

[54] **PHASE SHIFT TO PREVENT RELAY CONTACT EROSION IN A CLOTHES DRYER**

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[51] Int. Cl.² **F26B 19/00**

[58] Field of Search **34/44, 45, 46, 48, 53, 34/55; 307/138**

[56] **References Cited**

UNITED STATES PATENTS

3,662,186 5/1972 Karkiys..... 34/45

3,702,030 11/1972 Janke..... 34/45
3,707,634 12/1972 Arlen et al..... 307/138
3,762,064 10/1973 Offutt 34/45
3,769,716 11/1973 Janke et al..... 34/45

Primary Examiner—Charles J. Myhre

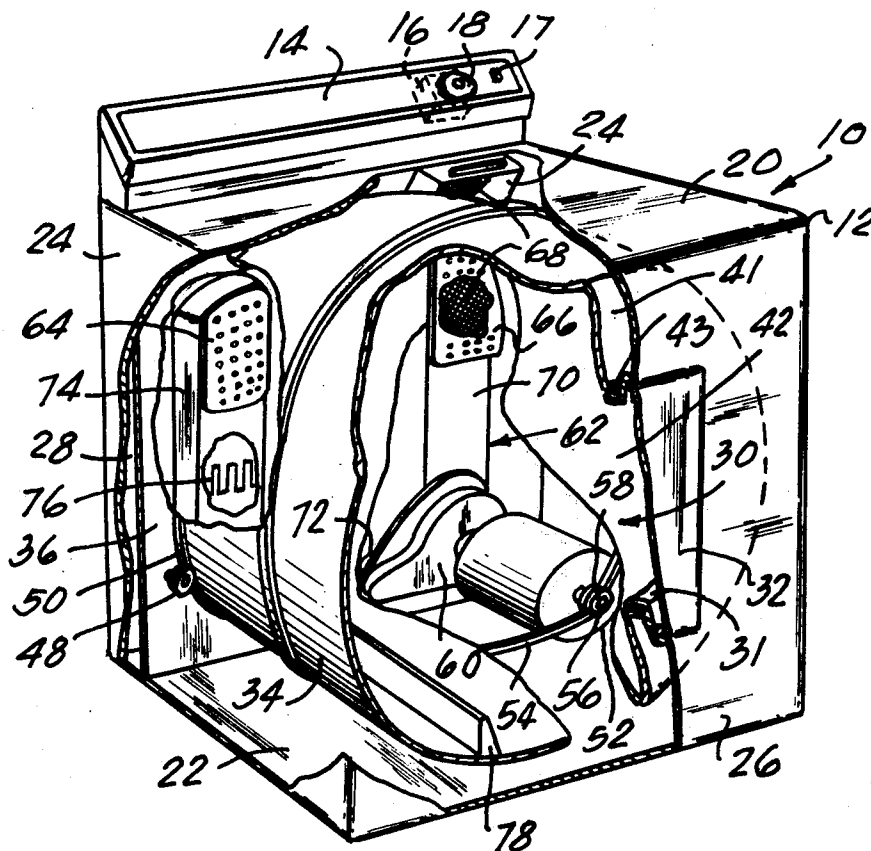
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[57] **ABSTRACT**

In a clothes dryer, an integrated circuit control which governs the operation of an alternating current relay through a phase shift circuit for shifting the point of operation of the relay 180° to provide relay operation at reverse line polarities to prevent relay contact erosion. The drive motor relay is the most active and therefore the one relay precisely controlled, although other relays are also controlled by the circuit.

5 Claims, 6 Drawing Figures



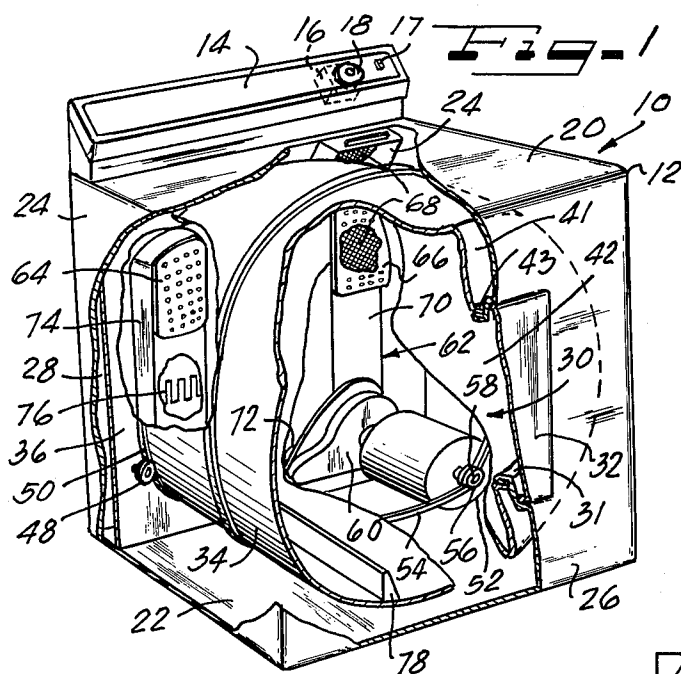
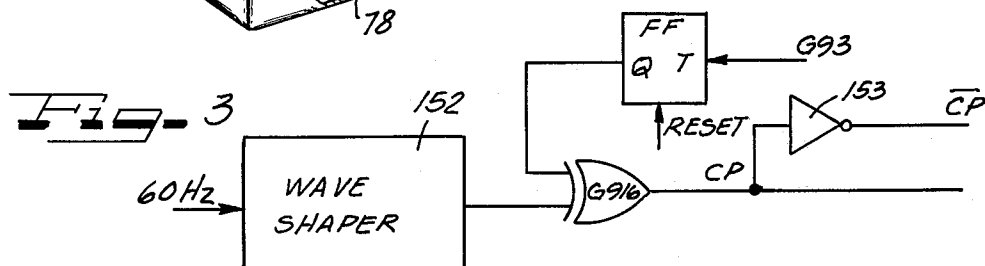


Fig. 4

WAVE SHAPER	Q	CP
1	0	1
0	0	0
1	1	0
0	1	1



60HZ
SHAPED LINE CYCLE

CP

$\overline{CP}$

G811

G913

QFF2

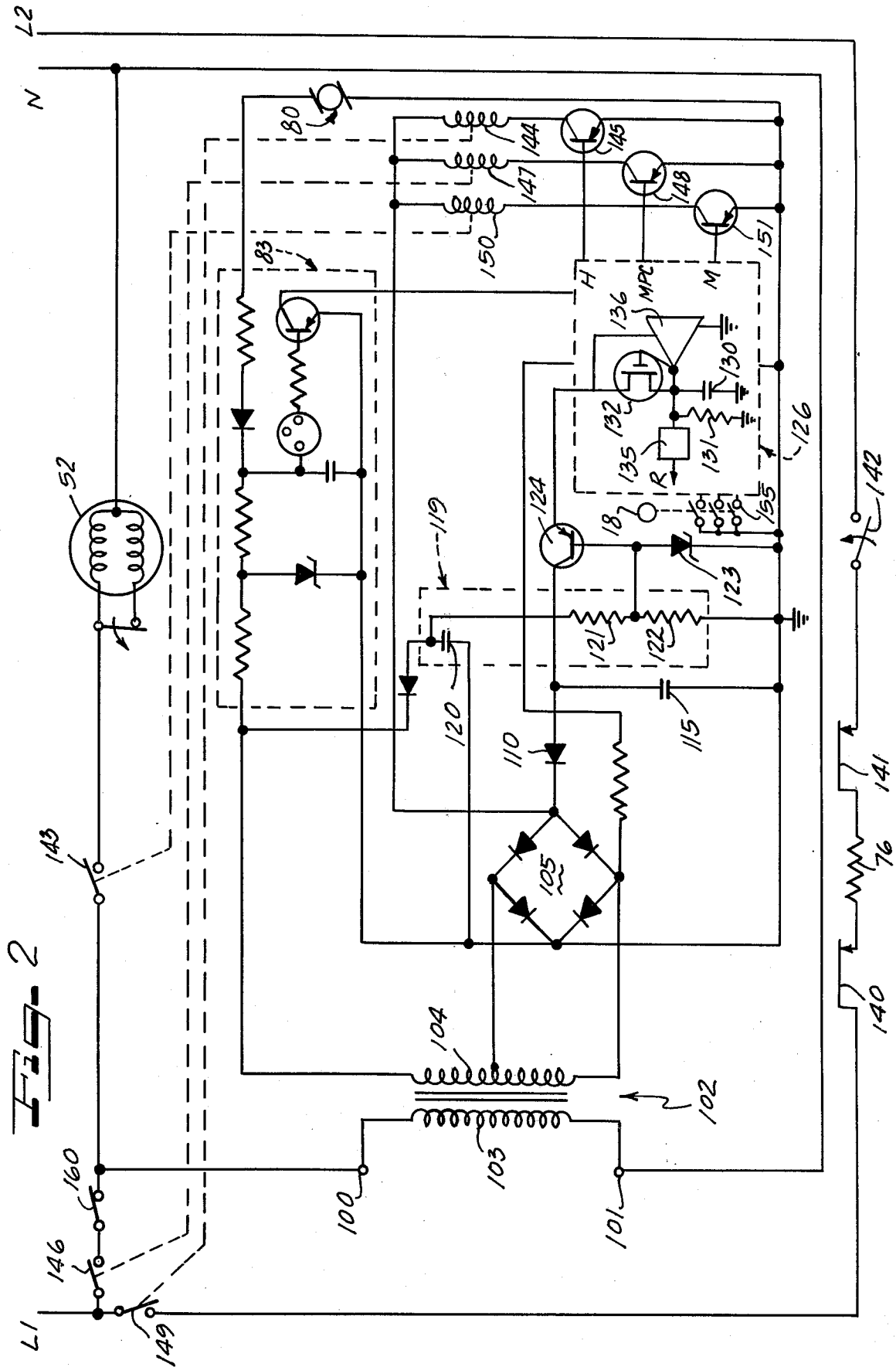
M1

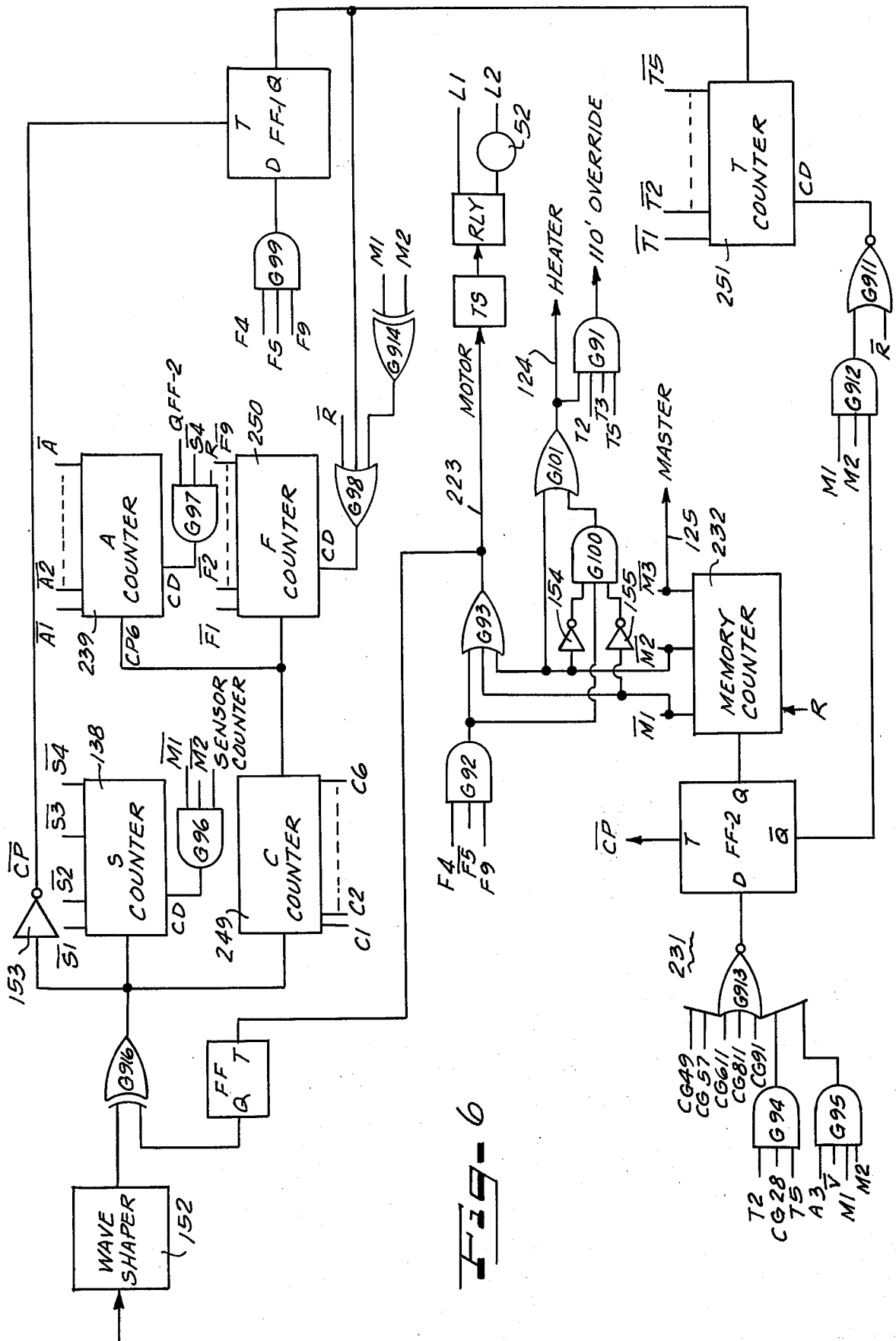
M2

G93

Q

Fig. 5





PHASE SHIFT TO PREVENT RELAY CONTACT EROSION IN A CLOTHES DRYER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a circuit for controlling the operation of a relay, and is more particularly concerned with a circuit for preventing contact erosion of an alternating current relay controlled by an integrated circuit which has a line frequency derived clock.

2. Description of the Prior Art

In my U.S. Pat. No. 3,702,030, issued Nov. 7, 1972 and assigned to the assignee of the present invention, there was disclosed an integrated circuit control for a dryer which operates on a digital basis and which derives its clock from the conventional power supply line frequency waveform. The disclosed integrated circuit control performs all of the functions of the conventional timer motor cam-stack dryer control to govern the operation of such controlled elements as the dryer motor, the heater, and the master power connection. A relay and a relay driver may be interposed between the integrated circuit and the corresponding controlled component. It has been discovered that the relay contacts open at the same point in the line cycle due to the precise nature of the integrated circuit and its response to the line derived clock pulses. Consequently, the alternating current at the contacts is effectively a direct current upon opening of the contacts so that metal is always transferred in the same direction causing contact erosion and reduced contact life.

U.S. Pat. No. 3,707,634 discloses a circuit which may be utilized for controlling traffic signal lights and which provides alternate line cycle polarity on successive relay operations to prevent contact erosion. The circuit derives a signal which is coupled to the relay load to effect the line polarity switching. An external command signal may be utilized with the circuit to effect the line polarity switching.

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide a circuit for switching polarity at the motor relay contacts each time such contacts open because in a dryer having an anti-wrinkle cycle these contacts are the most active.

A further object of the invention is to provide a circuit which will switch polarity of the motor relay contacts at each successive operation, provide some random polarity switching of other relay contacts, and which is fabricated as a part of the integrated circuit that contains the integrated circuit dryer control.

The integrated circuit dryer control includes a plurality of counters and decoding circuits which operate in response to elapsed time and drying program status to control the dryer operational components, such as the drive motor, heater and master control. An EXCLUSIVE OR gate and a flipflop are additionally provided on the integrated circuit chip to reverse the line derived clock pulses in response to operation of the drive motor control portion of the circuit. Thereby reversed polarity is provided for the motor and heater relays upon successive operations, and random line polarity for the master control relay. The EXCLUSIVE OR gate receives the line derived clock pulses and the output of the added flip-flop. The flip-flop is toggled by the output of the motor control portion of the integrated circuit

cuit to effect polarity reversal of the clock pulses each time the drive motor is operated. The flip-flop is provided with a reset input to reset the flip-flop to the same state each time that the dryer is restarted.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention, its organization, construction and operation will be best understood from the following detailed description of a preferred embodiment thereof, taken in conjunction with the accompanying drawings, on which:

FIG. 1 is a fragmentary sectional view of a dryer which may employ the present invention;

FIG. 2 is a schematic circuit diagram of the dryer apparatus of FIG. 1;

FIG. 3 is a schematic logic circuit diagram of the phase shifting apparatus for practicing the present invention;

FIG. 4 is a truth table for the circuit illustrated in FIG. 2;

FIG. 5 is a timing diagram for the apparatus illustrated in FIGS. 3, and 6; and

FIG. 6 is a schematic logic circuit diagram of an integrated circuit dryer control constructed in accordance with the principles of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A more detailed description of the integrated circuit dryer control is disclosed by Carl R. Offutt in his U.S. Pat. No. 3,762,064 entitled "Timer With Cycle And Time Dependent Runout For Dryer," and in his United States Patent application entitled "Shutdown Circuitry for I.C. Controlled Dryer" No. 358,092; filed May 7, 1973, now U.S. Letters Pat. No. 3,802,091 both Offutt inventions being assigned to the assignee of the present invention. FIG. 6 of this patent application is essentially FIG. 8 of the aforementioned Offutt U.S. Pat. No. 3,762,064, revised to incorporate apparatus which embodies the present invention. The teachings of my aforementioned U.S. Pat. No. 3,702,030, and the aforementioned Offutt U.S. Pat. No. 3,762,064, and Offutt application Ser. No. 358,092 are fully incorporated herein by this reference, and a brief discussion of the above Offutt disclosures as they relate to the present invention will be given below to enable one skilled in the art to practice the present invention.

Referring to FIG. 1, a clothes drying appliance is generally referenced 10 and is shown as comprising an enclosure cabinet 12 having a control console 14 thereon housing a control device 16 for regulating the drying operation. A control knob 18 is selectively operable to set the control device 16 for programming various drying cycles of operation, as, for example, automatic or timed drying cycles. The enclosure cabinet 12 comprises a horizontal top panel 20 and a horizontal bottom panel 22, a pair of vertical side panels 24 and vertical front and rear panels 26 and 28, respectively. An access opening 30 is provided in the front panel 26 and is defined by an axially in-turned flange 31. A closure door 32 is located in the front panel 26 and cooperates with the access opening 30 for loading and unloading the dryer 10.

The dryer 10 further includes a drying container for tumbling clothes, the container being in the form of a rotatable drum 34 housed within the cabinet 12 and extending axially from the front panel 26 to a bulkhead

36 spaced forwardly of the rear panel 28. To encourage tumbling action in the clothing being dried, a plurality of circumferentially spaced baffles 78 (only one being illustrated) project from the inner surface of the drum 34. The drum 34 includes a radially inward extending front closure wall 41 having an access opening 42 therein formed by means of an axially outturned flange 43. The flange 43 provides a forwardly extending bearing annulus which overlies and is suitably journaled on the complementary flange 31 of the cabinet 12. It is readily apparent from the foregoing description that the opening 42 into the drum 34 and the opening 30 formed in the front panel 26 are concentric and provide access into the rotatable drum 34 from the outside of the cabinet 12. The drum 34 is supported at the rear by a pair of support rollers 48 (only one being illustrated) mounted on the bulkhead 36. A raceway in the form of a circumferential groove 50 indented into the peripheral wall of the rear portion of the drum 34 serves as a track for the rollers 48.

A drive motor 52 is mounted to the bottom panel 22 in a rear corner of the cabinet 12 and rotatably drives the drum 34 by means of a drive belt 54 extending around the periphery of and in frictional engagement with the drum 34 and around a motor pulley 56 mounted at one end of a motor shaft 58. The other end of the motor shaft 58 drives a blower 60 which is arranged to circulate air through the drum 34. The blower 60 is positioned between the rear panel 28 and the bulkhead 36 and communicates with ductwork forming part of the warm air system for the dryer generally indicated at 62.

The bulkhead 36 serves to enclose the open-ended rear portion of the drum 34 and provides a fixed rear wall in which is located a pair of spaced openings comprising an air inlet 64 and an air outlet 66. The blower 60 draws moisture-laden air from the interior of the drum 34 through the outlet 66, through a removable lint screen 68, through an air duct 70 to the blower 60 and then blows the air out of the cabinet 12 through an exhaust duct 72. Air exhausted from the drum 34 is replaced by ambient air entering the warm air system 62 by way of an intake opening in the rear panel 28 (not shown) and is drawn through a fresh air duct 74 passing over a heater means 76 and into the drum 34 through the air inlet 64. The warm air system 62 thus circulates a stream of warm air through the drum 34, subjecting clothing placed therein to a drying environment to remove moisture from the fabrics while the clothing is tumbled as the drum rotates.

The controlled elements, for example the drive motor 52, and heater 76, of the dryer illustrated in FIG. 1 may be controlled by an integrated circuit dryer control, as disclosed in my aforementioned U.S. Pat. No. 3,702,030 and in Offutt U.S. Pat. No. 3,762,064 and Offutt Patent application Ser. No. 358,092 wherein relays are employed to effect connection and disconnection of line current with respect to the drive motor, heater, and master power control contacts. The relays, and their transistor switch or relay drive circuits are, in turn, controlled by a corresponding output of the integrated circuit which goes logically high and low at the appropriate times in the drying program to indicate on and off conditions of the drive motor.

With the foregoing concept of dryer operation and integrated circuit control of such operation in mind, and turning to FIG. 2, a schematic circuit diagram for

the dryer of FIG. 1 is shown. The dryer is connected to a power supply, for example a three-wire 230 volt AC electrical power supply, at terminals L1, L2, and N. With such a power supply, a 230 volt potential is provided across terminals L1-L2. The circuit is divided such that one portion of its components is generally associated with 115 volt operation from terminals L1-N and another portion of its components is associated with 230 volt operation provided by way of terminals L1-L2.

More specifically, the portion of the circuit associated with terminals L1-L2 comprises the heater 76 serially connected with an operating thermostat 140, a safety thermostat 141, a switch 142 centrifugally operated by the motor 52 at a predetermined speed, and relay contacts 149 controlled by a coil 144 such that the heater is energized across terminals L1-L2 when contacts 149 are closed and the motor reaches the predetermined speed to close switch 142.

The circuit associated with L1-N comprises a motor 52 serially connected with motor relay contacts 143, normally closed door switch 160, and master power control relay contacts 146 across L1-N. Further, a transformer 102 is connected across terminals L1-N as will be more fully explained. Associated with and receiving power from the transformer 102 are the sensor circuit 83, sensor 80, and a rectifier 105 which supplies DC power to the integrated circuit 126. A detailed explanation of the sensor circuit may be had by reference to my aforementioned U.S. Pat. No. 3,702,030. The integrated circuit 126, which may be embodied in a chip, provides output control signals M, MPC and H which control the conduction of respective transistors 151, 148, 145 causing energization of respective relay coils 150, 147, 144. The relay coils 150, 147, 144 respectively control closure of contacts 143, 146, 149, whereby output signals M, MPC, and H respectively control energization of the motor 52, the master power control contacts 146 and heater 76.

In operation, manual closure of contacts 146 through a push to start button on the console 14 energizes the integrated circuit to provide output signals M, MPC and H to cause energization of the motor, heater and the master power control relay contacts 146 for operation of the dryer through a drying program under the control of the integrated circuit 126 determined by a selector switch 155 in association with control knob 18.

The energization of the integrated circuit 126 is controlled by circuitry associated with the power supply 102 as in hereinabove explained. The integrated circuit 126 is shown connected through a D.C. power supply and a D.C. shutdown circuit to the transformer 102. In the integrated circuit 126, a reset pulse, referenced by the output R, is generated to reset the integrated circuit memory to an initial state, for example to zero. If for any reason power is removed from the integrated circuit 126 and the reset pulse R is not produced, the memory may assume a random state. In developing the reset pulse R in a circuit 135, which may be a gate circuit, a capacitor 130 is utilized to provide a delay in the pulse generation. When power is removed from the integrated circuit or chip 126, the capacitor 130 must be completely discharged in order that the circuit 135 and the amplifier 136 can cooperate again to produce the reset pulse R. A transistor 132 is utilized to bleed off charge on the capacitor 130 when power is removed from the chip. However, the transistor 132 ceases to

conduct at approximately 4.5 volts and, therefore, a resistor 131 is connected in parallel with the capacitor 130 to bleed the remaining charge from the capacitor. In order for the pulse R to be generated after an interruption of power to the integrated circuit 126, as by the opening or closing of the dryer door, or by the termination and then restarting of the dryer, the voltage must be quickly removed from the integrated circuit chip in order that the time required to bleed the capacitor to zero will be available before the machine can be restarted. The circuit illustrated in FIG. 2 for performing this function comprises the power transformer 102 having a primary winding 103 which is connectible to the 115 volt supply at the terminals 100, 101 and a secondary winding 104, a full wave bridge rectifier 105, a diode 110, a filter capacitor 115, an emitter-follower voltage regulator including a transistor 124 and a Zener diode 123, and the D.C. shutdown circuit indicated at 119 including a resistor 121, a resistor 122 and a capacitor 120.

Referring to FIGS. 3 and 4, a phase shift circuit for ensuring reverse polarity at the relay contacts upon alternate openings of the relay contacts, and a truth table for this circuit are illustrated. In FIG. 3, a wave shaper 152 is employed to change the 60Hz sinusoidal line waveform to a corresponding squared waveform. Ordinarily, the squared waveform constitutes the clock pulses CP for the integrated circuit control and an inverter 153 simultaneously provides the inverted CP pulses. According to the present invention, an EXCLUSIVE OR gate G916 may be connected to receive an input from the wave shaper 152 and to receive another input from the output Q of a flip-flop FF. The flip-flop FF has a toggle input T which is, in turn, fed by a portion of the integrated circuit control which is assigned to govern the operation of a controlled device. Here, the output is from a gate G93 which, as will become evident from the discussion below, is that portion of the integrated circuit control assigned to the drive motor. The flip-flop FF is therefore toggled in accordance with the status of the drive motor 52.

Referring to the truth table of FIG. 4, it is apparent that when the output Q of flip-flop FF is "0," the clock pulse CP is in phase with the output of the wave shaper 152. Also, when the output Q is "1," the clock pulse CP is out of phase with the wave shaper 152. This provides a 180° phase shift and all of the circuits of the integrated circuit control operate in accordance with this phase shift. Accordingly, the phase shift provides for relay operations during reverse line polarity.

Inasmuch as the motor output is the most active output during a drying program, this circuit has been utilized for reversal of the line polarity during repeated relay operations. As will be explained, this utilization of the motor output further provides line polarity reversal for the heater and master control relay contacts.

FIG. 5 is a timing diagram illustrating the operation of the apparatus of FIG. 3 as it is applied to the integrated circuit dryer control of FIG. 6. As previously indicated, the basic circuit of FIG. 6, is disclosed in the aforementioned Offutt U.S. Pat. No. 3,762,064. Briefly, the dryer control operates as follows. Referring to FIG. 2, manual closure of contacts 146 through a push to start button 17 on the console 14 energizes the integrated circuit to provide output signals M, MPC and H to cause energization of the motor 52, heater 76 and the master power control relay contacts 146 for

operation of the dryer through a drying program under the control of the integrated circuit 126 as determined by a selector switch 155 in association with control knob 18.

The energization of the integrated circuit 126 is controlled by circuitry associated with the transformer 102 as is hereinafter explained in detail. The integrated circuit 126 is shown connected through a D.C. Power supply and a D.C. shutdown circuit to the transformer 102. In the integrated circuit 126, a reset pulse, referenced by the output R, is generated to reset the memory counter 232 of FIG. 6 to an initial state, for example to zero.

The A.C. voltage applied to the primary winding 103 of the transformer 102 from terminals L1-N is transformed to approximately 30 volts, rectified by the full wave bridge rectifier 105 and filtered by the capacitor 115. Simultaneously, approximately 110 volts becomes available at the upper terminal of the secondary winding 104, is half wave rectified by a diode 125 and is then fed to the capacitor 120 as a half wave charging current. The charge on the capacitor 120 is then coupled to the base of the regulator transistor 124 through the voltage divider network including the resistor 121 and the resistor 122. When at least 90 volts is applied to the primary winding 103 of the transformer 102, sufficient current is delivered to the base of the transistor 124 to turn on the transistor and maintain the Zener reference diode 123 in conduction. This provides a regulated source of smooth D.C. voltage from the capacitor 115 to the integrated circuit 126. The values of the resistors 121 and 122 and the capacitor 120 are selected so that the RC time constant of the circuit supplying base current to the transistor 124 is very short. As a result, when an interruption in A.C. supply voltage occurs, the charge on the capacitor 120 is quickly exhausted and the current provided to the base of the transistor 124 is insufficient to maintain the transistor in conduction. The voltage on the base of the transistor falls to zero quickly, the transistor turns off and the D.C. current from the capacitor 115 is isolated from the integrated circuit 126.

Referring to FIG. 6, the wave shaper 152 squares the sinusoidal 60 Hz line waveform to provide a 60Hz pulse train CP as a clock for the control. As indicated in the drawing, the clock pulses CP actuate an S counter 138 and a C counter 149. The C counter 149 operates as a frequency divider for driving an A counter 139 and a F counter 150 at a slower rate than the S counter 138. With a 60 Hz clock and six stages in the C counter 149, the A counter 139 and the F counter 150 are actuated at approximately one pulse per second. The integrated circuit control also includes a memory counter 232 whose outputs are actuated through a drying program in accordance with sensed moisture conditions, elapsed time and completed portions of a program to control the drive motor 52, the heater 76 and the master power control contacts 146 for the dryer. The memory counter 232 is indexed by a memory index circuit 231 which includes a plurality of gates G94, G95 and G913 and a flip-flop FF-2. The gate G94, including the input CG28 which indicates the T3 and T4 outputs of the T counter 251, reads the outputs of the T counter 251 for indexing the memory counter 232. The T counter 251 and the F counter 250 record elapsed drying time. The gate G95 combines the M1 and M2 outputs of the memory counter 232 with the A3 output of the A

counter 239 and an indication of selection of an anti-wrinkle cycle ($\bar{V}$ input of gate G95) for indexing the memory counter 232 in accordance with such conditions. The gate G913, in addition to inputs from the gates G94 and G95, includes a plurality of other inputs for indicating timed cycle termination (CG49), auto drive cycle termination (CG57), proportional add-on time termination (CG611), cool down time termination (CG811) and maximum time drying override termination (CG91). Therefore, with the gate G913 in the logic 1 state and a pulse CP available, the control input D and the toggle input T of the flip-flop FF-2 have signals applied for indexing the memory counter 232. Most of the remainder of the circuit has no connection with the present invention, and is readily apparent from the drawing so that discussion thereof at this point is not necessary.

As can be seen in FIG. 6, the gate G916 has been interposed between the wave shaper 152 and the common input to the inverter 153, the S counter 138 and the C counter 249. Also, the flip-flop FF has been connected between the output of the gate G93 and one of the inputs of the gate G916.

Referring also to FIG. 5 the sequence of events occurring during clock pulse reversal is as follows. The first sinusoidal cycle illustrated in FIG. 4 for the line waveform, and for the shaped line cycle, is the last full clock pulse of a cool down function of the dryer. The output of the memory counter 132 is such that $M1 = 0$ and $M2 = 1$. The negative going edge of the pulse CP in the second line cycle is the final point in the cool down interval. An appropriate gate (not shown) which reads the output of the T counter 251 responds and causes the input CG811 of gate G913 to change to a 1. This causes the gate G913 to transfer from a 1 output to a 0 output.

One half line cycle later, the pulse $\bar{CP}$ goes to 0. This negative edge causes the information at the output of the gate G913 to be transferred into the D type flip-flop FF-2 and the output Q of the flip-flop FF-2 goes to 0. This latter drop toggles the memory counter 232 to cause the output M1 to assume a 1 condition, an anti-wrinkle code. In response to the advance of the memory, the output of the gate G93 goes to 0. A 0 on the output 223 causes a transistor switch TS to deenergize the motor control relay RLY to open the circuit to the motor 52. The 0 condition of the output 223 also toggles the flip-flop FF causing its Q output to assume a 1 condition to invert the CP and $\bar{CP}$ pulses by way of the EXCLUSIVE OR gate G916. This inversion causes the $\bar{CP}$ output of the inverter 153 to rise again, the rise not affecting the chip. During this time the gates G811 and G913 also change condition without affecting any functions.

One half line cycle later, the pulse $\bar{CP}$ resets the flip-flop FF-2 to provide a 1 condition at its output Q finalizing the transfer into an anti-wrinkle portion of the program. Thus, the CP and $\bar{CP}$ timing pulses which control the integrated circuit counters, have been phase shifted 180° with respect to the AC line cycle. This phase shifting will occur each time a signal is supplied by gate G93 to deenergize relay 150, and thus the relay contacts will be opened in opposite line cycle polarities when the relay is successively operated. Metal transfer on the contacts 143 will be in opposite directions each time the contacts are opened and the contact life will be greatly extended.

An anti-wrinkle cycle is well known in the art as a portion of a drying program wherein the clothing is intermittently tumbled, generally after a cool down cycle, to prevent the setting of wrinkles. After the integrated circuit has transferred into the anti-wrinkle cycle, the motor is energized for 10 seconds every five minutes for up to two hours. Thus, each time that the motor 52 is energized and then deenergized through contacts 143 by relay 150, transistor 151 and gate G93, the timing pulses CP and $\bar{CP}$ will be phase shifted 180° with respect to the AC line cycle and the relay 150 will open successively in opposite line cycle polarities.

Because the point in time during the anti-wrinkle cycle at which the user terminates the operation of the machine is random, the line polarity at which the master control relay contacts break is also random because gate G93 is phase shifting CP. Thus, the contact life of contacts 146 is increased because the line cycle polarity in which they open is randomly determined.

In the integrated circuit illustrated in FIG. 6, the heater is energized throughout the drying cycle and intermittently energized and deenergized with the motor during the anti-wrinkle cycle through inverters 154 and 155, connected respectively to the $\bar{M1}$ and $\bar{M2}$ memory counter outputs, and the output of gate G92 which provides a signal for motor energization during the anti-wrinkle cycle. The inverters and gate G92 are connected to an AND gate G100, which provides an input to OR gate G101. Therefore, during the drying cycle when the memory counter 132 is in a state wherein $\bar{M1}$, $\bar{M2}$, and $\bar{M3} = 1$, the heater relay receives an energization signal through G101 from $\bar{M2}$. During the anti-wrinkle cycle when the memory counter 132 is in a state wherein $\bar{M1}$ and $\bar{M2} = 0$, and $\bar{M3} = 1$, the heater receives an energization signal through inverters 154 and 155, the output of gate G92, and gate G100 to OR gate G101. This allows for alternate line polarity during relay contact opening for the heater relay as well as for the motor relay while utilizing only one flip-flop and one exclusive OR gate because the signals are controlled by the internal gate G93 and the timing pulses CP for the entire integrated circuit chip are phase shifted 180° .

In order to provide for assurance that the integrated circuit or chip 126 will function properly when installed into the dryer of FIG. 1, the chip 126 is electronically tested before installation. In order to insure that all functions occur during a known line cycle polarity, the FF flip-flop is provided with a reset signal R, generated internally by the chip, as previously discussed, at the start of any cycle so that it is known in what polarity line cycles the counters are reading CP. By this means the testing equipment can be set to check the operation of the chip at given points in the cycle. In the present invention the FF flip-flop is always reset to 0 output state.

Although I have described my invention by reference to a specific illustrative embodiment thereof, many changes and modifications of the invention may become apparent to those skilled in the art without departing from the spirit and scope of the invention. I therefore intend to include within the patent warranted hereon all such changes and modifications as may reasonably and properly be included within the scope of my contribution to the art.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A clothes dryer comprising:
means including a drum forming a laundry treatment zone for receiving clothes to be dried;
a drive motor for rotating said drum;
control means for controlling treating of the clothes within the treatment zone;
said control means including a circuit having a relay provided with contacts which are operable to connect said control means to and disconnect said control means from an A.C. electrical power supply, and a digital control circuit including
clock means for deriving an alternating square pulse waveform from the A.C. waveform of the A.C. electrical supply,
program means including a relay control circuit connected to said relay, said program means being clocked by one polarity of the square pulse waveform for operating said relay in a prescribed sequence,
phase shifting means, including means operable to effect a 180° phase shift, connected to said program means for shifting the phase of the squared waveform in response to operation of said relay to cause each opening of said relay contacts to occur during a polarity of the A.C. supply waveform that is opposite to the polarity of the A.C. supply waveform during the last previous opening, and reset means connected to said phase shifting means for resetting said phase shifting means to an initial state whenever power from said A.C. electrical supply is removed and reapplied to said digital control circuit, an EXCLUSIVE OR gate having a pair of inputs and an output, one of said inputs being connected to receive the squared waveform from said clock means, and means connected between said relay control circuit and the other input of said EXCLUSIVE OR gate for providing said EXCLUSIVE OR gate with a signal each time said relay is operated for causing a 180° phase shift of the square waveform.
2. A clothes dryer according to claim 1, wherein said means for providing said gate with a signal comprises a flip-flop connected between said relay control circuit and said other input of said gate.
3. A clothes dryer according to claim 2, wherein said relay control circuit includes an internal gate means connected to an input of said flip-flop and to said relay for providing a signal to simultaneously toggle said flip-flop and to operate said relay.
4. A clothes dryer according to claim 3, wherein said dryer includes a heater for heating air circulated through said treatment zone, said dryer being con-

trolled by another relay, said other relay being controlled by another internal gate, said other internal gate being connected to said program means to insure opening of said other relay in the same polarity of the A.C. waveform as said relay.

5. A clothes dryer comprising:
a laundry treatment zone including a drum for receiving clothes to be dried;
a drive motor for rotating said drum;
a heater for heating air circulated through said drum,
a digitally controlled circuit for operating said dryer through a dryer program including an anti-wrinkle cycle,
said digitally controlled circuit including:
first, second and third relay means respectively for connecting said motor, said heater and said circuit to and disconnecting from an A.C. electrical supply,
clock means for deriving an alternating square pulse waveform from the A.C. waveform of the A.C. electrical supply
program means including control means for controlling said first, second and third relays,
said program means being clocked by one polarity of the square pulse waveform for operating said relays in a prescribed sequence, and phase shifting means being connected to said program means for shifting the phase of the squared waveform in response to said control means for operating said first relay to cause opening of the contacts of said first relay to occur during a polarity of the A.C. supply waveform that is opposite to the polarity of the A.C. supply waveform during the last previous opening, said control means including gate means for operating said second relay essentially simultaneously with said first relay means during said anti-wrinkle cycle,
said control means further including means for operating said third relay in the same polarity A.C. waveform as said first and second relay means, and reset means connected to said phase shifting means for resetting said phase shifting means to an initial state whenever said third relay contacts are operated to a closed position,
said phase shifting means comprising
an EXCLUSIVE OR gate having a pair of inputs and an output, one of said inputs being connected to receive the squared waveform from said clock means, and means connected between said control means and the other input of said EXCLUSIVE OR gate for providing said EXCLUSIVE OR gate with a signal each time said first relay is operated for causing a 180° phase shift of the square waveform.

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