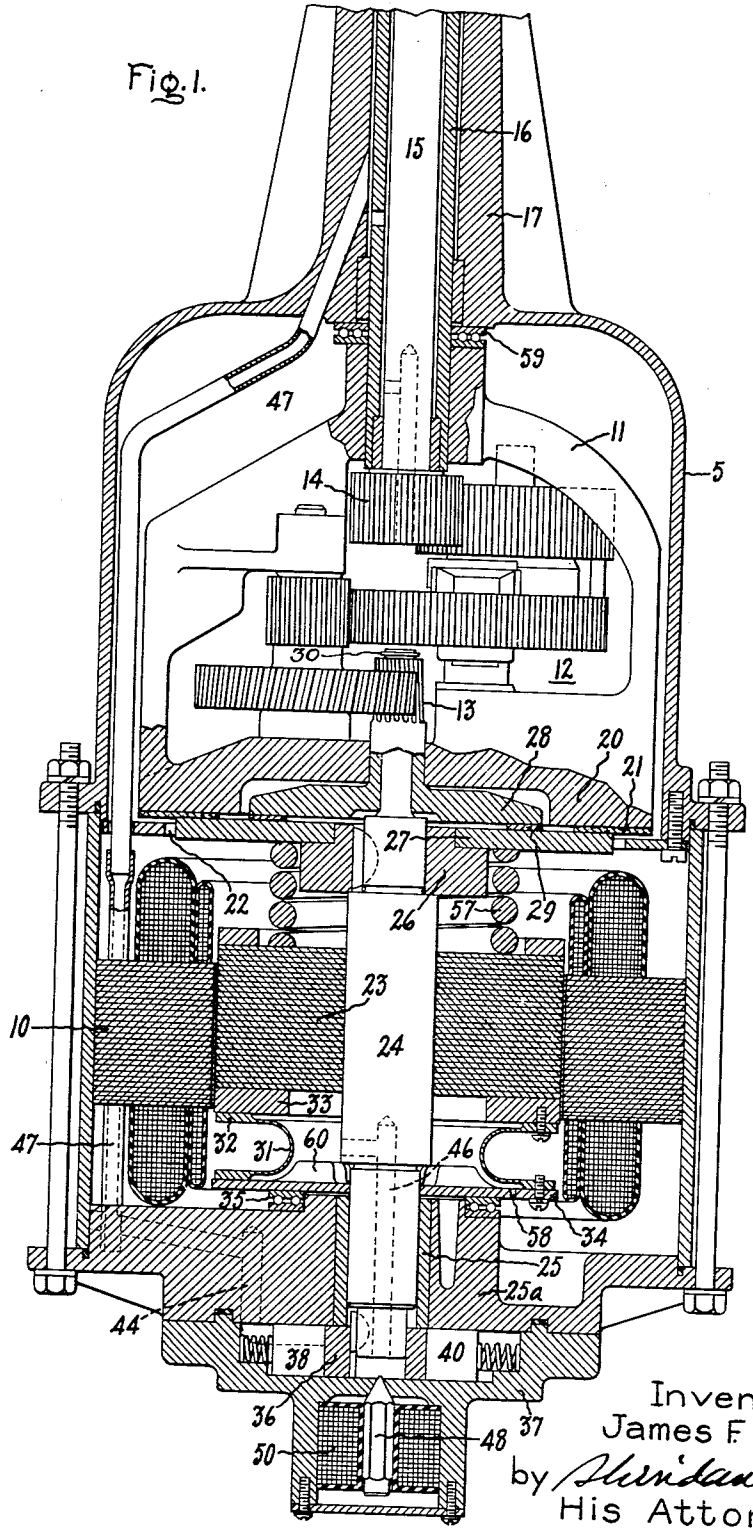
Oct. 18, 1955 J. F. YOUNG 2,720,955

CENTRIFUGALLY OPERATED CLUTCH FOR WASHING MACHINES

Filed Oct. 31, 1950

2 Sheets-Sheet 1

Fig. 1.



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2 Sheets-Sheet 2

Fig. 5.

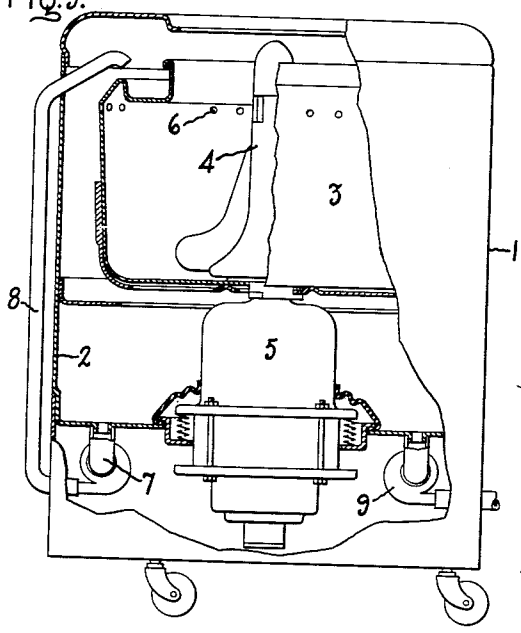


Fig. 4.

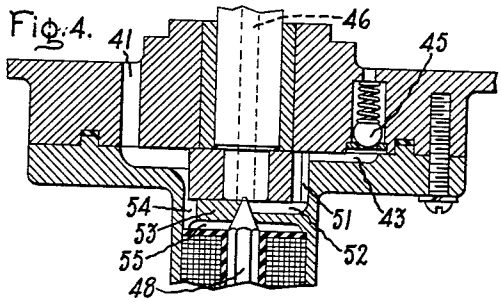


Fig. 3.

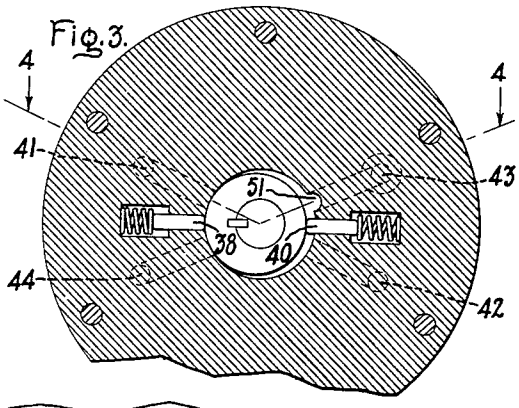
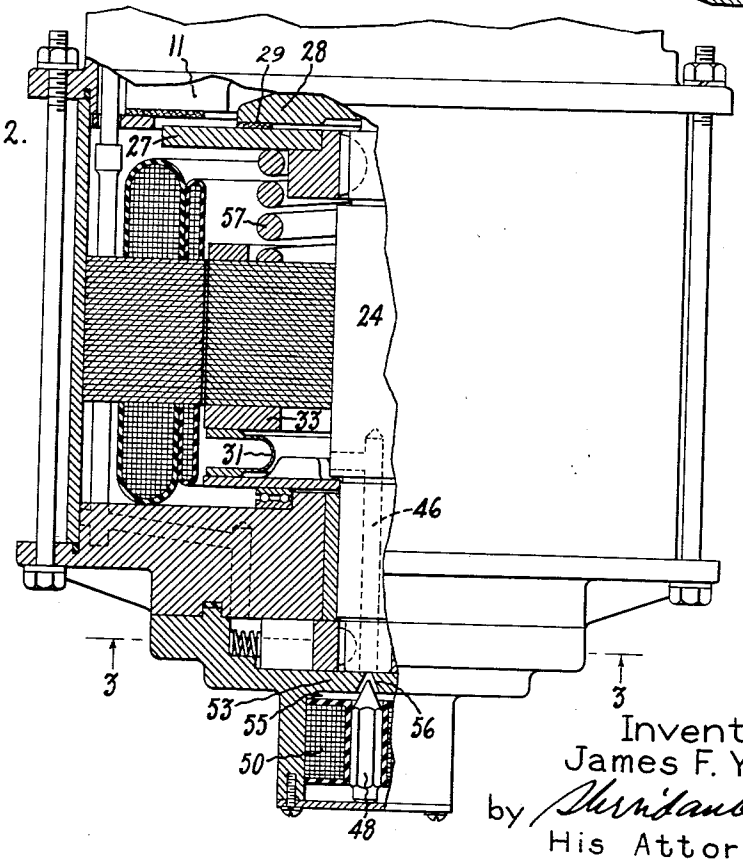


Fig. 2.



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2,720,955

CENTRIFUGALLY OPERATED CLUTCH FOR WASHING MACHINES

James F. Young, Erie, Pa., assignor to General Electric Company, a corporation of New York

Application October 31, 1950, Serial No. 193,143

5 Claims. (Cl. 192—18)

This invention relates to mechanisms for driving selectively either of two shafts from a common driving shaft, and has for a particular object the provision of a simplified hydraulic system for operating a clutch mechanism which transfers the application of power from one to the other of the driven shafts.

Although my invention is not limited to any one type of mechanism, it relates particularly to the driving mechanism of washing machines of the type in which washing is performed in a basket which is then rotated to extract centrifugally the water from the clothes. Such machines and driving mechanisms therefor are shown in McNairy United States Patent No. 2,485,621 granted October 25, 1949, for Washing Machine, and assigned to the assignee of this application. The basket or receptacle in which the clothes are washed is provided with a coaxial agitator which, when oscillated, flexes the clothes and imparts certain washing liquid movements which effect a turnover and movement of the clothes within the basket. During such operation the basket is held stationary. The gearing for operating the agitator is contained within a gear frame rotatably mounted in the main drive mechanism casing. The gear frame provides the rotatable mounting for the basket itself and during the washing period the weight of the basket and its contents urges an element of the gear frame into contact with a brake fixed within the drive casing. When the basket is to be spun for centrifugal extraction of the liquid content thereof the gear frame is lifted and motor power applied directly thereto by friction clutch means. Thus the gear frame and the basket carried thereby may be rotated rapidly— either at motor speed or at a suitable reduction thereof according to whether reduction gearing or equivalent is interposed between the drive motor and the driving element of the clutch. In the McNairy mechanism above referred to the displacement of the gear frame relative to its brake element is accomplished by an expansion bellows in a hydraulic system which includes a pump continuously driven by the motor and serving an oil distribution system controlled by a valve which during the washing operation circulates oil through the mechanism at relatively low lubrication pressure and during the spin operation directs oil under substantial pressure to the bellows for expansion and accompanying movement of the gear frame from its braked to its driving status. A disadvantage of clutch shift mechanisms of the McNairy type resides in the fact that unless means are provided to bleed oil from the bellows the motor may at the initial stages of spin be severely overloaded. Accordingly it has been necessary to apply various pressure relief mechanisms to provide for clutch slippage during the initial portion of the spin cycle. In addition the high oil pressure required to expand the bellows against the load imposed thereon by the basket and its clothes and water load—which may be of the order of 225 pounds or more—requires a pump capable of such pressure generation.

It is an object of my invention to provide a hydraulic clutch shifting system which is simple and direct in operation and which provides continuous overload protection without the use of bleeder valves or the like.

It is a further object of my invention to provide a hydraulic clutch shifting mechanism in which the hydraulic pressure required for the shift operation is provided by centrifugal forces acting on a quantity of oil within a bellows rotating at motor speed.

It is a further object of my invention to provide a hydraulic clutch actuating system of the expansion bellows type in which the oil pumping requirements are only those incident to supplying the bellows with oil to meet the volumetric increase as the bellows expands and to carry out the normal lubrication function.

In a presently preferred embodiment of my invention I affix an expansible bellows directly to the underside of the motor rotor and provide thrust bearing means enabling the end wall of the bellows remote from the rotor to bear against a fixed frame element. The end of the rotor shaft opposite the bellows is provided with a clutch plate which cooperates with a complementary clutch member provided on a drive shaft pinion and a clutch member provided on the base of the rotatably mounted gear frame. A suitable pump drawing continuously on a reservoir of lubricating oil within the motor casing is directly connected to the motor so as always to be in pumping operation. A solenoid control valve of conventional pattern occupies a position when deenergized to effect lubricating oil circulation and when energized to direct oil to the interior of the expansion bellows. The solenoid valve is deenergized during the washing cycle of the machine and the relative clutch parts are arranged so that the rotor is clutched to the main drive pinion of the gearing which effects the oscillation of the agitator. In that condition the clutch facing of the gear frame structure rests upon the brake and the gear frame is held against rotation.

In the spin cycle the oil fed to the interior of the bellows is subjected to centrifugal force causing the bellows to expand and shift the rotor and its driving clutch plate axially toward the gear frame whereupon the friction surface of the gear frame clutch plate is engaged by the rotor clutch plate and the frame is lifted from the brake surface and begins to rotate. The imposition of an overload will result in an immediate reduction in motor speed and reduction in the centrifugal force acting on the oil content of the bellows. The immediate reduction in the expansion pressure acting on the bellows will provide a clutch slip factor immediately effective to reduce the motor load. A feature of my invention therefore resides in the inherent ability of the clutch shift mechanism to accommodate motor overload conditions before abnormal strain is imposed on the drive mechanism.

Other features and advantages of the invention will be apparent from the following detailed description of a presently preferred embodiment thereof read in the light of the accompanying drawings in which Fig. 1 is a vertical sectional elevation of a drive mechanism embodying the invention, the bellows being in its expanded position; Fig. 2 is a partial sectional elevation of the lower portion of the mechanism of Fig. 1 showing the relation of parts when the bellows is in a collapsed position corresponding to the operation in the wash cycle of the machine; Fig. 3 is a plan section taken on lines 3—3 of Fig. 2 to illustrate more clearly the structural arrangement of the oil pump; Fig. 4 is a sectional elevation looking in the direction of the arrows 4—4 of Fig. 3 to show an oil return passage to the pump and the relay valve in the oil pressure system; and Fig. 5 is a side elevation with portions broken away of a single basket washing machine in connection with which I have chosen to illustrate my invention.

Referring to Fig. 5, the washing machine 1 with which I have chosen to illustrate my invention, has a casing section providing a tub or water collector 2, and a

basket 3 mounted for rotation within the tub. Within the basket is a washing device 4; for example, a bladed agitator which oscillates within the stationary basket during the washing operation. The basket is rotatably mounted by bearing means within a main drive mechanism casing 5 resiliently supported on the bottom wall of tub 2, as is shown somewhat schematically. The basket is imperforate except for a row of openings 6 at the maximum diameter. Water or washing liquid is introduced into tub 2 from a suitable spout means (not shown) under the control of a conventional program switch. A program switch and controls for carrying out a desired sequence of operations are old and well known in the washing machine art and have not been illustrated. The liquid is transferred by pump 7 and conduit 8 to the basket. In some machines washing liquid overflows the basket and returns to the tub from which it is pumped again into the basket in a continuously circulating system designed to filter out lint, soap curds and the like during the washing operation. The liquid is centrifugally extracted from the clothes at the end of the wash cycle by rotating the basket rapidly, discharging the liquid through the openings 6 in the basket 3. The spent liquid which is collected in the tub 2 is pumped to a plumbing drain by a conventional pump 9. The basket is then supplied with suitable quantities of clear water for rinsing, and after a desired period of operation of the agitator 4, the rinse water is centrifugally extracted by again rotating the basket. During the washing and the agitator-rinse cycles, the basket is held against rotation; during centrifugal extraction, the agitator rotates with the basket.

In the drive mechanism shown in Fig. 1, it is noted that casing 5 has in its lower part a motor 10, preferably of the induction type, coaxially arranged beneath a gear frame 11. The gear frame 11 mounts a gear system 12 of known type in which a drive pinion 13 effects an oscillation of a gear 14 on the lower end of a shaft 15 which carries the agitator 4. Shaft 15 is independently rotatable within a tubular shaft 16 which in turn is journaled within a long hub portion 17 of the gear casing 5. It will be understood that suitable bearing means are provided for the respective shafts. To shaft 16 is affixed a suitable collar (not shown) which carries the basket 3. The arrangement by which the basket and agitator are affixed to their respective shafts for rotation is disclosed in the aforementioned McNairy Patent 2,485,621.

It will be understood that frame 11 is fixed to shaft 16; therefore, to rotate the shaft and its thereon carried basket, the entire gear frame is rotated. Also it will be observed that, in order effectively to oscillate gear 14 and its shaft 15, gear frame 11 must be held stationary so as to prevent the reaction of the gear system from urging the frame 11 into rotation. Consequently, I provide a brake system for holding the frame stationary during the washing cycle. Advantageously, the gear frame 11 is formed with a circular base 20, the face of which is treated to have the desired coefficient of friction. For example, I apply a facing 21 of a conventional clutch facing material. A brake plate 22 fixed within the casing 5 cooperates with the facing 21. Shaft 16 is axially movable within its supporting bearings, and during the washing operation in which the basket may contain as much as twelve to fourteen gallons of water and nine pounds of clothes, there is an effective load on the brake plate 22—taking into consideration the weight of the basket structure—of about 250 pounds. When the basket is to be spun, the gear frame 11 is lifted from the brake plate 22 by a motor driven element which serves as a clutch plate for transmitting motor torque to the gear frame as presently described.

The mechanism optionally applying motor power to the drive pinion 13 or gear frame 11 includes the improved hydraulic system embodying the present invention. Rotor 23 of the motor is affixed to motor shaft 24 journaled in a bearing 25 provided in a lower plate member 25*a* forming the base of the casing 5. Shaft 24 is axially slidable in said bearing. At its upper end, shaft 24 carries a collar 26 non-rotatably secured to which is a clutch drive plate 27. The driving relation between shaft 24 and collar 26 is such as to permit relative axial movement therebetween; suitable keying will permit such axial movement and effect transfer of motor power. The shaft 24, extending slidably through the collar 26, carries on its upper end a flat circular clutch disk 28 on the underside of which may be provided an annular collar 29 of clutch facing material. Extending upwardly from the disk 28 is a cylindrically bored hub member on the upper end of which the pinion 13 is formed or applied, and through which extends a pilot end of the shaft 24. A thrust washer 30 on the pilot end of the shaft 24 is provided to limit the upward movement of the disk 28 relative to the shaft 24.

It will be seen from a comparison of Figs. 1 and 2 that, while drive plate 27 maintains contact with clutch facing 29 at all times, it engages with the facing 21 only when shaft 24 and its drive plate 27 have been moved upwardly relative to gear frame 11. The lift for the shaft 24 to bring plate 27 into engagement with facing 21 and then to lift the gear frame and its basket and clothes load is provided by a suitable expansible member such as the bellows 31 rotatable with the motor shaft and arranged to be supplied with liquid from a reservoir of lubricating oil so that the centrifugal force generated within the bellows by the rapidly rotating oil contained therein will expand the bellows in an axial direction. A relatively heavy gauge nylon bellows will provide suitable structural characteristics though a metal diaphragm can be used as the expansible member. Preferably, I dispose the bellows 31 immediately beneath the rotor 23 and affix end flange 32 of the bellows directly to a rotor plate 33. The opposite bellows end flange is secured to a plate 34 fixed on shaft 24 in fluid tight relation therewith. Plate 34 is carried on a suitable thrust bearing 35 on the casing rod plate 25*a*. For supplying the bellows with oil and for oil circulation for general lubrication purposes, I employ a suitable pump drawing on a reservoir of lubricating oil with which the case is permanently supplied. The demands on the pump are moderate and relatively simple; conventional pump devices may be used. Purely as an example, I have shown a common eccentric pump in which a pump rotor 36 is keyed to the lower end of shaft 24 for operation within a pump chamber provided by an end cap 37 fixed to the plate 25*a*. The usual spring biased plates 38 and 40 are suitably disposed within the end cap as appears in Fig. 3. It will be understood that the driving relationship between shaft 24 and pump eccentric 36 permits axial movement of the shaft relative to the eccentric; the latter is confined against such axial movement by the upper and lower walls of the pump chamber. The charge of lubricating oil (not shown) on which the pump draws, occupies the casing to a level submerging the lower end of the stator windings. The pump casing as shown in Fig. 3 has two inlets 41 and 42 and two outlets 43 and 44. The first named outlet serves a relief valve 45 of any suitable pattern and loading. It will be noted that shaft 24 has a central bore 46, a lateral branch of which communicates with the interior of the bellows 31. Outlet 44 communicates with a lubricating duct system 47 which conveys the oil to various bearings and rotating elements as is well understood in the art.

During the washing cycle bellows 31 is in the collapsed position, indicated in Fig. 2, whereas, during the spin cycle the bellows is supplied with oil substantially to the full capacity thereof. This requires not only that the collapsed bellows be filled immediately, but that oil be continuously available at the bellows to make up for the expansion of the bellows under the centrifugal force of the oil contained therein. This phase of operation is controlled by a plunger valve 48 operated by a solenoid coil

50 under control of the program switch previously noted. Figures 2, 3, and 4 illustrate to best advantage the oil flow paths as dictated by the operative position of plunger valve 48. Fig. 3 shows a discharge passage 51 provided in the wall of the pump chamber. This passage, which may advantageously comprise a slot cut in the wall of the chamber, communicates with a passage 52 (Fig. 4) formed in a web 53 providing the base of the pump chamber. Said web has a port 54 communicating between the inlet passage 41 and a passage 55 below the web. A valve seat 56 is provided in the web and extends therethrough to define a connecting passage between the passage 55 and the central bore 46 in the shaft 24. With the solenoid deenergized, which is its status during the cycles when the basket is to remain stationary, the oil discharging along groove 51 will be held at low pressure because of the passage afforded by channel 52, the valve seat 56, and passages 54 and 55 to the inlet or return system of the pump. However, oil will also be pumped through duct 44 to supply the lubrication circulation conduit 47. Bellows 31 will therefore not be supplied with oil in adequate volume to fill it. A spring 57 confined between the driving plate 27 and the top of the rotor stack has driven the plate 27 upwardly against the clutch face 29 of the agitator clutch disk 28, moving the disk 28 upwardly until its upper hub portion has engaged the thrust washer 30 on the shaft 24. The reaction of the spring 57 is borne by the top portion of the rotor fixed on the shaft 24. With the bellows 31 collapsed, as shown in Fig. 2, the lower end of the shaft 24 has engaged the web 53 which functions therefore as a thrust bearing. In this position, as shown in Fig. 2, the bellows is collapsed, sufficient oil having bled therefrom through a small port 58 in the plate 34. The motor 10 is driving the disk 28 through its resilient engagement with the drive plate 27 and the pinion 13 on the disk 28 is transmitting the motor torque through the gear train 12 to oscillate the pinion 14 and to agitate shaft 15.

When the agitation cycle has been completed and centrifugal extraction of the washing liquid is desired, solenoid 50 is energized so as to drive valve 48 upwardly into seated position as shown in Figs. 1 and 4. In such position the recirculation of the oil to the inlet part of the valve chamber is blocked and the oil will pass through groove 51 and channel 52 to enter the passage 46 and eventually discharge into the bellows 31. The capacity of passage 46 is so much greater than the drainage capacity of port 58 that the bellows 31 is almost immediately filled with lubricating oil. The motor is, of course, in operation and centrifugal forces are created within the oil body sufficient to expand the bellows 31 to lift shaft 24 relative to collar 26 so as to engage with the underside of said collar, as best shown by comparison of Figures 1 and 2. The further rise of shaft 24 moves collar 26 upwardly to force clutch plate 27 into engagement with the facing 21. The thrust washer 30 has moved upwardly with the shaft 24 permitting the disk 28 also to move upwardly under the bias of the spring 57. The spring 57 has not freely expanded as the shaft 24 moved upwardly because it has carried the initial thrust tending to lift the gear frame and its load off the brake plate 22. Thus the shaft 24 and the thrust washer 30 have moved upwardly a greater distance than the clutch plate 27 as is evident from a comparison of Figs. 1 and 2. Therefore, the disk 28 is no longer held against the plate 27 by the spring 57 but instead is resting lightly on the plate 27 out of driving engagement therewith. This disengagement of the agitator during the initial stage of the spin cycle is necessary to prevent relative motion between the agitator and the spin basket during acceleration of the latter as such relative motion is a cause for tearing of the clothes being washed. A still further rise of shaft 24 causes the plate 27 to lift the gear frame 11 and its load off the brake plate 22 within limits defined by a thrust bearing 59 immediately above the end hub of the gear frame 11. The motor is then directly connected to frame 11 and the frame, agitator and basket will commence to rotate as a unit. In order to limit angular velocity gradients in the oil within the bellows and thus to reduce oil power losses, I provide a suitable plurality of radially extending vanes 60 on the base plate 34 of the bellows.

Calculations indicate that with the bellows full of oil:

$$P=\frac{pr^2w^2}{2\ g}$$

where

P=pressure, lb./in.^{2}
p=density of oil, lb./in.^{3}
g=gravity acceleration, in./sec.^{2}
r=radius, inches
w=angular velocity, rad./sec.

Integrating this pressure over the area indicates a bellows radius of 4.25" at motor speed of 1100 R. P. M. to exert a lift of 250 lbs. Actually, additional forces are required and on the basis that force varies as the fourth power of the radius a 4½" radius will provide about 62½ lbs. for extending the bellows plus 250 lbs. for applying clutch torque.

The self-expanding bellows makes it feasible to utilize a low-cost centrifugal pump instead of a higher cost positive displacement pump. The required pump pressure is only that required to circulate oil for lubrication.

The bellows inherently provides motor overload protection. The clutch torque depends upon the coefficient of friction and the clutch force. When the torque is too large the induction motor will slip to lower speed. This reduces the centrifugal force acting on the bellows to extend it for applying clutch torque so that the motor torque is quickly and materially reduced. Consequently, the overload is lessened and the motor will regain speed. To best insure overload protection, a motor with a relatively high resistance rotor should be employed because of its high slippage characteristic under overload conditions.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made; and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A torque transmitting mechanism of the type having a driving shaft coaxial with and adapted to be selectively coupled to one of a pair of coaxial driven members comprising, a clutch disk rotated by said driving shaft and movable with said shaft in an axial direction, means normally biasing said clutch disk into engagement with the first of said driven members, liquid impervious means secured to said driving shaft, a plate slidable on said driving shaft with a flexible and radially inwardly bowed corrugation interconnecting said plate and said liquid impervious means in a liquid-tight manner, means forming a fixed bearing for said plate, means for selectively supplying liquid to and draining liquid from the enclosed space between said plate and liquid impervious means, and means for imparting rotary motion to liquid between said plate and liquid impervious means whereby centrifugal force acting on the liquid forces said plate and liquid impervious means apart thereby to move said shaft axially and engage said clutch disk with the second of said driven members.

2. In a combined clutch and brake mechanism, a driving shaft having a clutch disk thereon, said shaft and disk being rotatable and movable axially, a rotatably driven member journaled for operative engagement with said

driving shaft clutch disk when said shaft is in one of its axial positions, a brake member cooperable with said driven member to restrain rotation thereof, means biasing said driving shaft and disk to an axial position out of engagement with said driven member, means biasing said driven member into engagement with said brake, a plate on said driving shaft slidable axially with respect thereto, a fixed thrust bearing for said slidable plate, an inwardly bowed annular and flexible corrugation connected to said plate, closure means secured to said corrugation thereby defining an enclosed expansible member, means for supplying and draining liquid from the space between said plate and said closure means, and means imparting rotary motion to liquid contained within said expansible member as said driving shaft is rotated, thereby to develop through centrifugal force on the contained liquid an axial force on said driving shaft to engage said driven member with said driving disk and to disengage said driven member from said brake.

3. In a clutch mechanism of the type having a driving shaft and clutch disk movable axially for engagement with a driven member, power means for moving said shaft axially comprising means for rotating said driving shaft, a closure member fixed to said shaft, a disk axially slidable on said shaft, a flexible and radially inwardly bowed corrugation interconnecting said disk and said closure member thereby to define an expansible member, a thrust bearing for said slidable disk to prevent axial movement thereof and force movement of said shaft on expansion of said expansible member, means supplying liquid to the enclosed space within said expansible member, an aperture through one of the elements defining said expansible member for draining liquid therefrom at a maximum rate less than the liquid supply rate, and means for impelling liquid contained within said expansible member whereby the centrifugal force acting on said liquid provides an axial force tending to separate said disk and said closure member.

4. In a washing machine of the type including a driving shaft, a first driven shaft, a second driven shaft concentrically mounted therein; a driven mechanism operable selectively to drive one of said two driven shafts, said mechanism comprising clutch means including a first clutch member secured to said first driven shaft, a second clutch member connected to said second driven shaft, a brake member fixed relative to said first clutch member for cooperation therewith, biasing means biasing said first clutch member into engagement with said brake member to restrain rotation of said first driven shaft, a drive member carried by and secured to said driving shaft engageable with said first and second clutch members to transmit torque thereto, resilient means biasing said drive member and said second clutch member into engagement to drive said second driven shaft; the improvement in

means for shifting said drive member relative to said first clutch member for drivingly engaging the same and moving it out of engagement with said brake member to rotate said first driven shaft comprising a radially expansible bellows fixed to said driving shaft for rotation therewith, said expansible bellows having an end closure secured to said driving shaft and movable toward said first clutch member in response to expansion of said expansible bellows, pump means for supplying liquid to the interior of said expansible bellows whereby the centrifugal forces acting on the contained liquid effect an expansion of said expansible bellows axially to shift said driving shaft and said drive member, and valve means controlling the flow of liquid from said pump to said bellows.

5. In a washing machine of the type including a driving shaft, a first driven shaft, a second driven shaft concentrically mounted therein, a drive mechanism for rotating selectively one of said driven shafts, comprising clutch means including a first clutch member secured to said first driven shaft, a second clutch member connected to said second driven shaft, a brake member fixed relative to said first clutch member for cooperation therewith, biasing means biasing said first clutch member into engagement with said brake member to restrain rotation of said first driven shaft, a drive member carried by and secured to said driving shaft engageable with said first and second clutch members for transmitting motor torque thereto, resilient means effecting driving engagement between said drive member and said second clutch member thereby rotating said second driven shaft; the improvement in means for shifting said drive member relative to said first clutch member to drivingly engage the same and to move said first clutch member out of engagement with said brake member and to release said resilient means, comprising an expansible bellows including end closure means fixed to said driving shaft for rotation therewith, a pump, and a passage way in the driving shaft communicating between said pump and said bellows for supplying liquid to the interior of said bellows whereby the centrifugal forces acting on the liquid therein effects an expansion of said expansible bellows axially to shift said driving shaft and said drive member.

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