Aug. 7, 1956 W. L. FOX 2,757,531

WASHING MACHINE

Filed Nov. 22, 1952 6 Sheets-Sheet 1

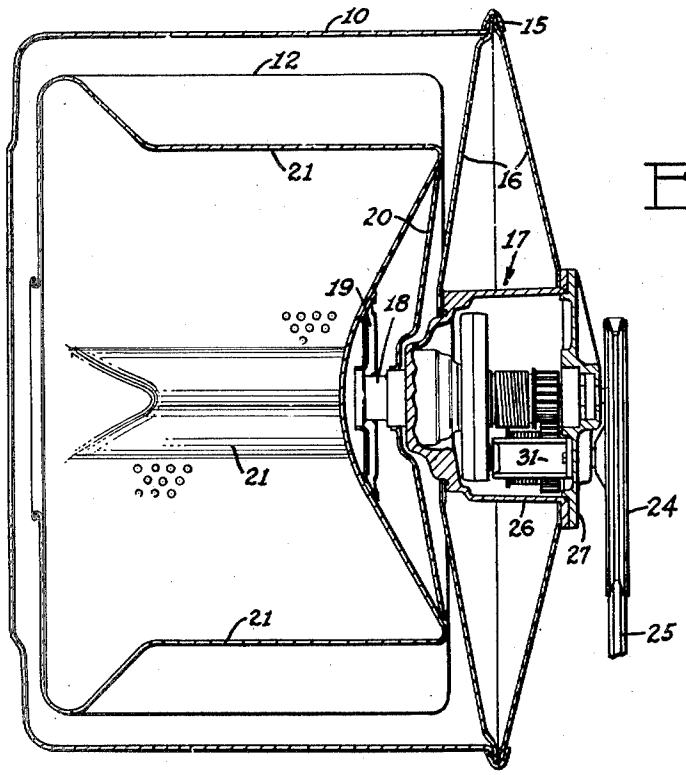


Fig. 2.

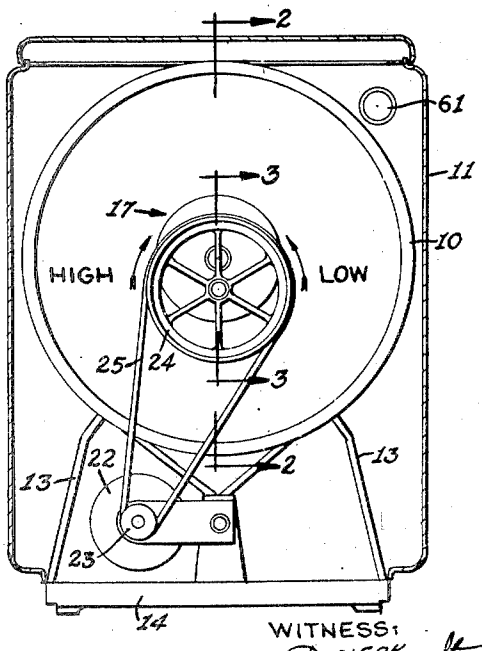


Fig. 1.

WITNESS:
D. W. Vanstory

INVENTOR.
WILLIAM L. FOX
BY
ATTORNEY.

Aug. 7, 1956 W. L. FOX 2,757,531

WASHING MACHINE

Filed Nov. 22, 1952 6 Sheets-Sheet 2

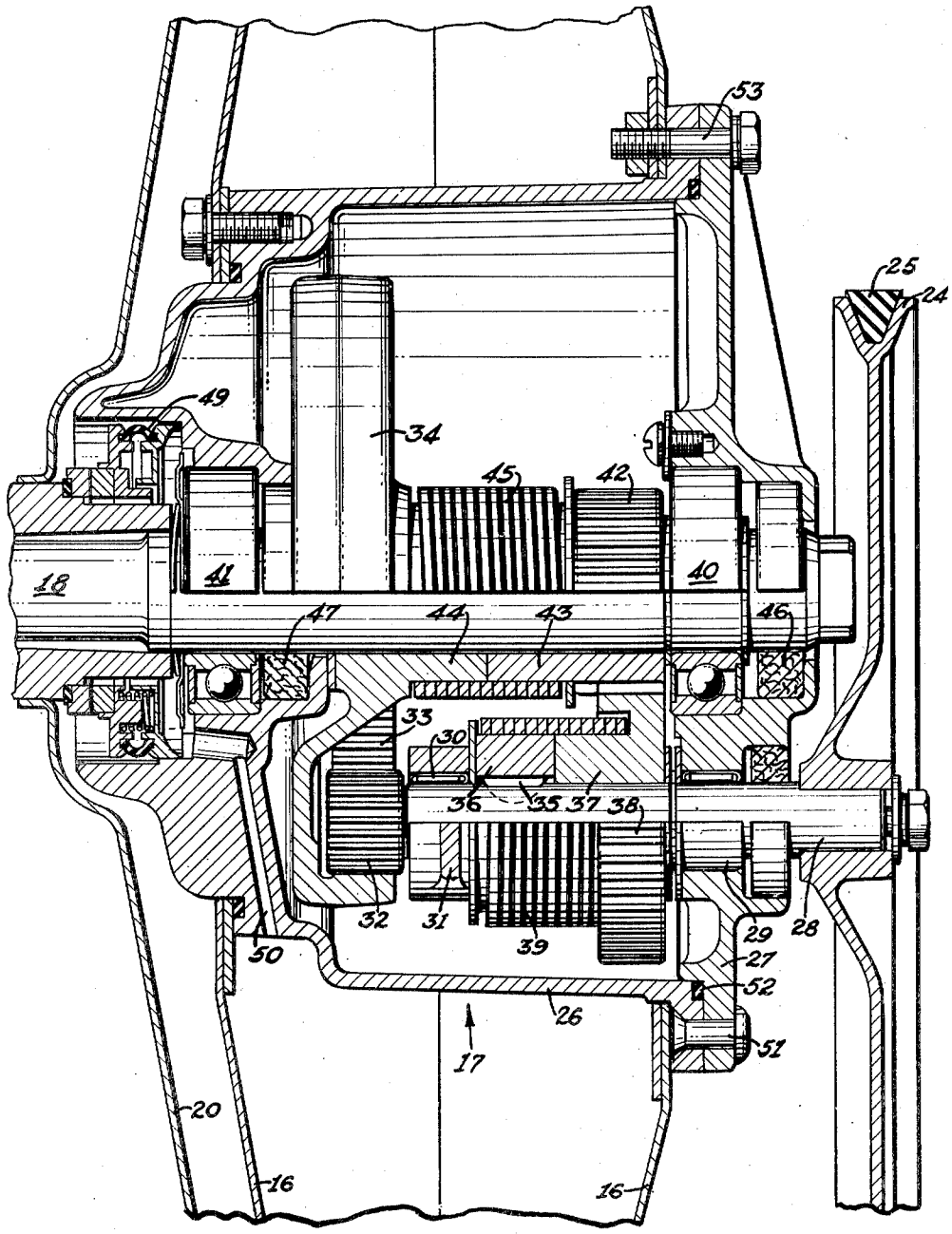


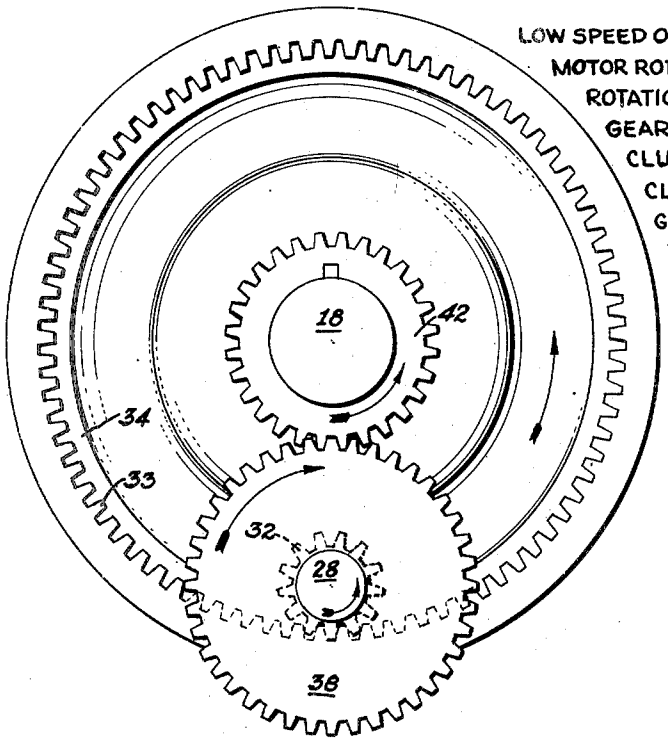
Fig. 3.

INVENTOR.
WILLIAM L. FOX
BY
ATTORNEY.

WITNESS:
D. W. Van Story

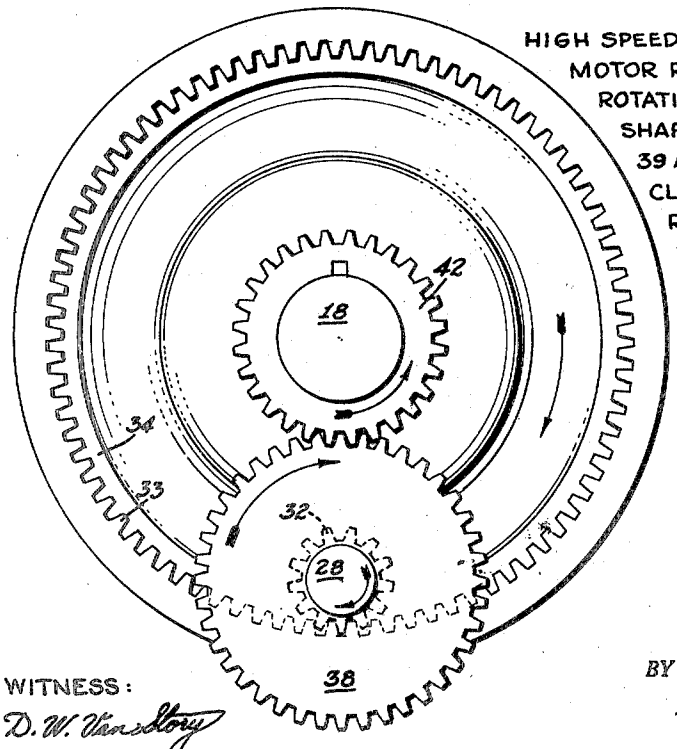
WASHING MACHINE

Filed Nov. 22, 1952 6 Sheets-Sheet 3



LOW SPEED OF CYLINDER SHAFT 18. MOTOR ROTATES COUNTERCLOCKWISE. ROTATION OF PINION 32 AND RING-GEAR 34 DRIVES SHAFT 18 THRU CLUTCH SPRING 45 (FIG. 3). CLUTCH 39 DISENGAGED. GEAR 38 FREE-WHEELS WITH SHAFT 28.

Fig. 4.



HIGH SPEED OF CYLINDER SHAFT 18. MOTOR ROTATES CLOCKWISE. ROTATION OF SHAFT 28 DRIVES SHAFT 18 THRU CLUTCH SPRING 39 AND GEARS 38,42. CLUTCH 45 DISENGAGED. RING-GEAR 34 FREE-WHEELS WITH SHAFT 18.

Fig. 5.

WITNESS:
D. W. Vanstory

INVENTOR.
WILLIAM L. FOX
BY
ATTORNEY.

Aug. 7, 1956 W. L. FOX 2,757,531

WASHING MACHINE

Filed Nov. 22, 1952 6 Sheets-Sheet 4

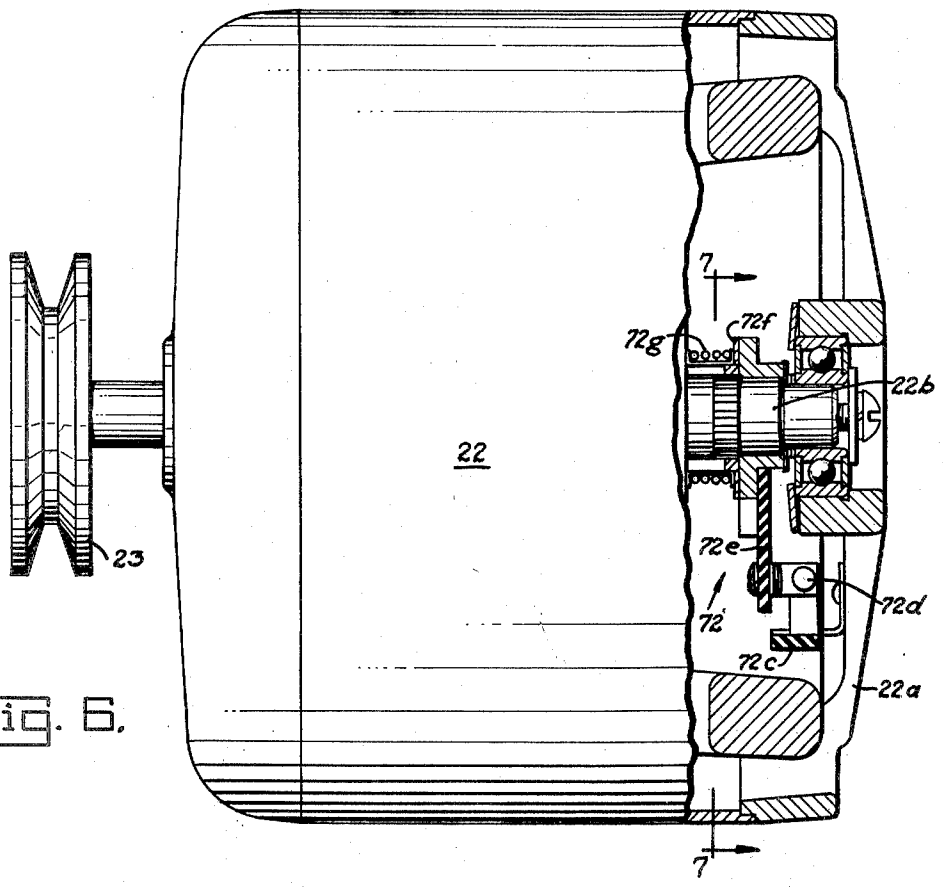


Fig. 6.

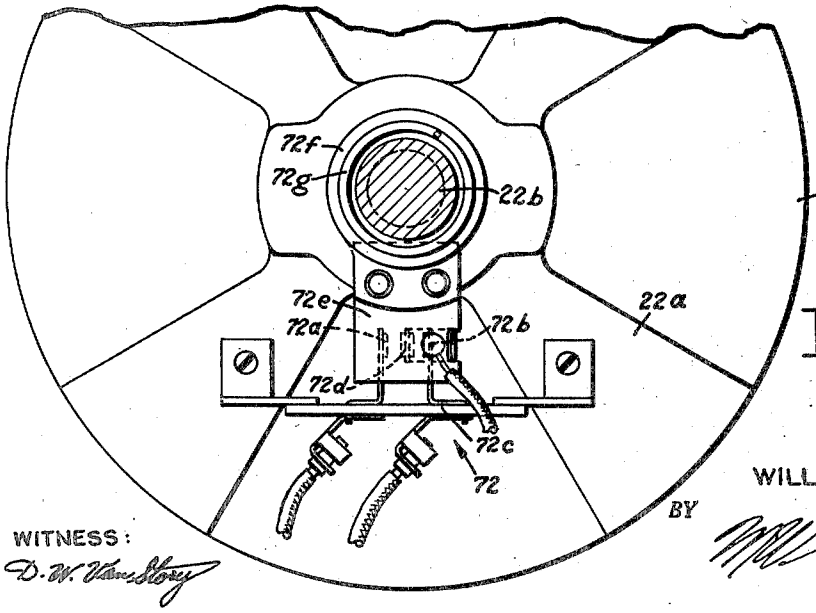


Fig. 7.

INVENTOR.
WILLIAM L. FOX
BY
ATTORNEY.

WITNESS:
D. W. Van Story

Aug. 7, 1956 W. L. FOX 2,757,531

WASHING MACHINE

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Fig. 8.

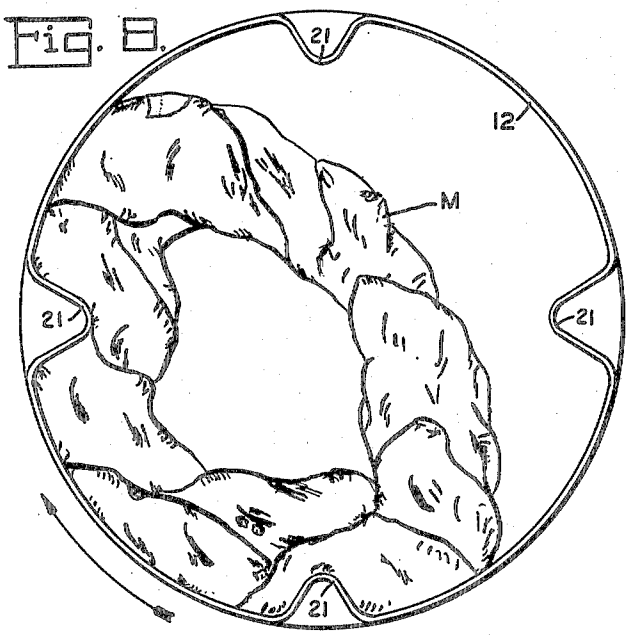
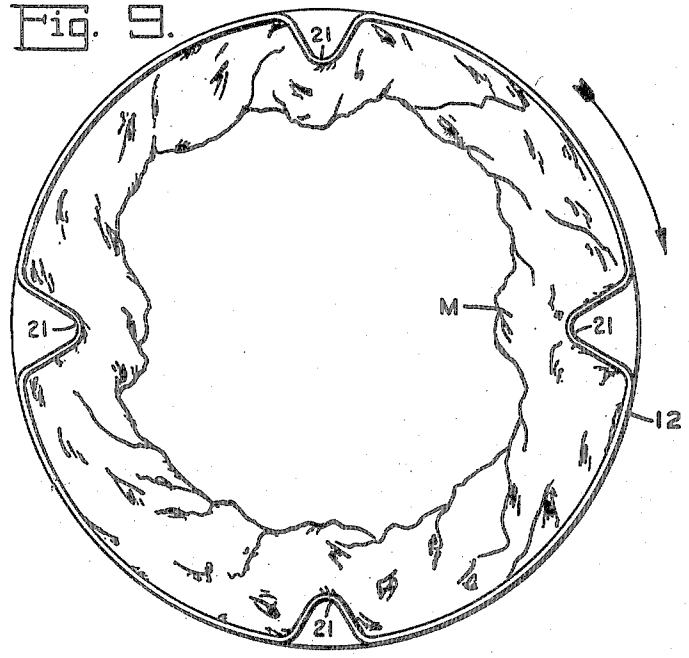


Fig. 9.



INVENTOR.
WILLIAM L. FOX
BY
ATTORNEY.

WITNESS:
D. W. Landry

Aug. 7, 1956 W. L. FOX 2,757,531

WASHING MACHINE

Filed Nov. 22, 1952 6 Sheets-Sheet 6

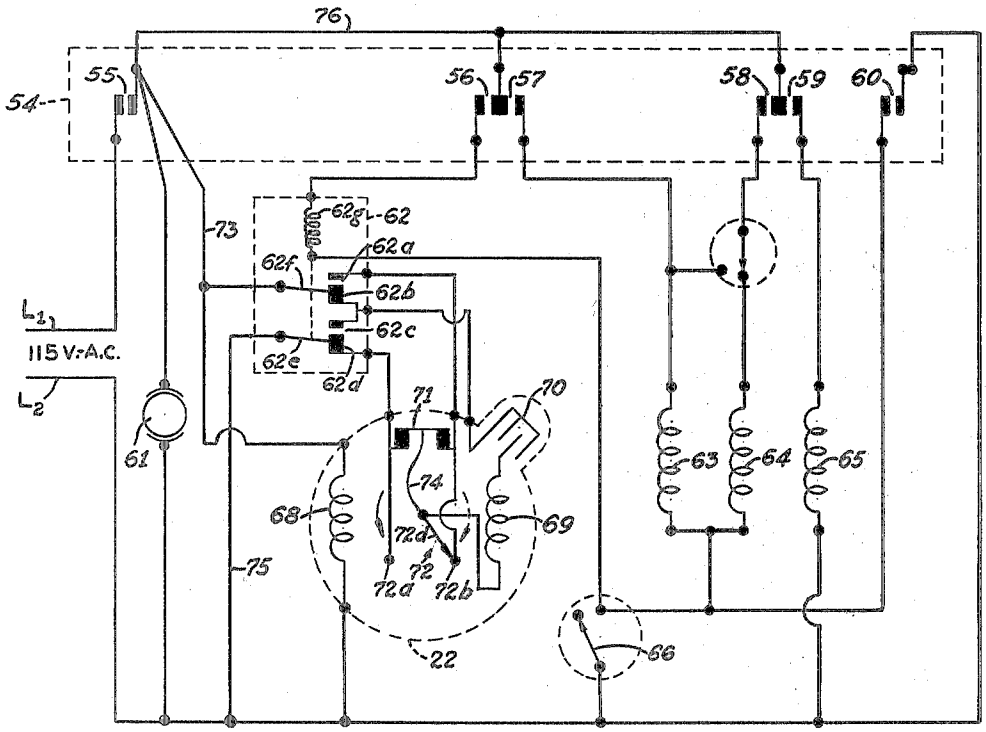


Fig. 10.

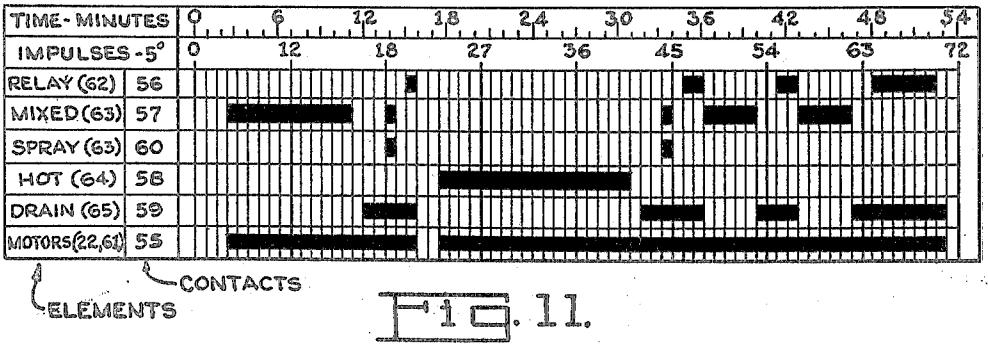


Fig. 11.

INVENTOR.
WILLIAM L. FOX

BY

ATTORNEY.

WITNESS:
D. W. Van Slooy

United States Patent Office 2,757,531 Patented Aug. 7, 1956

2,757,531

WASHING MACHINE

William L. Fox, South Bend, Ind., assignor to Bendix Home Appliances Division of Avco Manufacturing Corporation, South Bend, Ind., a corporation of Delaware

Application November 22, 1952, Serial No. 322,117

6 Claims. (Cl. 68—24)

This invention relates to automatic clothes washing machines and is particularly concerned with a combination of mechanism for a washing machine with a rotating cylinder for washing and extraction including driving and control means therefor.

The present invention will be described as applied to, and as an improvement upon, a horizontal rotating cylinder, automatic washing, rinsing and drying machine of the general type described in U. S. Patent No. Re. 22,375 dated September 14, 1943. In the type of automatic washer described in that patent a clothes containing cylinder is rotated on a horizontal axis in a container holding a liquid detergent at a rate of rotation suitable for creating the necessary agitation of the clothes for cleansing thereof by the tumble action of the clothes falling within the cylinder as the rotation is continued at a uniform speed. The speed of rotation is so selected that suitable tumbling is afforded during the time that liquid is present and when the free liquid is drained the continued rotation at the same speed provides a suitable distribution of clothes around the periphery of the rotating cylinder, so that when the rate of rotation of the cylinder is accelerated, but still in the same direction of rotation, a centrifugal extraction of liquid from the clothes contained in the cylinder is effected without disturbing the distribution of the clothes so necessary for smooth operation during the centrifugal extraction. It is to be emphasized that this method employing two speeds of rotation, (1) for tumble action washing and distribution followed by, (2) increased speed in the same direction for extraction, requires that there be no material pause in the rotation during the transition from low washing rate of rotation to the higher extraction rate of rotation. The type of transmission mechanism shown in the Patent No. Re. 22,375 makes use of a constant speed electric motor provided with gearing for effecting the change in rate of rotation of the cylinder while maintaining the rotative speed of the driving motor as constant. The change in gear ratio for the prior art device above noted is effected by clutch mechanism actuated by an electrical solenoid device requiring control mechanism outside the transmission. It is recognized that a simpler transmission mechanism can be produced by a gear unit provided with unidirectional clutches so that the input shaft of the transmission is driven by a motor rotating in one direction to produce a low speed of rotation at the output shaft and by the rotation of such motor in the opposite direction and at the same speed to produce a high speed of the output shaft still in the same direction of rotation. Such a result is accomplished without the use of special clutch shifting mechanism in the transmission, but requires, in view of the necessity for change in rotative speed in the output shaft without pause, a substantially instantaneous reversal of the motor to accomplish the desired result in the clothes cylinder, as any pause in the rotation during transition will result in the loss of proper distribution of the clothes in the cylinder. There was, therefore, a recognition for the necessity for this continuous rotation that prompted the

selection of the combination of elements making up the present invention comprising a means to produce substantially instantaneous reversal of the rotation of the driving motor coupled with the type of transmission mechanism having a minimum amount of control mechanism as a means to drive the rotating cylinder of an automatic washer with resulting advantages in structure and function.

An important object of the present invention is to provide a transmission mechanism and control means therefor capable of producing two different forward speeds of a washing machine cylinder upon driving of the transmission input shaft at the same speed forwardly for a low rate of rotation of the cylinder, and reversely for a higher rate of rotation of the cylinder in the same direction without substantial pause in rotation during transition from low to high rate of rotation.

Another important feature of the present invention is the provision of a substantially instantaneously reversing motor to supply the driving power to the transmission, such instantaneous reversal resulting in a change of rotative speed of the washing machine cylinder without substantially disturbing the distribution of the clothes load therein.

A further important object of the present invention is to provide a new and novel switching arrangement for the supply of current to provide an instantaneously reversing motor.

A still further object of the present invention is to provide a constructional arrangement such that the transmission mechanism, and its relationship to the cylinder drive shaft, requires only one set of bearings instead of the customary two sets heretofore required in a machine of this type.

A still further object of the present invention is to provide a factory-sealed, compact, efficient transmission unit capable of being readily removed from a washing machine with a minimum of time and effort in the event of failure of any of the component parts thereof.

A still further object of the present invention is to provide means in a transmission of this type arranged to permit coasting or free-wheeling of the gear train when the driving motor is reversed thereby to greatly reduce the large inertia forces, which would otherwise be present, in decelerating the cylinder from a high speed to washing speed.

Other and still further objects of the present invention will become readily apparent from the following more detailed description and by reference to the accompanying drawings forming a part hereof and wherein:

Fig. 1 is a rear elevation of a horizontal rotary washing machine showing the general arrangement of the driving mechanism with respect to the clothes receiving cylinder and tub;

Fig. 2 is a partial vertical section through the tub and cylinder showing in more detail the relationship of the cylinder driving transmission, the view being taken along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged vertical sectional view of the transmission mechanism taken along the line 3—3 of Fig. 1;

Fig. 4 is a diagrammatic view showing the action of the gear train members when driven in a direction to produce the low or washing speed of the clothes containing cylinder;

Fig. 5 is a diagrammatic view similar to Fig. 4, but showing the action of the gear train members when driven in a direction to produce the high or centrifugal extraction speed of the clothes containing cylinder;

Fig. 6 is a view of the driving motor, partially in section to show the general arrangement of a switching mechanism;

Fig. 7 is a partial sectional view taken along the line 7—7 of Fig. 6 to further illustrate the switching mechanism;

Fig. 8 is a diagrammatic showing of the pattern or path assumed by the laundry in the presence of washing liquid within the cylinder when same is rotated at the low or washing speed;

Fig. 9 is a diagrammatic showing of the pattern or path of the laundry in the cylinder when same is rotated at the low speed in the absence of washing liquid;

Fig. 10 is a circuit diagram for the machine; and

Fig. 11 is a cycle chart for the machine.

The illustrated machine consists of a generally cylindrical tub **10** disposed within a suitable cabinet **11** and adapted to rotatably support a perforated clothes receiving cylinder **12**. One convenient means of supporting the tub **10** within the casing **11** consists of a plurality of channel sectioned legs **13** rigidly attached to the outer surface of the tub **10** and to a base member **14** which forms a bottom of the cabinet **11** as shown in Fig. 1.

The tub **10** is secured by means of a clamp ring **15**, to the marginal edges of two frusto-conically shaped support plates **16** placed base-to-base as shown in Fig. 2. The support plates **16** provide a rigid structure within which is mounted a transmission mechanism **17** for rotatably driving the cylinder **12**. The cylinder **12** is attached to an output shaft **18** from the transmission **17** by means of spider plates **19** and **20**.

As more fully described in the previously mentioned Patent No. Re. 22,375, the cylinder **12** is provided with several inwardly projecting ribs or baffles **21** which are adapted to lift the clothes or materials M (see Figs. 8 and 9) out of a body of liquid contained within the tub **10** so as to tumble them in a path substantially as shown in Fig. 8 when the cylinder **12** is rotated at the proper speed for washing. As further described in said prior patent, when the liquid is drained away the materials M tend to arrange or distribute themselves in an annulus about the inner wall of the cylinder **12** substantially as herein illustrated by Fig. 9.

As shown in Fig. 1, a suitable fractional horsepower electric motor **22** is provided to supply the necessary driving force to the transmission **17** by means of pulleys **23** and **24** and a belt **25**.

Referring now to Fig. 3, it may be seen that the housing for the transmission **17** consists of a case **26** adapted to enclose the working parts of the transmission mechanism, and a cover **27**. Extending through the cover **27**, and rigidly attached to the pulley **24** is an input shaft **28** journaled in suitable bearings **29** and **30**. The innermost bearing **30** is mounted upon a rigid supporting arm **31** which has an extension at right-angles thereto and which extension is rigidly secured to the inside face of the cover **27** by suitable means such as machine screws. The construction of the supporting arm **31** can best be seen in Fig. 2. Attached to the innermost end of the input shaft **28** is a small pinion **32** arranged to mesh with internal teeth **33** of a ring gear **34**. The pinion **32** and the ring gear **34**, which is mounted on shaft **18** and free to rotate thereabout, constitute the low speed drive as will be later discussed.

Attached to the shaft **28** by means of a key **35** at a point adjacent the pinion **32** is a cylindrical hub **36** which rotates at all times with the shaft **28**. A second cylindrical hub **37**, which comprises an extension of a gear **38**, surrounds the shaft **28** in close proximity to the hub **36**; but has no direct means of attachment to the shaft **28**. Placed around the hubs **36** and **37** is a helically coiled friction clutch spring **39** which has several turns thereof extending onto each hub and is so wound as to have a slight interference or frictional driving fit thereon. The hubs **36** and **37** are of equal diameter and are preferably made of a hardened steel in order that they will not be subject to appreciable wear by reason of their frictional engagement with the spring **39**. It will be understood

by those skilled in the art that this construction is such that rotation of the shaft **18** in a clockwise direction (as viewed from the pulley end thereof) will tend to lock the hubs **36** and **37** together in frictional driving engagement and that rotation of the shaft **18** in a counter-clockwise direction will cause the spring **39** to unwind and thus expand radially along the length thereof so as not to be in driving engagement with the two hubs **36** and **37** whereby the gear **38** will then be in a free-wheeling relationship with respect to the rotation of input shaft **28**.

The output shaft **18** which, as previously mentioned rotatably carries the cylinder **12**, extends through the case **26** and cover **27** and is likewise journaled in suitable bearings adjacent each end thereof such as indicated by reference numerals **40** and **41**. Keyed to the shaft **18**, in much the same manner as the hub **36** with respect to shaft **28**, is a pinion **42** which is adapted to mesh with the gear **38**. The pinion **42** is also provided with an extension in the form of a cylindrical hub **43** which adjoins a hub **44** comprising an extension of the ring gear **34**. Placed around the hubs **43** and **44** is a second helically coiled friction clutch spring **45** which likewise has several turns thereof extending onto each hub and is so wound as to have a slight interference or frictional driving fit thereon.

As shown in Fig. 3, it may be seen that the spring **45** is wound opposite hand to the spring **39**. This construction is such that counter-clockwise rotation of the shaft **28** will result in a counter-clockwise rotation of the shaft **18** through the train comprised of pinion **32**, ring gear **34** and its hub **44**, clutch spring **45** and hub **43** which is keyed to the shaft **18**.

Fig. 4 diagrammatically illustrates the rotation of the various gears in the train when the motor **22** is driving in a direction to impart a counter-clockwise rotation of the input shaft **28**. When studied in connection with Fig. 3 and the foregoing description thereof; it may be seen that this rotation of the input shaft **28** will result in a counter-clockwise rotation of the output shaft **18**, the drive being effected through the pinion **32**, ring gear **34** and its hub **44**, engaged clutch spring **45** and hub **43** (keyed to shaft **18**). As previously explained, this direction of rotation is such that the clutch spring **39** will be disengaged and such disengagement is further assured by the fact that pinion **42** rotating in a counter-clockwise direction will cause the gear **38** and its hub **37** to rotate in a clockwise direction and thus free-wheel with respect to the shaft **28** inasmuch as the nature of friction spring clutches of this type is such that any tendency of the two hubs to rotate in opposite directions with respect to each other results in a disengagement of the clutch spring. It should also be noted that the reduction between pinion **32** and ring gear **34** constitutes the low-speed drive for tumbling the clothes at washing speed in a clockwise direction within the cylinder **12** as illustrated by Fig. 8.

Fig. 5 diagrammatically illustrates the rotation of the gears in the train when the motor **22** is driving in a direction to impart a clockwise direction of rotation to the input shaft **28**. When studied in connection with Fig. 3 and the foregoing description thereof, it may readily be seen that the clockwise rotation of input shaft **28** will result in a counter-clockwise rotation of the output shaft **18**; the drive being effected through the hub **36**, clutch spring **39**, hub **37**, gear **38** and pinion **42**; the ratio between gear **38** and pinion **42** constituting the high speed of rotation for effecting a centrifugal extraction of liquid from the clothes within cylinder **12**. When the pinion **42** and its hub **43** are rotating in a counter-clockwise direction as shown in Fig. 5 as above discussed; and the pinion **32** is driving the ring gear **34** and its hub **44** in the opposite or clockwise direction, it is obvious that the clutch spring **45** will be disengaged and that the ring gear **34** will free-wheel with respect to the output shaft **18**.

It may now be seen that the drive mechanism herein provided is capable of producing two different forward

speeds of the clothes containing cylinder 12 upon driving of the transmission input shaft 28 at the same speed both forwardly and reversely; such operation being effected by the provision of unidirectional clutches comprising the two oppositely operating friction clutch springs 39 and 45 one of which drives while the other free-wheels and vice versa.

It should be noted that suitable means such as oil seals, as indicated by reference numerals 46, 47 and 48, may be provided to maintain a substantially fluid tight assembly to contain a suitable lubricant within the transmission casing 26, and also, a suitable seal 49 is provided at the cylinder end of the output shaft 18 to substantially eliminate the leakage of water or vapor from the cylinder 12 into the transmission casing 25. In the event any water or vapor should pass through the seal 49; further protection is provided by means of a drain hole 50 extending through the casing 26.

The transmission cover 27 (Fig. 3) is attached to the casing 26 by means of rivets 51 or other suitable means spaced about the marginal edge thereof to maintain a sealed unit, the seal being effected by compression of a suitable gasket 52 between the cover 27 and the casing 26. The transmission assembly 17 is attached to the bearing plate 16 by means of machine screws 53 or other suitable means spaced between the rivets 51. In order to service a machine which may have a defective transmission, the service man merely removes the machine screws 53 and the transmission 17 will then be removable as a separate sealed unit and another transmission may be rapidly installed and secured in place by the machine screws 53. The transmission may then be returned to the factory for repairs or repaired in a shop having the necessary tools and equipment thereby effecting a tremendous saving in the amount of time and expense previously required to service such devices in the home without the proper facilities for the job.

Referring now to Fig. 10, there is diagrammatically shown a complete and operative electrical circuit for the operation of a machine of this type. Reference numeral 54 indicates an automatic electric timing switch mechanism, or so-called timer, of conventional type well known to the art, such timing mechanism having a plurality of cam operated contacts 55, 56, 57, 58, 59 and 60, arranged to be opened and closed by suitable cams rotated by a conventional self-starting synchronous motor 61 also of a type well known to the art such as is used in electric clocks.

To initiate operation of the timer 54, the operator manually closes the contacts 55 by advancing a suitable timer dial, thereby supplying current to the timer motor 61, and then the various functions of the machine are carried on automatically according to any predetermined sequence of operations. One suitable sequence of operations is shown by the cycle chart in Fig. 11 (to be more fully described presently). Inspection of Fig. 10 will show that contacts 56 control the supply of current to a solenoid operated relay 62; contacts 57 control the supply of current to the "mixed water" coil 63 (mixed hot and cold water) of a suitable solenoid operated thermostatically controlled water mixing valve of known type; contacts 58 control the supply of current to the "hot water" coil 64 of the mixing valve; contacts 59 control the supply of current to a suitable solenoid 65 for the operation of a drain valve; and contacts 60 control the supply of current to the mixing valve "mixed" coil 63 at predetermined periods to provide an assured spray rinse independently of the position of a pressure switch 66 which normally breaks the circuit through this coil when the level of the water in the tub 10 reaches a predetermined maximum. Reference numeral 67 indicates a selector switch which provides for the selectivity of either hot or mixed hot and cold water during the washing cycle (mixed or lukewarm water is provided during all other portions of the cycle of operations regardless of the position of the selector switch 67).

The motor 22 symbolically illustrated in Fig. 10, is of the single-phase induction type having a rotor, a main running winding 68, and an auxiliary starting winding 69. The windings 68 and 69 may each consist of any number of pairs of individual coils spaced around the frame of the motor 22 at diametrically opposite points. For example, with a two-pole motor, each of 68 and 69 comprises two coils, and for a four-pole motor, each thereof would comprise four coils. For the purpose of this disclosure, these windings are shown to be single coils, but it will be understood that all usual arrangements thereof about a motor field frame could be made.

The starting winding 69 and the running winding 68 are angularly displaced within the motor frame so that a phase difference between the energizing currents in the windings will produce a rotating magnetic field. For obtaining this phase difference, there is provided a reactance in series with the starting winding 69, indicated at 70, and preferably a capacitor. The reactance is of such size that the phase shift in the starting winding 69 is substantially equal in electrical degrees to the displacement between the windings 68 and 69 in magnetic degrees.

The starting winding 69 is in series with the circuit making-and-breaking contacts of a speed-responsive device or centrifugal switch 71. Such switches are well known to the art. They operate in conjunction with the rotor to cut out the starting winding 69 (i. e. to uncouple it from its energy source) when the rotor attains a predetermined speed, say 75% to 80%, of the operating speed in either direction of rotation. When the rotor falls below that speed the starting winding 69 is again cut in and energized.

As previously stated, the transmission 17 of the illustrated machine relies upon the reversal of rotation of the motor 22 to accomplish a change of speed from tumbling to centrifugal extraction. It is apparent that, when a motor such as the motor 22 is running at operating speed, a mere reversal of the starting winding leads of a prior art motor circuit accomplishes nothing, that winding being dead both before and after reversal of the leads inasmuch as the centrifugal switch maintains an open circuit at operating speed. Further, the main winding would still be energized and the motor would continue to run in the same direction. Also, if the polarity of the main winding is reversed, without waiting for the starting or centrifugal switch in series with the starting winding to close, the motor would still run in the same direction.

In accordance with the present invention there is provided a novel combination of the polarity-reversing switch or relay 62, a direction sensing switch 72, and other means and features required for obtaining the desired motor control; i. e., instantaneous ready reversing, starting and stopping. Specifically, the starting winding 69 is electrically arranged in series with the relay 62 which is a switch, effectively a double-pole double-throw switch having four sets of contacts, 62*a*, 62*b*, 62*c*, and 62*d*. The relay 62 is arranged so that the contacts 62*b* and 62*d* are normally spring biased to assume the position shown in Fig. 10, which is one of the closed or circuit making positions. As shown, a 115 volt alternating current supply source, L_1—L_2 is electrically coupled to the contacts 62*b* and 62*d* through contacts 55 (when closed), a conductor 73, reactance 70, starting winding 69, direction sensing switch 72 (or a shunt 74), through the centrifugal switch 71 and a conductor 75. When the circuit is electrically closed through the motor 22 in this manner, currents of a certain phase with respect to the running winding 68 (also closed through conductor 73) flow in the starting winding 69. For purposes of illustration let it be assumed that these currents induce a counter-clockwise rotation to the rotor as shown by the full line arrow.

The relay 62 is provided with a pair of switch arms 62*e* and 62*f* which are biased to move together due to interconnection with the armature of a solenoid coil 62*g*. When contacts 55 and 56 are electrically closed, current

flows from the supply source through a conductor **76** to energize the solenoid coil **62***g* thereby breaking the contacts **62***b* and **62***d* and making the contacts **62***a*, **62***c*, assuming however, that the circuit is closed through the pressure switch **66**. Such energization results in currents of the opposite phase flowing through the starting winding **69** and consequently the rotor will then have a clockwise rotation. It may thus be seen that the relay **62** constitutes phase-reversing or polarity-means for the starting winding **69**.

As previously stated, prior art motors have their direction of rotation changed by first bringing them to a halt, and then modifying the circuit so that the reactance gives the opposite direction of field rotation during the starting period. Due to the relatively high inertia of the rotating parts of the motor, a substantial period of time will elapse before the motor will come to a halt upon being deenergized unless it is connected with a load which will act as a brake. In many instances where it is desirable for the motor to be of a reversible nature, the load which it drives is comparatively light and cannot be depended upon to bring the motor to a halt in a very short time.

As previously stated the present invention contemplates an instantaneous reversal of the motor **22** for the following very important reason; reference being had to Figs. 8 and 9 of the drawing.

As more fully described in the previously mentioned Patent No. Re. 22,375, the clothing within the cylinder **12** assumes a path substantially as shown by Fig. 8 when the cylinder **12** is rotated at the slow or tumbling speed in the presence of a washing liquid. Also described in said prior patent is the attending phenomena illustrated by Fig. 9 which shows that the clothes arrange or distribute themselves in an annulus about the inner periphery of the cylinder **12**, substantially as shown, when the free washing liquid is drained from the tub **10** with the same driving force being applied to the cylinder **12**. This distribution is extremely important as it lessens the possibility of having a terrifically out of balance load during the centrifugal extraction portions of the cycle of operations, which extractions immediately follow each tumbling period. If the prior art teachings in motor reversal were followed in the present machine, which motor reversals cannot take place at least until the centrifugal switch closes; the machines would have an inherent impracticability inasmuch as any substantial reduction of the rotative speed of the cylinder **12** prior to the extraction period would result in an extremely out-of-balance load condition which could not be tolerated.

In accordance with the present invention, means in the form of a direction-sensing switch **72** is provided as a by-pass for the flow of current to the starting winding **69** independently of the position of the centrifugal switch **71**. The details of construction of the direction-sensing switch 72 are illustrated by Figs. 6 and 7 of the drawing.

The direction-sensing switch **72** comprises a pair of stationary contacts **72***a* and **72***b* mounted upon a suitable insulating member **72***c* which is in turn rigidly fastened by screws or other means to one end frame **22***a* of the motor **22**; and a movable contact **72***d* arranged to alternately electrically contact either of contacts **72***a* and **72***b*. The movable contact **72***d* is mounted upon a suitable insulating member **72***e*, which member is mounted upon and freely rotatable about a shaft **22***b* of the motor **22** which shaft is, of course, the rotor shaft. Adjacent to and in contact with the insulating member **72***e* is a collar **72***f* rigidly attached to the rotor shaft **22***b* for rotation therewith and is made of a suitable material so that it will frictionally drive the insulating member **72***e* in the direction in which the rotor shaft **22***b* is rotating. A suitable compression spring **72***g* is provided between the motor rotor and the collar **72***f* to insure that the collar **72***f* is urged with sufficient pressure against the insulating member **72***e* to provide the proper frictional contact therebetween. Referring specifically to Fig. 7, it should now be apparent that when the rotor shaft **22***b* is rotated in a clockwise direction, the insulating member **72***e* will be moved through an arc such that the contact **72***d* will engage the contact **72***a*, and similarly if the rotor shaft **22***b* is rotated in a counter-clockwise direction the insulating member **72***e* will be moved through an arc such that the contact **72***d* will engage the contact **72***b*. It will, of course, be understood that when the contact **72***d* engages either of the contacts **72***a* or **72***b* the frictional driving force of collar **72***f* against insulating member **72***e* will be overcome and these two elements will free-wheel with respect to one another until such time as the motor **22** is reversed and the rotor shaft **22***b* acts to move the contact **72***d* from one position to the other.

As previously stated, the direction-sensing switch **72** acts as a by-pass for the flow of current through the starting winding **69** independently of the position of the centrifugal switch **71** which otherwise must close the circuit in prior art motors before such motors can be reversed. Referring again to Fig. 10, it may be seen that the arrangement of relay **62**, centrifugal switch **71** (and its shunt **74**) together with the direction sensing swtich **72**, is such that substantially instantaneous reversal of the motor **22** may be accomplished. Let it be assumed that the contact **55** has been made and that current is flowing into the motor **22** through conductor **73**, contacts **62***b* of the relay **62**, reactance **70**, starting winding **69**, centrifugal switch **71** (normally closed) contact **62***d* of the relay **62** and conductor **75**. As aforementioned, such current flow induces currents through the starting winding of such phase that the motor **22** will run in a counter-clockwise direction, therefore the direction sensing switch **72** will be urged to the position shown in Fig. 10 immediately the rotor shaft **22** starts to move in its rotation. As soon as the motor **22** reaches a speed of approximately 75% to 80% of operating speed, the centrifugal switch **71** will open the circuit through the starting winding **69**, but the motor **22** will continue to run inasmuch as current continues to flow through the running winding **68**. At such time as it is desired to effect a reversal of the motor **22**, the timer **54** will close the contact **56** thereby energizing the solenoid **62***g* of the relay **62** causing the switch arms **62***e* and **62***f* to move to such position that the current phase will be reversed through the starting winding as previously described. It now becomes important to note that the prior positioning of the direction sensing switch is such that the reversal of current through the starting winding **69** is instantaneously effected thereby overcoming the objectionable time lag required in prior art motors wherein it is necessary for the motor to slow down to 75% to 80% of operating speed in order to close the circuit through the starting winding, which time lag, as previously discussed, would be fatal to the satisfactory operation of the herein described machine.

The reversal of current flow through the starting winding **69**, in effect, acts as a brake to hasten the deceleration of the motor **22** and thereby rapidly close the circuit through the centrifugal switch **71**. This braking action results in an extremely rapid deceleration of the motor rotor through zero speed and acceleration back up to operating speed in the opposite direction of rotation. As soon as the rotor shaft **22***b* starts to rotate in the opposite direction, the direction sensing switch **72** will be moved to the position making the contact **72***a*, so that the circuit will be conditioned for a subsequent reversal of the type just described. It is important to note that during movement of the direction sensing switch **72** from the contact **72***b* to the contact **72***a* (or vice versa) the circuit through the starting winding will be made through the shunt **74** from the centrifugal switch **71** which is always closed when the rotor shaft **22***b* starts rotation in either direction.

Another important feature of the present invention which may now be discussed, resides in the previously mentioned free-wheeling arrangement in the transmission

mechanism 17. Since the arrangement of the transmission mechanism 17 provides for free-wheeling thereof during the change-speed periods, there is no inertia load transmitted to the motor 22 during the reversal thereof other than the inertia load of the motor rotor, which load is not excessively heavy, relatively speaking, and may be successfully braked by the aforementioned instantaneous reversal of the current phase through the starting winding 69. It is a fact also that the clothes cylinder rotation is no reversed on reversal of the motor but is continued in the same direction thru a different set of gears so there is no requirement of cylinder load reversal to impair the action of the motor reversal.

The cycle chart shown in Fig. 11 illustrates a suitable manner of operating a machine embodying the structure of the present invention. The graduations on the upper scale indicates elapsed time in minutes and the graduations on the lower scale indicate impulses of the timer 61 corresponding to 5° of rotation thereof, or 45 seconds. The shaded portions on the chart indicate those portions of the cycle of operations when the contacts shown in Fig. 10 are closed for actuation of the specific elements designated in the column at the left hand side of the chart.

While the present invention has been described by reference to one particular illustrative embodiment, it is not intended that it be limited to that particular embodiment, nor otherwise than by the terms of the appended claims.

What I claim is:

1. A washing machine having a clothes receiving cylinder unidirectionally rotatable at low and high speeds for washing, distributing and extracting characterized by, a multiple-speed transmission having an input shaft for providing said low and high speeds by alternate reversal thereof, and control means for selectively causing said input shaft to be driven in a forward or a reverse direction, said control means comprising, an electric circuit for said machine, a motor in said circuit, a reversing switch in said circuit for operating said motor in a forward or a reverse direction, and a direction responsive switch in said circuit to condition said motor for immediate reversal upon actuation of said reversing switch.

2. In combination with a washing machine having a clothes receiving cylinder unidirectionally rotatable at a low speed for washing and at a high speed for extraction, a drive unit comprising a transmission arranged to provide two forward speeds of said cylinder by alternate reversal of the input shaft thereof, a drive motor for said transmission, and control means for said motor, comprising, a reversing switch and a direction responsive switch to condition said motor for immediate reversal upon actuation of said reversing switch.

3. In combination with a washing machine having a clothes receiving cylinder unidirectionally rotatable at a low speed for washing and at a high speed for extraction, a motor, a drive unit comprising a transmission having an output shaft connected to said cylinder and an input shaft connected to said motor, said transmission arranged to provide two forward speeds of said output shaft by driving said input shaft at the same speed both forwardly and reversely, and control means for reversing said motor comprising, a reversing switch and a direction responsive switch actuated by said motor, said direction responsive switch arranged to condition said motor for immediate reversal upon actuation of said reversing switch.

4. In combination with a washing machine having a clothes receiving cylinder unidirectionally rotatable at low and high speeds for tumble action washing, distributing and centrifugal extraction, a drive motor, a transmission mechanism having an input shaft connected to said motor and an output shaft connected to said cylinder, said mechanism arranged to provide said low and high rotative speeds of said cylinder upon driving of said input shaft in opposite directions respectively, control means for said motor comprising, an electrical circuit for said motor, a speed responsive switch in said circuit for controlling said motor, a reversing switch in said circuit having two operative positions for selectively causing said motor to rotate in opposite directions, and a direction sensitive switch in said circuit, said reversing switch upon actuation arranged to provide a reversal of said motor, and said direction sensitive switch arranged to short-circuit said speed responsive switch during a portion of each reversal, wherby said motor reversal and resultant change in rotative speed of said cylinder is effected without substantial disturbance of the distribution of clothes within said cylinder.

5. A control system for a washing machine of the character described comprising, an electric circuit for said machine, a time switch in said circuit, a motor in said circuit having starting and running windings, a speed responsive switch in said circuit for energizing and deenergizing said starting winding at predetermined speeds, said time switch arranged to energize and deenergize said starting winding for starting and stopping said motor, a reversing switch in said circuit operable with said time switch for operating said motor in a forward or a reverse direction, a direction responsive switch in said circuit having two operative positions assumed by initial rotative movement of said motor in either direction, said direction responsive switch operating independently of said speed responsive switch and arranged to energize said starting winding for operation of said motor in a reverse direction, whereby actuation of said reversing switch by said time switch will effect an immediate energization of said starting winding for operation of said motor in a reverse direction.

6. A washing machine having a clothes receiving cylinder unidirectionally rotatable at a low speed for tumble action washing and distributing and at a high speed for centrifugal extraction, an electrical circuit for said machine, a motor in said circuit for driving said cylinder, a multiple-speed transmission having an output shaft connected to said cylinder and an input shaft connected to said motor, said transmission arranged to provide said low and high speed unidirectional rotation of said cylinder by reversing the direction of rotation of said input shaft, said motor having starting and running windings and a speed responsive switch for energizing and deenergizing said starting winding, a time switch in said circuit, a reversing switch in said circuit operable by said time switch to operate said motor in a forward or a reverse direction, and a direction responsive switch in said circuit arranged to condition said motor for immediate reversal upon actuation of said reversing switch by said time switch.

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