, 5 and 6) of tough and resilient material surrounds door frame member **90** and is held tightly thereto by means of an iron band **106** (Figs. 1 and 5). Cooperating apertures are provided in sealing member **105** and ring **106** for the passage therethrough of admission chamber **87**. Sealing member **105** lies quite firmly against the outer face of front half **32** of container **20** and is sufficiently wetted over its area of contact therewith by the washing fluid to prevent appreciable wear. The function of sealing member **105**, is, of course, to seal off the space between container **20** and the door **23**-door frame **90** assembly while providing a comformable and yielding closure therebetween.

In Fig. 6 is shown the detail of the hot and cold water and steam supply piping. Operating levers **81** and **82** (Fig. 2) are respectively connected by suitable linkage (not shown) to conventional metering shut-off valve **110** in the hot water line **111** and similar valve **112** in the cold water line **113**. A butterfly valve **114** is placed at the junction of the cold and hot water lines from valves **110** and **112** and this butterfly valve **114** directs the mixed water either into tank **26** through a line **115** or into suction conduit **85** of pump **27** through line **116**. When the predetermined amount of water has been admitted to tank **26** or to pump **27**, valves **110** and **112** close and operating levers **81** and **82** (Fig. 2) are returned to their "off" position. The admission of steam to tank **26** is controlled by means of valve **117** in the steam admission line **118**, perforated pipe **119** being provided within tank **26** as shown in Figs. 1 and 6 to distribute the steam. As pointed out above, valve wheel **83** (Fig. 2 controls steam valve **117**. A second valve wheel **120'** is also provided on the front of the machine as shown in Fig. 2 and operates butterfly valve **114**. Suitable shut-off valves **121'** and **122'** are also provided in hot and cold lines **111** and **113**, respectively, as indicated diagrammatically in Fig. 6.

In Fig. 6 is also shown in detail the drive mechanism **28** and this will now be described in connection with that figure as well as Figs. 7, 8 and 9. Multiple V-belt pulley **120** (Figs. 1 and 6) is mounted upon shaft **39** for rotating the container **20** at the various speeds required during the separate operations or procedures (washing, rinsing, and extraction) of the complete washing routine. Note particularly in Fig. 1 that the center of the triple V-belt assembly shown is located directly above and over the oscillating point **47** disposed within the center of bearing **40**. The drive mechanism **28** shown in detail in Figs. 6–8, as well as a side view thereof in Fig. 1, is believed new and novel and is particularly adapted for use in this preferred embodiment of my invention. It allows the container **20** to be driven with one set of belting at three separate speeds, i. e., one for washing, a different speed for rinsing, and still a third speed for extracting, without the use of a clutch. Further, this may be accomplished with either one or two motors, the embodiment of Figs. 1–9 utilizing two motors, and an alternative embodiment, shown in Figs. 10–12, utilizing one motor.

As shown in Fig. 1, three V-belts **121** pass over driven pulley **120** on shaft **39**, over a driver pulley **122**, and over a second driver pulley **123**. Driver pulley **122** is mounted on shaft **124** of motor **125**, which is secured to A-shaped frame **56**, as shown in Fig. 6. Pulley **122** is the driver pulley for the extracting cycle and during the washing

and rinsing cycles this pulley merely acts as an idler. Driver pulley **123** is the driver pulley for the washing or slow speed cycle, and still a third driver pulley **126** is provided for the rinsing cycle, driver pulley **126** being adapted to be moved into the position occupied in the showing of Fig. 6 by means presently to be described. As best shown in Fig. 8, driver pulley **123** is mounted on and keyed to shaft **127** with gear **128**, shaft **127** being supported in frame **129**. Gear **128** meshes with gear **130** rotatably mounted in frame leg **131** and driven through a flexible coupling **132** by electric motor **133**, which preferably is equipped with an integral speed reducer **134**. Gear **130** is also in mesh with gear **135**, gears **130** and **135** being of equal size and smaller than gear **128**. Shaft **127**, gear **128**, and driver pulley **123** therefore rotate more slowly than driver pulley **126**.

Frame **129** is mounted on and secured to supporting shaft **138**, which is rotatably supported adjacent one end within frame leg **139** and rotatably supported at its other end within gear **130**, which is journaled in frame leg **131**. Frame **129** is journaled on shaft **138** as shown and may thus be revolved so as to place either driver pulley **123** or driver pulley **126** in engagement with belts **121**, this movement of frame **129** being controlled by means of gear **140** keyed to shaft **138**. Gear segment **141** meshes with gear segment **140**, as best seen in Fig. 7, and is supported at its center by shaft **142**. Shaft **142** is supported in bearing **143** mounted atop plate **144**, which joins frame legs **131** and **139**, as shown in Fig. 8. A pin **145** is secured in gear segment **141** for movement of this gear segment. While not shown, suitable linkage is, of course, provided and connected to pin **145** so that either a manual or mechanical (as by a hydraulic or air piston) force may be applied to rotate gear segment **141** and gear **140** to reverse the positions of driver gears **123** and **126** from that shown in Figs. 7 and 8 when it is desired to proceed from the washing to rinsing cycles, or vice versa.

Pulley **126** is mounted on two anti-friction bearings **150** rotating on shaft **151**. Between bearings **150** is disposed sleeve **153** keyed to shaft **151**, as best shown in Fig. 9. Driver pulley **126** is provided with a uni-directional or over-running drive relative to sleeve **153** by means of the ball, spring, and adjusting machine screw assemblies **154**, each disposed in a slot **155** (Fig. 9). Thus gear **130** (Fig. 8), driven by motor **133**, can drive V-belts **121** through gear **135**, sleeve **153**, driver pulley **126**, and the over-running drive therebetween, and yet pulley **126** can be rotated faster than the speed at which sleeve **153** rotates when desired, as during the extraction cycle presently to be described.

Operation

As pointed out above, the process of laundering or cleaning fabrics or the like is divided into three major operations or stages: washing, rinsing, and extracting. Initially, door **22** is opened and the load of fabrics or the like to be washed placed inside container **20**. Door **22** is then closed, dump valve **73** of tank **26** is closed, and soap and/or detergents in the proper amount for the type and size of the load dumped into tank **26** through chute **80**. Hot and cold water are next added in the proper amount to tank **26** my manipulation of levers **81** and **82** (Fig. 2). If the temperature of the water mixture is lower than that desired, steam may be added by manual operation of valve wheel **83** (Fig. 2). Pump **27** and motor **133** are then started, driver pulley **123** being moved into engagement with V-belts **121**, as shown in Figs. 1 and 6–8, if the drive mechanism **28** is not already in this washing speed position. The soap and/or detergent laden heated water is thus discharged into rotating container **20** by way of conduit **86**, admission chamber **87**, and semi-circular annulus **92** disposed about the upper half of door **22**. This discharge into the container is quite forceful and the fluid is added to the container at a rate faster than it returns to tank **26** by way of orifices **21**, channel **25** and pipe **70**. Tank **26** is preferably but not necessarily dimensioned and initially filled such that when it is emptied the active and desired washing level within the container **20** will have been obtained. Should a higher level of fluid or more supplies appear necessary as viewed through the transparent glass **98** (Fig. 4) of door **22**, additional water or soap and/or detergents may be added to tank **26** in the necessary amount to be pumped for discharge within container **20**. More soap or detergent may be added at any time as desired in the manner described above, thus refortifying the washing solution, and when the initial washing or sudsing operation is ready to be terminated, dump valve **73** (Fig. 3) is opened and the spent material directed to a suitable drain through conduit **74**. If desired, a second sudsing or washing may be provided by thereafter closing dump valve **73** and repeating the operation above described.

At the conclusion of the last desired sudsing or washing operation dump valve **73** is left open, hot water valve lever **81** is operated to open the valve **110** in hot water line **111**, and butterfly valve **114** is set to direct the water into suction conduit **85** of pump **27** through line **116**. At the same time, gear **140** (Figs. 7 and 8) is rotated 180° by suitable movement of pin **145** and gear segment **141**, thus placing driver pulley **126** in engagement with V-belts **121** and driver pulley **123** out of engagement therewith. Container **20** thus now rotates at rinsing speed, which is higher than the sudsing or washing speed and is such that the rinse water entering the washer through semi-circular annular segment **92** is permitted to discharge evenly over the rotating load without being obstructed by falling or tumbling pieces of the load. This speed is determined by the size of the container **20** and is at least equal to the speed at which free pieces of the load falling within a radius sluightly larger than the radius of the liquid admission annular segment **92** may remain discrete until they fall into a space outside the radius stated, whereupon centrifugal force holds them in place against the mass of the load held by centrifugal force against the inside of container **20**. The centrifugal action now forces out the spent rinse or washing water through the orifices **21** ahead of the displacing fresh rinse water and this is continued for a predetermined time until the desired residual concentration of the supplies in the load has been reached. Dump valve **73** is then closed and bleaching and bluing supplies added in the desired amount to tank **26** through chute **80**. Fresh water is admitted to the correct level and the bleaching and bluing are circulated until they have been thoroughly diffused in the load. This latter operation may be effected with the container **20** rotating at either the washing or rinsing speed.

Dump valve **73** is next again opened and motor **125** energized, with driver pulley **126** (Figs. 6–8) still in engagement with V-belts **121**. Motor **125** and pulley **122** driven thereby are proportioned such that when motor **125** is energized container **20** is rotated at a high speed, higher than that at which the container is driven by means of motor **133** driving through pulley **126**. This high-speed operation is possible in spite of driver pulley **126** still being in engagement with the V-belts **121** because of the over-running drive between driver pulley **126** and its enclosed driving sleeve **153** (Figs. 8 and 9), as above described. The high-speed rotation of container **20** is continued until the excess water is removed from the load. In my embodiment operation at this top speed for two or three minutes will reduce the load to approximately 150% of its dry weight. After the desired amount of excess water has been removed, power to high-speed motor **125** is shut off and motor **133**, which has been idling although connected to the power source, again takes up the load and rotates container **20** at the rinsing speed. Gear **140** (Figs. 7 and 8) is next rotated back 180° by means of suitable movement of pin **145** and gear segment **141** to place driver pulley **123** in engagement with V-belts **121** and driver pulley **126** out of engagement therewith. Container **20** is then rotated at this slow washing or sudsing speed for a short time in order to loosen or free the load which has been packed out against the inner periphery of container **20** during the extraction cycle. Motor **133** and pump **27** are then stopped and door **22** opened, whereupon the washing load may be removed.

It is to be noted that since motor **133** is energized continuously even when high-speed motor **125** is placed into operation, no deceleration of speed is possible while shifting over to the high extraction speed. This is important because a deceleration at this point would permit the load placed in its position by centrifugal influence during the rinsing cycle to shift to a position causing unbalance and producing undesirable vibration.

It is also to be noted that because of the relative disposition of driver pulleys **123** and **126** and the construction provided, no deceleration of speed is possible while shifting over from the washing cycle to the rinsing cycle. This feature, however, is not as important.

It will be obvious to those skilled in the art that I

provide a novel laundry machine which is well adapted to be operated in a new and novel manner, as described above, to effect a method of cleansing fabric materials wherein rinsing is achieved by displacement rather than by dilution as in the prior art. The force acting upon each particle of the fabric material being cleansed and also, of course, upon each particle of the cleansing fluid in the container is given by the formula:

$$F=0.00034084WRN^2$$

where

F=centrifugal force in lbs.,
W=weight of the revolving body in lbs.,
R=radius of the circle in which the body revolves, in feet, and
N=revolutions per minute.

As pointed out above, if the centrifugal force is just equal to the weight of the body or, in other words, is at least equal to 1 G (1 gravity), tumbling or falling of the body within the rotating container will be prevented and, assuming that the container is rotated on an horizontal axis, all flow of the contained fluid must be outward from the axis of rotation and this contained fluid will be forced outward through the peripheral orifices with a force of 2 G at the lowermost point of the container. By dimensioning the container relative to the contained load such that all the load lies outside the radius R_1 (at which F=1 G), centrifugal force tends to force out the fluid from the wetted fabric material. Furthermore, when the fresh or rinse fluid is added within the container, it assists in forcing out the spent fluid in the wetted material by displacement. The value for R_1 can, of course, be determined by equating W and F in the above formula, resulting in:

$$1=0.00034084R_1N^2$$

which may be simplified to:

$$R_1=\frac{2933.9}{N^2}$$

While my method of rinsing can be utilized with containers of the various shapes referred to above, it is not as efficacious in those where the cross-sectional area along the outward passage of the fluid is not approximately constant or progressively decreasing, but instead increases from the axis of rotation to the periphery of the container. As pointed out previously, with such a progressive increase of the cross-sectional area of the fluid flow, the desired interfaces will not be as sharply defined or maintained between successive portions of the fluid. This is one of the reasons I prefer to utilize my preferred shape of container, i. e., lenticular or elliptical in cross-section, wherein the shape at least beyond the radius R_1 is such that the adjacent opposed walls extending away from the axis of symmetry converge in such manner as approximately to compensate for the progressive increase in circumference from the symmetrical axis to the periphery of the container. For exact compensation each of the adjacent opposed converging walls would be straight beyond the radius R_1, since the desired constant cross-sectional area is the product of the radius and the separation of the walls. For practical purposes, slight curvature of these walls is provided, giving an elliptical cross-section container and providing some degree of over-compensation. This curvature is increased adjacent the periphery of the container for closing the latter within practical limits.

In Figs. 10–12 is shown an alternative form of three-speed driving mechanism for use with my extractor-washer. This driving mechanism has the advantage that it utilizes only a single motor instead of the two driving motors **125** and **133** of the embodiment just described. Referring now particularly to Fig. 12, which is a developed sectional elevational view, driving gear **160** is keyed to shaft **161** of motor **162**, the latter replacing motor **133**. Gear **160** meshes with gear **163** keyed to shaft **164**, which is rotatably supported in anti-friction bearings **165** mounted in circular disc frame **166** (see Fig. 10). Gear **167** and V-belt pulley **168** are also keyed to shaft **164**, the relative sizes of gears **160** and **163** determining the speed of rotating driving pulley **168** for driving my extractor-washer at the desired high extraction speed. A series of step-down gearing is employed between gear **167** and the next lower speed driving pulley **169**, i. e., the rinsing speed driving pulley. In one particular embodiment, three stages of speed reduction gears were employed as shown, gears **170** and **171** being fixed together and rotating on a common fixed pin shaft **172** secured to frame **166** with gear **170** meshing with gear **167**. Gear **173** and rinsing speed driving pulley **169** are keyed to shaft **174** which is rotatably supported by anti-friction bearings **175** and **176** in circular disc frame **166**. Meshing with gear **173** is gear **177** which is fixed to gear **178**, gears **177** and **178** rotating on fixed pin shaft **179** also secured in disc frame **166**. Idler gear **180** meshing between gears **177** and **178** completes the three-stage speed reduction between driver pulley **168** and driver pulley **169**, and rotates upon fixed pin shaft **181** secured in disc frame **166**. Idler gear **180** is included solely to obtain the proper rotational direction of rinsing driver pulley **169**. A two-stage gear reduction is provided between rinsing driver pulley **169** and the third or washer driver pulley **183**. Gears **184** and **185** are fixed together and rotate on fixed pin shaft **186** secured to disc frame **166**. Gear **184** meshes with gear **173** and gear **185** meshes with gear **187** which is keyed to shaft **188**. The third driver pulley **183** is also keyed to shaft **188**, which is rotatably supported in disc frame **166** by means of anti-friction bearings **189** and **190**.

Referring now particularly to Figs. 10 and 11, it will be seen that this disc frame **166** is provided with a groove or channel **195** around its entire circumference. This groove or channel **195** serves as a means of supporting the frame by means of rollers **196**, four of which are shown in Fig. 10. Each roller **196** is rotatably supported on a shaft **197** which is affixed to frame **198**. A ring gear **200** is secured to disc frame **166** and meshes with pinion **201**. Pinion **201** is mounted upon and keyed to shaft **202** (Figs. 10 and 12) which is supported in turn in bearing **203** (Fig. 12) also affixed to frame **198**. Rotation of shaft **202** causes disc frame **166** to rotate about its geometric center, the three driving pulleys **168**, **169** and **183** thereby also revolving until the desired driver pulley is in engagement with the V-belts **121** and the other two driver pulleys are out of engagement therewith. In Fig. 10 the lowest speed or washer cycle driver pulley **183** is shown in this position, in engagement with belt **121**, driver pulleys **168** and **169** being out of engagement therewith.

To change the speed of movement of belts **121**, shaft **202** is rotated rapidly by any suitable means, which may for example be by a hand crank through suitable gearing or by an electric motor. This rotation of disc frame **166** is preferably done rapidly in order to reduce the time and amount of slippage between the V-belts **121** and the two adjacent pulleys between which the speed change is being effected at any instant.

Note that, as in the two-motor driving mechanism described previously, no deceleration of speed is possible while shifting over from the washing cycle to the rinsing cycle, or from the rinsing cycle to the extraction cycle. This is because of the relative positioning of the driving pulleys **168**, **169** and **183** and the construction provided. Of course, as described previously, it is only in the shift from the rinsing cycle to the extraction cycle that this factor is important in my laundry machine.

While I have described a particular embodiment of my invention as required by the patent statutes, the principles of my invention are of broader application in ways which will be apparent to those skilled in the art. The scope of my invention is defined in the following claims.

What is claimed is:

1. A laundry machine comprising: a symmetrical container mounted for rotation upon a horizontal axis of symmetry thereof and having those adjacent opposed walls thereof extending away from said axis converging toward and abutting in a plane perpendicular to said axis, an opening axially of said container for inserting therein and removing therefrom material to be washed, means for introducing washing fluid to said opening continuously during rotation of the container, orifices in the container along the line of abutment of its opposed walls for permitting the fluid to escape centrifugally from said container continuously during rotation thereof, the orifices being of such restricted size that a substantial volume of fluid may be maintained within the container during rotation as a result of the fluid introduced through the opening.

2. A laundry machine including a container having an axis and walls which are spaced apart from each other

on said axis and extend radially from said axis and towards each other so as to form a peripheral space radially spaced farther from said axis than is the balance of the interior of said container, means for mounting said container for rotation about its said axis, and means for injecting the cleaning liquid into said container, said container having a peripheral series of outlet passages formed therethrough in substantial registration with said peripheral space, and said container otherwise being substantially liquid-tight.

3. A laundry machine including a container having a horizontal axis and dished walls which are spaced apart from each other on said axis and extend radially from said axis and towards each other so as to form a peripheral space radially spaced farther from said axis than is the balance of the interior of said container, said container having an opening through which the material to be laundered may be passed and means for closing said opening, means for mounting said container for rotation about said axis, and means for injecting cleansing liquid into said container, said container having a peripheral series of outlet passages formed therethrough in substantial registration with said peripheral space, and said container otherwise being substantially liquid-tight, said passages being of such restricted size that a substantial volume of fluid may be retained within the container during the rotation thereof as a result of the fluid introduced to the container.

4. The laundry machine of claim 2 wherein the container is of substantially elliptical cross section.

5. A laundry machine including a container having an axis and walls which are spaced apart from each other on said axis and extend radially from said axis and towards each other so as to form a peripheral space radially spaced farther from said axis than is the balance of the interior of said container, said container having an opening through which the material to be laundered may be passed and means for closing said opening, means for mounting said container for rotation about its said axis, a tank for cleansing liquid, said container being arranged exteriorly of said tank, and means for injecting liquid from said tank into said container, said container having a peripheral series of outlet passages formed therethrough in substantial registration with said peripheral space and said container otherwise being substantially liquid-tight, and said passages being of such restricted size that a substantial volume of fluid may be contained within the container during the rotation thereof as a result of the fluid introduced into said container.

6. A laundry machine including a substantially lenticular container having an axis and walls which are spaced apart from each other on said axis and extend radially from said axis and towards each other without increase in the cross-sectional area of the container in the direction outwardly from the axis thereof so as to form a peripheral space radially spaced farther from said axis than is the balance of the interior of said container, said container having an opening through which the material to be laundered may be passed and means for closing said opening, means for mounting said container for rotation about said axis, and means for injecting cleansing liquid into said container, said container having a peripheral series of outlet passages therethrough in substantial registration with said peripheral space and said container otherwise being substantially liquid-tight.

7. A laundry machine including a substantially lenticular container having an axis and walls which are spaced apart from each other on said axis and extend radially from said axis and towards each other without increase in the cross-sectional area of the container in the direction outwardly from the axis thereof so as to form peripheral space radially spaced farther from said axis than is the balance of the interior of said container, said container having an opening through which the material to be laundered may be passed and means for closing said opening, means for mounting said container for rotation about said axis, and means for injecting cleansing liquid into said container, said container having a peripheral series of outlet passages therethrough in substantial registration with said peripheral space, said container otherwise being substantially liquid-tight, and means for rotating said container at a relatively low speed during cleansing periods, at a higher speed during rinsing periods to force the spent rinse and cleansing fluid from the material by displacement by fresh rinse water, and at a still higher speed during fluid extracting periods.

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