July 4, 1967 B. L. BRUCKEN ET AL 3,328,983

WASHING MACHINE HAVING A TRANSISTOR CONTROLLED MAGNETIC CLUTCH

Filed Dec. 2, 1965

3 Sheets-Sheet 1

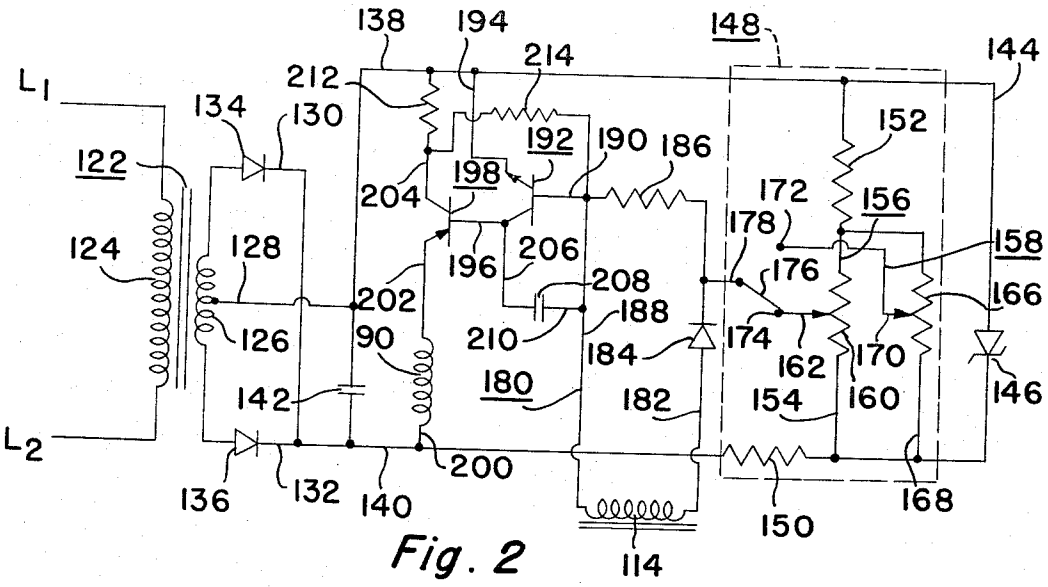


Fig. 2

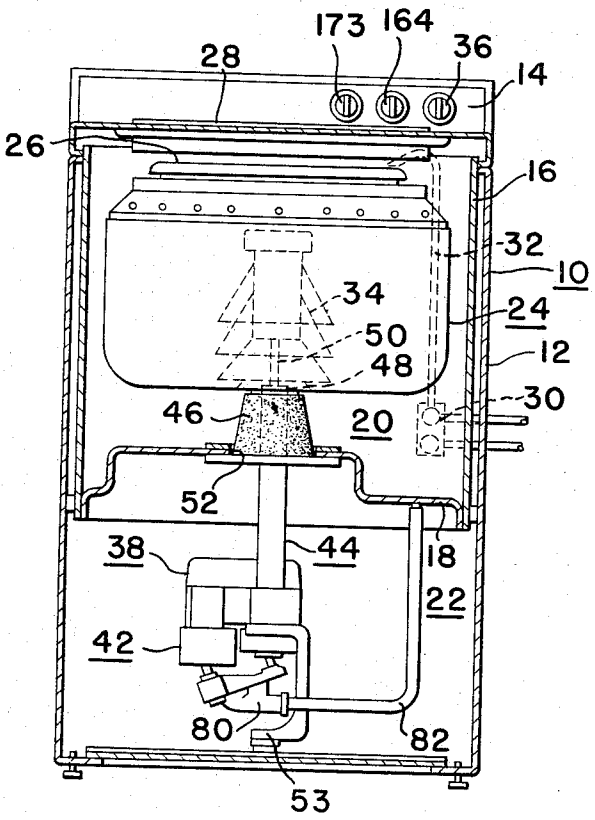


Fig. 1

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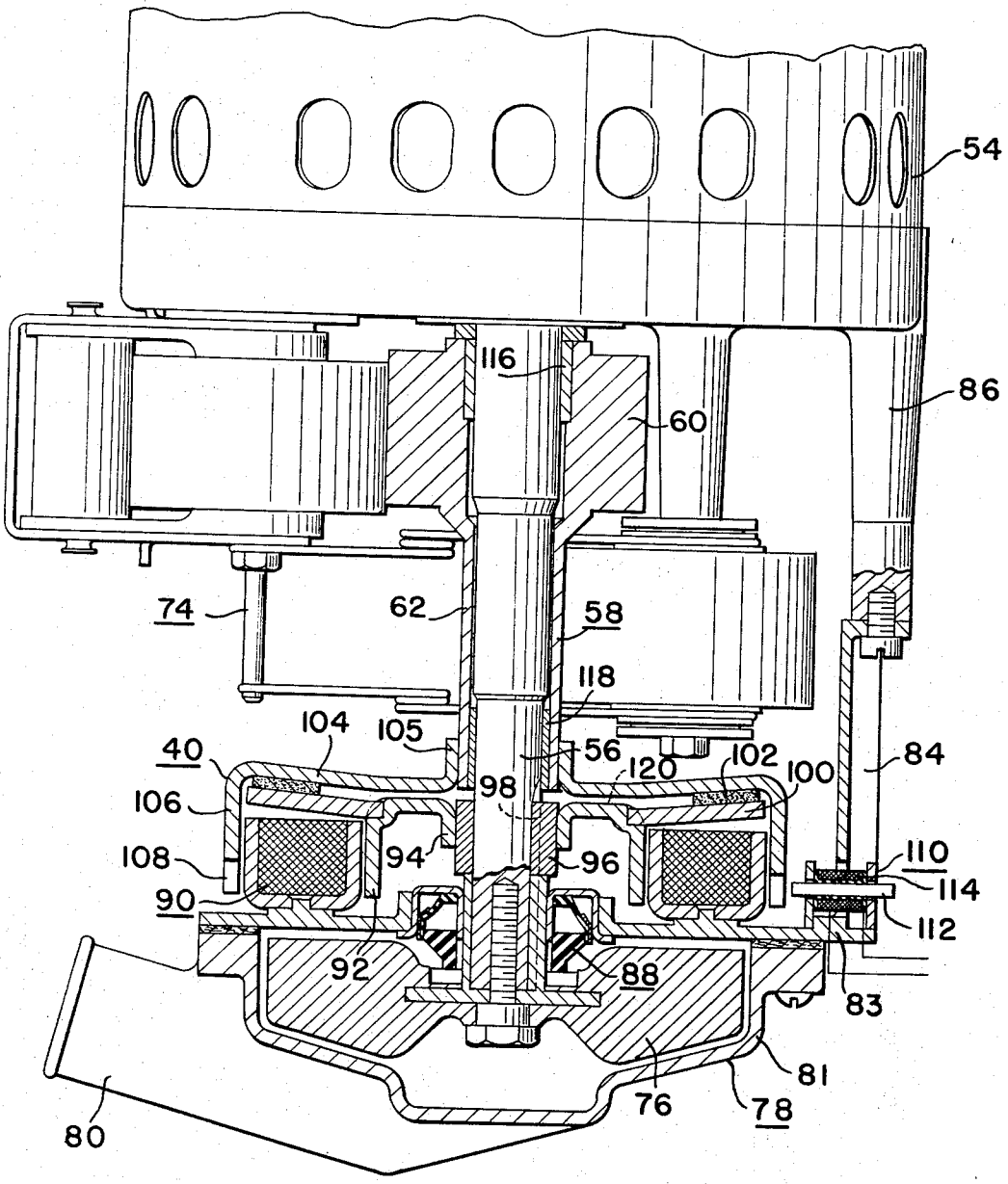


Fig. 3

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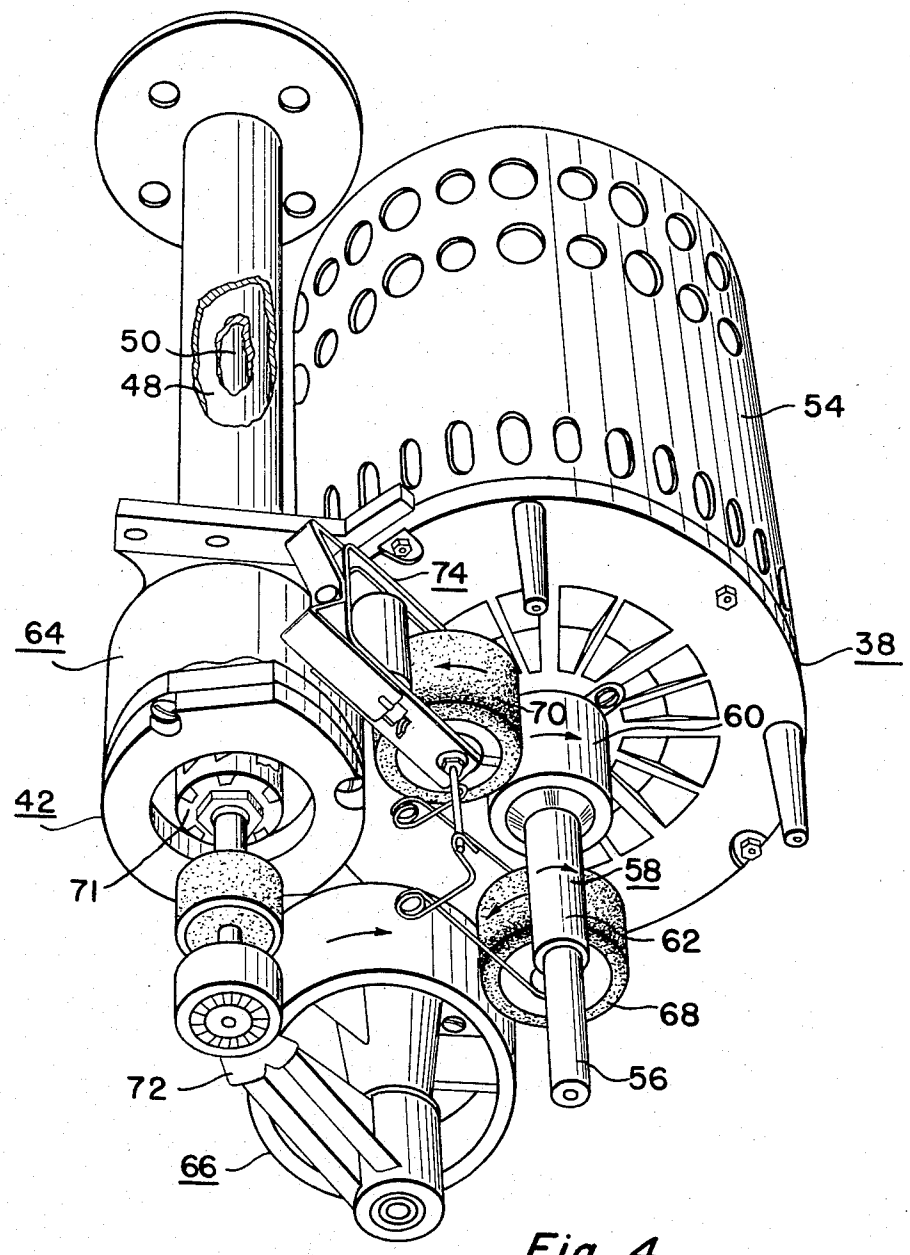


Fig. 4

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United States Patent Office 3,328,983 Patented July 4, 1967

3,328,983

WASHING MACHINE HAVING A TRANSISTOR CONTROLLED MAGNETIC CLUTCH

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7 Claims. (Cl. 68—12)

This invention is directed to variable speed domestic appliances and more particularly to variable speed domestic appliances utilizing a magnetic slip clutch in the drive mechanism for producing a variable speed operation of a driven component in such appliances.

The development of various types of synthetic materials and fabrics has resulted in a wide range of clothing articles and the like that require hand laundering or like treatment to avoid adversely affecting the basic characteristics of the materials and fabrics. It has been found that single-speed and two-speed domestic washing machines of the type presently marketed today are characterized by clothes washing actions that fail to approximate the gentle washing characteristics of hand laundering and as a result, these machines often are unsuited for washing the fabrics mentioned above. One solution to the problem set forth above is to improve domestic washing machines by the provision therein of a variable speed control mechanism that will operate the agitator and spin tub and like driven components of domestic appliances to approximate hand-type washing operations. In such machines, the variable speed controller is capable of operating the driven components of the machine through a wide range of speeds including very low agitation and spin speed rates.

While variable speed drive washing machines are known, for example, as disclosed in United States Patent No. 3,174,595, issued Mar. 23, 1965, to Brucken, one problem in in such machines has been to produce uniformly smooth operating characteristics of the driven components of the machine through a full range of speed settings. For example, one problem has been to maintain a smooth, low-speed drive of an agitator in a domestic washing machine under variable loading conditions placed thereon that are normally encountered as the agitator is reciprocated or oscillated with respect to a load of wet clothes.

An object of the present invention, therefore, is to improve variable speed clothes washers or like domestic appliances by the provision therein of a drive system including a magnetic slip clutch disposed exteriorly of a drive motor and operatively between it and the driven component of a domestic appliance such as an agitator member or the like wherein the clutch is operatively associated with improved speed selector control means for directing a power supply to the clutch and further associated with means for sensing the speed of the clutch and for continually modulating the base energization of the clutch in response to the sensed speed signal to maintain a substantially constant clutch slip to produce a smooth operation of the operative component of the appliance.

Still another object of the present invention is to improve variable speed washing machines or like domestic appliances by the provision therein of driven components associated with power transmitting means including a magnetically operated slip clutch having a coil energized across a transistorized direct-current power supply and wherein means are provided for preselecting a base energization of the clutch coil through the transistorized power supply to establish a predetermined speed output from said clutch and wherein means are provided for controlling the output speed of the clutch in response to variable driven loads.

A further object of the present invention is to improve variable speed washing machines of the type mentioned in the preceding objects wherein the means for controlling

the output speed of the clutch includes means for directly sensing the speed of operation of the clutch and responding thereto to continually modulate the base energization of the clutch coil.

A further object of the present invention is to improve variable speed domestic washers or like domestic appliances by the provision therein of a roller drive mechanism and a magnetically operated slip clutch operatively associated with a drive motor and driven components of the domestic appliance wherein the slip clutch is associated with control means including means for preselecting a speed of operation of the driven components of the domestic appliance and means for directly sensing the speed of operation of the clutch to modulate the energization thereof in response to variable, driven loads.

Still another object of the present invention is to improve variable speed domestic appliances by the provision therein of a power transmission including a drive motor having a first output driven at motor speed to drive a predetermined constant load and a second output associated with means for preselecting a speed of operation of the output shaft and additional means for automatically controlling the speed of the output shaft at said predetermined speed in response to variable, driven loads.

Still a further object of the present invention is to improve domestic appliances set forth in the preceding object wherein the means for automatically controlling the speed of the second output includes a transistorized direct-current power supply for directing a predetermined constant, non-cyclic power supply to the clutch and means for sensing the speed of the clutch and for continually modulating the base energization of the clutch in response to a sensed speed signal to maintain a substantially constant clutch slip to produce a smooth operation of the driven portions of the domestic appliance to a wide range of speed settings.

Yet another object of the present invention is to improve a transistorized power supply suitable for association with an energizable slip clutch of a domestic appliance power transmission or the like by the inclusion of voltage divider means in association with one of a pair of transistors to direct a predetermined current flow from the collector of said one transistor to the base of the other of the pair of transistors to improve the responsiveness of the transistor pair to a control signal imposed on said other transistor.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a view in vertical elevation of a domestic appliance including the present invention;

FIGURE 2 is a diagrammatic electrical control circuit in the present invention;

FIGURE 3 is an enlarged view in vertical section of a portion of the drive mechanism of the present invention showing a variably energized magnetic slip clutch and an associated speed pickup; and

FIGURE 4 is an enlarged view in perspective of the improved drive mechanism showing the drive motor and an associated roller drive mechanism.

Referring now to FIGURE 1, a clothes washer **10** is illustrated including the present invention. The clothes washer includes an outer casing **12** and a representatively shown rearwardly located control panel **14**. Within the outer casing **12** is located a cylindrical water container **16** having a bottom bulkhead **18** that separates a water containing space **20** formed by the cylindrical container **16** from a mechanism compartment or space **22** located therebelow. Within the water containing space **20** is lo-

cated a rotatable clothes containing spin tub **24** which has a top opening **26** therein located in alignment with a top loading port in the outer casing **12** of the washer that is closed by a suitable closure member **28**. The spin tub **24** is associated with a suitable water supply system including a hot and cold water solenoid operated mixing valve **30** connected into a household water supply and to a supply conduit **32** that terminates at a chute overlying the opening **26** into the spin tub **24**. Within the tub **24** is located an agitator or pulsator **34** that is adapted to be reciprocated vertically to circulate or agitate the water admitted by the water supply conduit **32**. Thus, clothes placed within the tub **24** are washed as the agitating action of the pulsator **34** forces surging torroidal currents of washing fluid and detergent through the fabric. Conventional sequential operating cycle control timer means, shown generally at **36** on the control panel **14**, are presettable to selectively admit water through the supply conduit **32** to vertically reciprocate the agitator or pulsator **34** and to spin the tub **24**.

In order to obtain the above-described rotation of the spin tub **24** and the reciprocation of the agitator or pulsator **34**, an improved drive mechanism **38** is associated therewith including a magnetically operated slip clutch **40** and a roller drive mechanism **42**. The roller drive mechanism **42** is suspended from a stationary shaft enclosing housing portion **44** which is connected to a resilient cup-shaped support member **46**. The stationary shaft housing portion **44** encloses a spin shaft **48** and an agitator shaft **50**. The support member **46**, in turn, is connected to the bulkhead **18** through an opening **52** therein which includes a suitable sealing gasket to effect a water-tight seal between the support member **46** and the bulkhead **18**. In order to dampen excessive gyrating or surging movement of the lower end of the drive mechanism **38**, a snubber device **53** may be used of the type disclosed in copending United States application, Ser. No. 430,266, filed Feb. 4, 1965.

Referring now to FIGURE 4, the drive mechanism **38** is shown as including a one-third horsepower, split phase, single-speed 1725 r.p.m., four-pole reversible motor **54** with a built-in automatic reset type thermal overload protector. The motor **54** has a depending drive shaft **56** operatively connected through the improved slip clutch mechanism **40**, as seen in FIGURE 3, to a driven sleeve element **58** having a large diameter spin portion **60** on one end thereof and a reduced diameter agitate portion **62** at the lower end thereof. On the same general plane as the spin drive portion **60** is a spin wheel assembly or spin driven roller means **64** of the type taught in copending United States application, Ser. No. 430,264, filed Nov. 13, 1963, and an agitate wheel or agitate driven roller means **66** lies in the same plane as the agitate drive portion **62** of the driven shaft **58**. Interposed between the agitate end portion **62** of the driven sleeve **58** and the agitate wheel assembly **66** is an agitate roller or idler **68** which is spring loaded and laterally floating to make it self-energizing in accordance with the explanation of such mechanisms set forth in the United States application, Ser. No. 430,265, filed Feb. 4, 1965, now Patent No. 3,287,942, by Brackman et al. Similarly, a self-energizing spin roller or idler **70** lies between the spin drive portion of the driven sleeve **58** and the spin wheel assembly **64**. The spin driven roller means **64** is associated with a brake system **71** that is actuated by relative movement set up during deceleration between the roller drive mechanism **42** and the spin tub **24** in a manner more specifically set forth in the United States Patent No. 3,087,321, issued Apr. 30, 1963, to Brucken.

In general, the operation of the motor **54** in the direction of the arrows shown in FIGURE 4 will drive the agitate wheel **66** through the agitate roller **68**, this driving motion being translated into reciprocation through a rocker arm assembly **72** more specifically set forth in the above-described Brucken patent. Conversely, when the motor **54** is reversed from the operation shown by the arrows in FIGURE 4, the spin roller **70** will be drawn into a wedging driving connection between the spin drive portion **60** of the driven sleeve **58** and the spin wheel **64** to rotate the spin tub **24** through the spin shaft **48**.

In the illustrated arrangement, to prevent scuffing of either the agitate roller **68** or spin roller **70** against the drive sleeve **58** due to overrunning produced during a period when either one of the rollers is not in power train transmitting relationship with the drive force transmitted by the motor **54**, a roller retractor device **74** is provided in association therewith of a type more specifically set forth in the above-mentioned copending application of Brackman et al.

Referring now to FIGURE 3, the drive shaft **56** of the motor **54** is shown as being directed through the sleeve **58** and having the lower end thereof secured to an impeller **76** of a drain pump **78** that includes an inlet **80** connected to a conduit **82** in communication with the interior space **20** of the water container **16** and an outlet (not shown) that is adapted to be connected to a suitable drain from the machine **10**. The shaft **56** is driven at motor speed and represents a first motor output shaft for driving a constant load represented by the pump **78**. The pump **78** has a pump chamber forming casing portion **81** secured to a top cover plate **83** having upwardly directed extensions **84** thereon secured to depending arms **86** off the housing of the motor **54**. A suitable seal assembly **88** is disposed about the end of the shaft **56** directed into the pumping chamber of the drain pump **78** to present a water-tight seal between the cover **83** and the shaft **56**.

An energizable coil **90** of the magnetically operated slip clutch **40** is secured on the top cover **83** of the pump **78** concentrically of the shaft **56** and driven sleeve **58**. Within the coil **90** is located a cup-shaped member **92** of magnetic material having the base thereof turned inwardly at **94** and secured to a key member **96** fit into a groove **98** in the end of the shaft **56**. An annular disc member **100** of non-magnetic material has the inner peripheral edge thereof supported by the cup-shaped member **92** in overlying relationship with the coil **90**. The disc **100** serves as a support for an annular member **102** of a suitable frictional clutch facing material. Above the friction material carrying disc **100** is located a cup-shaped armature member **104** of the clutch including a radially inwardly located tubular portion **105** fixedly secured to the small diameter end of the driven sleeve **58** and an outer peripheral portion **106** having a plurality of teeth **108** formed on the end thereof. The outer peripheral ring **106** is telescoped over the outer periphery of the coil **90** and is located in close spaced relationship with a speed pickup tachometer **110** that has a permanent magnet portion **112** thereof received within the extension **84** or a like suitable fixed support point to closely align one end of the permanent magnet **112** in close spaced relationship with the teeth **108** on the cup-shaped armature portion **104** of the clutch **40**. The speed pickup tachometer further includes a coil **114** around the permanent magnet **112** in which is induced a current generated as the teeth **108** are rotated with respect to the permanent magnet **112**.

The sleeve **58** is rotatably supported on the drive shaft **56** at the large diameter or spin drive portion **60** thereof by a bearing **116** and the opposite end thereof likewise is rotatably supported on the drive shaft **56** by a bearing **118**. Upon energization of the coil **90**, the sleeve **58** and cup-shaped armature member **104** are axially moved along the shaft to produce a frictional engagement of the inner surface of the armature **104** with the annular friction material **102** on the disc member **100** which is being rotated with respect to the armature **104** by the drive shaft **56** of the motor **54**. The magnetic flux from the coil **90** passes through a circuit including the cup-shaped member **92** and the armature member **104** across an effective air gap **120** between the base of the member **92** and the inner surface of the armature **104**. The attractive force

of the flux of the coil **90** will vary the frictional engagement between the armature **104** and the rotatable annular friction member **102** so as to produce a predetermined slip between the drive disc **100** and the driven armature **104** whereby the speed of rotation of the axially movable sleeve **58** will vary to a greater or lesser degree so as to vary the speed of the spin tub **24** and agitator or pulser **34** connected to the driven sleeve **58** through the roller drive mechanism previously described. The shaft **56**, clutch **40** and sleeve **58** effectively serve as a second output shaft from the motor **54** to drive variable loads represented in the illustrated arrangement by the agitator **34** and the spin tub **24**.

Another advantage of the illustrated arrangement of the slip clutch between the drive shaft **56** and the driven sleeve **58** is that the heat generated by the slip clutch **40**, in part, is dissipated by conduction through the drain pump **78**. Furthermore, the slip clutch **40** is arranged compactly between the drive shaft **56** of the motor **54** and the roller-matic drive mechanism and requires little or no modification to roller drive mechanisms of the type set forth in the previously mentioned Brucken patent.

Referring now to FIGURE 2, a control circuit for the energizable coil **90** of the magnetic slip clutch **40** is illustrated as including a step transformer **122** having a primary coil **124** with one end thereof connected to a wire L_1 and the opposite end thereof connected to a wire L_2. The secondary coil **126** of the transformer **122** is center tapped by a conductor **128** and the ends of the secondary coil **126** are connected to conductors **130**, **132**, respectively, each of which includes a diode **134**, **136** for producing a full wave rectification of the power input through the transformer **122** across conductors **138**, **140** constituting a direct-current source of power to the control circuit. A capacitor **142** is connected across the conductors **138**, **140** to filter AC pulses from the DC supply. A conductor **144** across the conductors **138**, **140** includes a Zener diode **146** for regulating the DC power supply thereacross to a predetermined value.

The control circuit further includes a preprogrammable reference or speed norm network **148** for varying the set speed of the agitator and spin tub in the washing machine **10**. The network **148** includes a resistance **150** in the conductor **140** and a resistance **152** connected in a conductor **154** across the conductors **138**, **140**. The resistances **150**, **152** maintain a predetermined voltage across an agitate speed control potentiometer **156** and a spin speed control potentiometer **158**. The agitate speed control potentiometer **156** includes a resistance **160** in series with the resistance **152** across the DC power source and a movable contact carrying arm **162** that is connected to a manually adjustable preprogramming agitate speed knob **164** on the control panel **14** of the clothes washer **10**. The spin speed potentiometer **158** includes a variable resistance **166** electrically connected across the DC power source in series with the resistance **152** by a conductor **168** and it further includes a movable contact carrying arm **170** that is operatively connected to a manually adjustable preprogramming spin speed knob **173** for presetting a desired spin speed of operation with the knob **173** being located on the control panel **14** adjacent the agitate speed control knob **164**.

By varying the positions of the contact carrying arms **162**, **170** with respect to the resistances **160**, **166**, a variable reference potential is maintained at a pair of spaced apart contacts **172**, **174** electrically connected to, respectively, the movable contact carrying arms of the spin speed potentiometer **158** and the agitate speed potentiometer **156**. The contacts **172**, **174** are selectively contacted by a double-throw, single-pole switching arm **176** operated by the timer control **36** during the cycle control operation thereof.

The timer controlled switch **176** is electrically connected to a conductor **178** that connects to a speed pick-up signal circuit **180** including the coil **114** of the speed tachometer **110**, as seen in FIGURE 3. One side of the coil **114** is electrically connected to a conductor **182** that includes a rectifying diode **184**. The conductor **182** also connects to one end of a resistor **186** which has the opposite end thereof electrically connected by a conductor **188** to the opposite side of the coil **114**. The speed signal circuit **180** is electrically connected by conductor **190** to the base of a control transistor **192** having its emitter connected by a conductor **194** to the conductor **138**. The collector of the transistor **192** is connected by a conductor **196** to the base of a power supply transistor **198**. The power supply transistor **198**, under the control of the transistor **192**, controls the energization of a power circuit including the energizable coil **90** of the slip clutch **40**.

More particularly, the power supply circuit for the coil **90** is completed from the conductor **140** through a conductor **200** connected to one side of the coil **90** thence through a conductor **202** connected to the opposite side of the coil **90** which is electrically connected to the emitter of the transistor **198**. The collector of the transistor **198** is electrically connected to a conductor **204** that is electrically connected to the conductor **138** whereby, when the power transistor **198** is conductive, non-cyclic current of a predetermined steady state value will flow through the transistor **198** from the conductor **140** to the conductor **138** to produce a predetermined frictional drive between the armature **104** and the drive disc **100** of the slip clutch **40**.

The control circuit further includes a capacitor feedback circuit from the collector of the control transistor **192** through a conductor **206** which electrically connects to one side of a capacitor **208** that has the opposite side thereof electrically connected by conductor **210** to the conductor **188** of the speed signal circuit **180** thence to the base of the control transistor **192**. The capacitor **208** between the base and the collector of the transistor **192** will filter any large magnitude pulses from the speed signal circuit without any appreciable delay in the response of the transistor circuit since the peak voltages of the pulsing signal therein are balanced across the collector and base of the transistor **192** to offset one another.

A further feature of the illustrated circuit is a voltage divider resistance **212** in the conductor **204** that produces a potential across a resistance **214** that is electrically connected from the conductor **204** to the base of the control transistor **192**. The resistance **212** is of a magnitude that will not appreciably reduce the current flow through the coil **90** when it is energized. The resistance of the resistor **212** is sufficient, however, to produce a voltage differential across the resistance **214** to cause a small current flow to the base of the control transistor **192**. As current from the collector to the emitter of transistor **198** progressively increases the current flow through the resistor **214** is increased to thereby produce an effective amplification of the control signal for regulating the conductivity of the power supply through the power transistor **198** whereby the pair of transistors **192**, **198** are more sensitive to the differential between the control potential at the conductor **178** and the induced potential in the speed signal circuit **180**.

By virtue of the above-illustrated arrangement, the washer **10** is conditioned for a control cycle of operation by turning on the timer control **36**, and presetting the agitate speed control knob **164** to a desired rate of pulsation and the spin speed control knob **173** to a desired rate of rotation of the spin tub.

When the timer control **36** enters a washing cycle of operation, in the illustrated arrangement, the timer control switch **176** is positioned, as shown in FIGURE 2, to connect the agitate speed potentiometer **156** in the speed signal circuit **180**. The movable contact **162** of the agitate speed potentiometer **156** is positioned with respect to the resistance **160** to produce a control voltage at the conductor **178** to produce a predetermined rate of pulsation of the agitator **34**.

Initially, as the drive motor **54** is energized to drive

the agitator **34**, the slip clutch **40** will be driven toward the desired speed necessary to produce the rate of pulsation as established by the agitate speed control **164**. Since the clutch **40** is initially off, the speed signal circuit **180** will have a low initial potential induced therein and the control potential from the reference or control circuit **148** will act on the base of the control transistor **192** to condition the power transistor **198** for full conductivity whereby the full potential across the conductors **140, 138** will pass through the coil **90**. This causes the movable armature **104** to be drawn axially along the drive shaft **56** into tight engagement with the annular ring of friction material **102** on the drive member **100** of the slip clutch **40**. As a result, there is no slip between the drive disc **100** and the driven armature **104** and the driven sleeve **58** will be rotated with respect to the idler roller **68** which is held by the retractor assembly **74** in driving engagement with the sleeve **58**. During this phase of operation, the spin idler roller **70** is retracted out of engagement with the driven shaft **58**. The drive is transferred from the agitate idler roller **68** thence through the agitate wheel or agitate driven roller means **70** thence through the agitate rocker arm assembly **72** to cause the agitator shaft to pulse at a predetermined rate. As the speed of rotation of the armature **104** approaches the speed required to produce the desired rate of pulsation of the agitator **34**, the teeth **108** will move with respect to the magnet **112** of the speed pickup tachometer **110** to induce an AC voltage in the coil **114** that will produce a signal in the circuit **180** that will balance the reference signal established by the preprogrammable reference control circuit **148**. As this occurs, the current in the base of the control transistor **192** will drop to cause a commensurate drop in the non-cyclic DC current flow through the power transistor **198** which flow reaches a predetermined base value or steady state condition that causes an energization of the coil **90** whereby the movable armature **104** will be attracted to a predetermined degree against the friction material **102** on the drive disc **100** of the clutch **40** to produce a substantially constant slip therebetween that will maintain a rate of rotation of the driven sleeve **58** necessary to maintain the desired rate of pulsation of the agitator from the roller-matic drive system associated with the driven sleeve **58**. The control thereafter continually energizes the coil **90** in a modulated fashion in response to the speed signal to maintain the set speed.

One advantage of the illustrated system is that where agitators of washing machines or like driven components of like domestic appliances are continually subjected to a variable loading, for example, in the illustrated arrangement, the agitator **34** is subjected to a maximum loading both on its upstroke and its downstroke which tends to produce a torque on the agitate shaft **50** of a magnitude to cause the unit to tend to stall with a predetermined slip in the clutch **40**. However, as the agitator is subjected to such magnitudes of loading, the increased torque on the agitate shaft **50** will cause an immediate reduction in the speed of the armature **104** of the clutch **40** to cause an immediate reduction in the magnitude of the signal generated in the speed signal circuit **180** by the speed tachometer **110**. As a result, the control potential will be increased on the control transistor **192** to immediately increase the conductivity of the power transistor **198** whereby the clutch **40** is conditioned to overcome the increased torque on the agitate shaft **50** whereby the agitator **34** will not be appreciably hindered in its travel by the increased magnitude forces imposed thereon. As a result, the agitator **34** will pulsate very smoothly at or very close to the desired pulsing rate established by manual setting of the agitate control knob **164**.

The control transistor **192** and the power transistor **198** are characterized by a high gain that enables the energization of the coil **90** to effect a continual high torque output from the slip clutch **40** until it is closely approximate to the desired control point at which time the controller will respond sharply to back off the coil energization to produce a slip in the clutch to give the desired rate of pulsation set by the manually adjustable agitate speed controller **164**. Thus, a small differential between the pickup signal and the reference voltage will condition the transistors **192, 198** to obtain an immediate and substantial change in the energization current through the clutch coil **90**. The controller thereby acts as a very sensitive proportioning device to modulate the current through the coil **90** continually in response to increased loadings on the agitator to produce a very efficient washing action by the agitator **34**.

Following the washing cycle of operation, the timer control **36** conditions the motor **54** and another retractor assembly (not shown) similar to the spin idler retractor **70** to disengage the agitate idler roller **68** from the driven shaft **58** and to move the spin idler roller **70** into driving engagement with the driven sleeve **58**. During this phase of operation, the driving action of the motor **54** is transferred from the drive shaft **56** through the slip clutch **40** and the driven sleeve **58** thence through the spin idler roller **70** and the spin drive member **64** to the spin shaft **48** whereby the spin tub **24** is rotated for extracting washing fluid therefrom. The action of the controller during a spin cycle of operation is substantially like that set forth in the agitate or washing cycle of operation. Initially, the motor **54** is conditioned off and the slip clutch **40** is at a rest position. The timer switch **176** is positioned by the timer control **36** to electrically engage the contact **172** whereby a spin speed reference potential is directed through the conductor **178** depending upon the positioning of the spin speed potentiometer **158** by the spin speed control knob **172**. This potential will produce a current on the base of the control transistor **192** which then will condition the power transistor **198** to fully energize the coil **90** whereby the armature **104** of the slip clutch **40** will be held in tight engagement with the drive disc **100** thereof to direct the full torque of the motor **54** into the spin portion of the roller drive mechanism **42**. The spin tub **24** thereby is brought quickly up to a speed approaching that set by the spin speed control knob **172** and the teeth **108** on the armature **104** will induce a voltage in the speed signal circuit **180** that will bias the reference control potential whereby the control transistor **192** will be conditioned to reduce the conductivity of the power supply transistor **198** to effect an immediate and substantial change in the energization of the clutch **40** back to a base or steady state condition to produce a desired degree of slip between the drive shaft **56** and the driven sleeve **58** to maintain the desired rate of spin rotation in the washer **10**. By continually modulating the base energization of the coil **90** in the clutch to effect the spin speed control, the tub conditioned brake **71** of the roller drive system as discussed above is only rendered operative when the motor **54** is de-energized. Otherwise, if the clutch **40** were to be turned on and off during the controlling thereof rather than having the energization of the coil **90** modulated, the brake **71** would become operative to produce an undesirable effect on the operation of the machine during its spin cycle of operation.

It will be appreciated by those skilled in the art from the foregoing explanation of the present invention that applicant has developed an improved infinite speed domestic appliance which in the illustrated washer includes means for selectively controlling the action of an agitating component and a spin tub in an automatic washer wherein an energizable slip clutch is associated with the agitator and spin tub and selectively continually controlled by circuit means including means for presetting the speed of operation of the appliance and for automatically controlling that speed by modulating a predetermined non-cyclic energization of the coil to produce a smooth agitation action through a wide range of control points as well as to closely maintain the rate of rotation of the spin tub at a desired predetermined control point selected from a

wide range of control speeds. By virtue of the improved agitation and spin speed action in the washer, the unit is adapted for cleaning a wide variety of fabrics with a gentle hand laundering type agitation and spin action being available for certain delicate fabrics, a more moderate action being available for certain types of wash and wear fabrics and a variety of other control positions necessary to produce adequate cleaning of various heavy-duty fabrics or the like.

Another aspect of the present invention as set forth above is a variable speed domestic appliance including a drive system for attaining the improved variable speed wherein a single motor has a first output shaft for driving a constant load at motor speed and a second output shaft including slip clutch means for varying the speed of the second output shaft by varying the energization of the slip clutch in accordance with variable loads driven by the second shaft as manifested in the illustrated arrangement by a speed pickup signal of the speed of the output of the slip clutch.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a washing machine, a tub, means for agitating in said tub, means for rotatably supporting said tub, a motor, power transmitting means drivingly connecting said motor to said tub and said agitating means for rotating said tub and moving said agitating means, said power transmitting means including a plurality of self-energizing motion transmitting rollers having different moment arms, said power transmitting means further including means for selectively transmitting motion through different combinations of rollers to select different predetermined speed ratios between said motor and said tub and said agitating means, said power transmitting means further including an energizable magnetic clutch including a drive member connected to said motor and a driven member connected to said plurality of self-energizing motion transmitting rollers, semiconductor switch means in power supply relationship with the coil of said magnetic clutch means for maintaining a predetermined non-cyclic power supply thereto, means for deriving a control voltage responsive to the speed of rotation of the driven member of said clutch means, means for processing said control voltage for modulating the non-cyclic power supply of said semiconductor switch means to maintain said slip clutch at a predetermined speed norm, and speed norm programmer means for varying the modulation of said semiconductor switch means within predetermined limits to operate said self-energizing motion transmitting rollers for producing a desired agitating means, cleaning action and spin tub extraction during the operative cycles thereof.

2. In a washing machine, a tub, means for agitating in said tub, means for rotatably supporting said tub, a motor, power transmitting means drivingly connecting said motor to said tub and said agitating means for rotating said tub and for moving said agitating means, said power transmitting means including an energizable magnetic clutch including a drive member drivingly connected to said motor and a driven member, means for connecting said driven member to said tub and said agitating means, semiconductor switch means for directing a predetermined non-cyclic power supply to said slip clutch to establish a predetermined slip between said drive member and said driven member, and means for modulating said non-cyclic power supply in response to variable driven loads to maintain a smooth agitator cleaning action and spin tub extraction during the operative cycles thereof.

3. In the combination of claim **2**, said means for modulating the energization of said semiconductor switch means including means for deriving a control voltage responsive to the speed of said driven member of said clutch, means processing said control voltage responsive to the speed of said driven member of said clutch, said means processing said control voltage for controlling conductivity of said semiconductor switch means to modulate the energization of the coil of said magnetic clutch means to maintain a predetermined speed norm of operation of said agitator and said tub.

4. In the combination of claim **3**, said means for modulating the conductivity of said semiconductor switch means including first presettable means to establish a first modulation of the conductivity of said semiconductor switch means during the agitate cycle of operation and second presettable means to establish a second modulation of said semiconductor switch means during the spin cycle of operation.

5. In the combination of claim **3**, said semiconductor switch means including a power transistor and means for connecting the coil to said magnetic clutch across a DC power source, a control transistor for regulating the conductivity of said power transistor, means for producing a predetermined reference potential and means for comparing said predetermined reference potential with said control voltage to condition said control transistor to continually modulate the conductivity of said power transistor.

6. In the combination of claim **4**, said first presettable means including means for varying the first modulation of the semiconductor switch means and said second presettable means including means for varying the second modulation of said semiconductor switch means.

7. In the combination of claim **5**, a resistance in series connection with the collector of said power transistor, a second resistance electrically connected between the conductor of said power transistor and the base of said control transistor, said second resistance directing a predetermined current to the base of said control transistor for improving the sensitivity thereof to the differential between said control voltage and said reference voltage.

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