

Aug. 20, 1968

G. H. FATHAUER

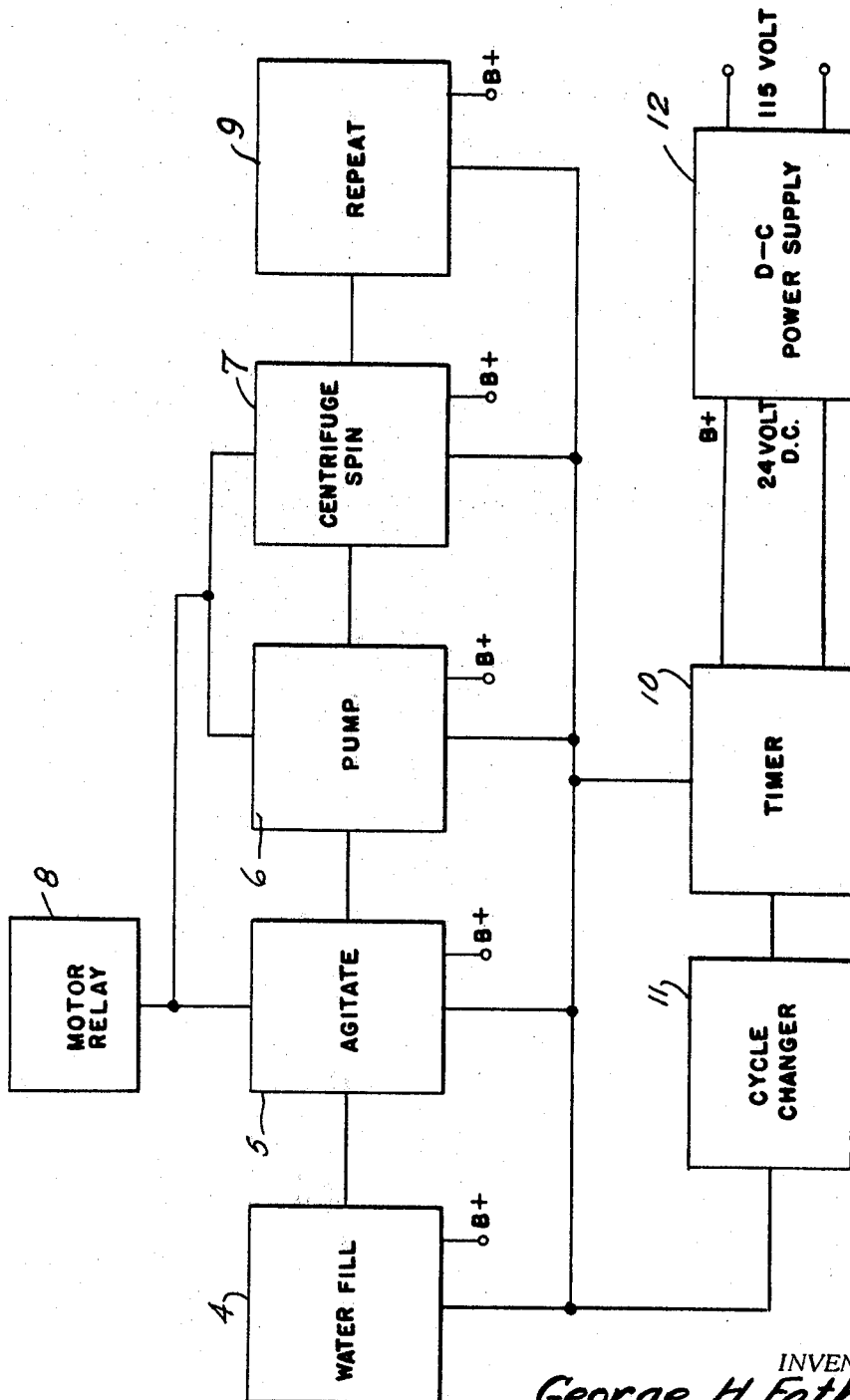
3,398,295

ELECTRONIC TIMER

Filed May 5, 1965

2 Sheets-Sheet 1

Fig-1



INVENTOR.

George H. Fathauer

BY

Hill, Sherman, Meroni, Gross & Simpson
ATTORNEYS

Aug. 20, 1968

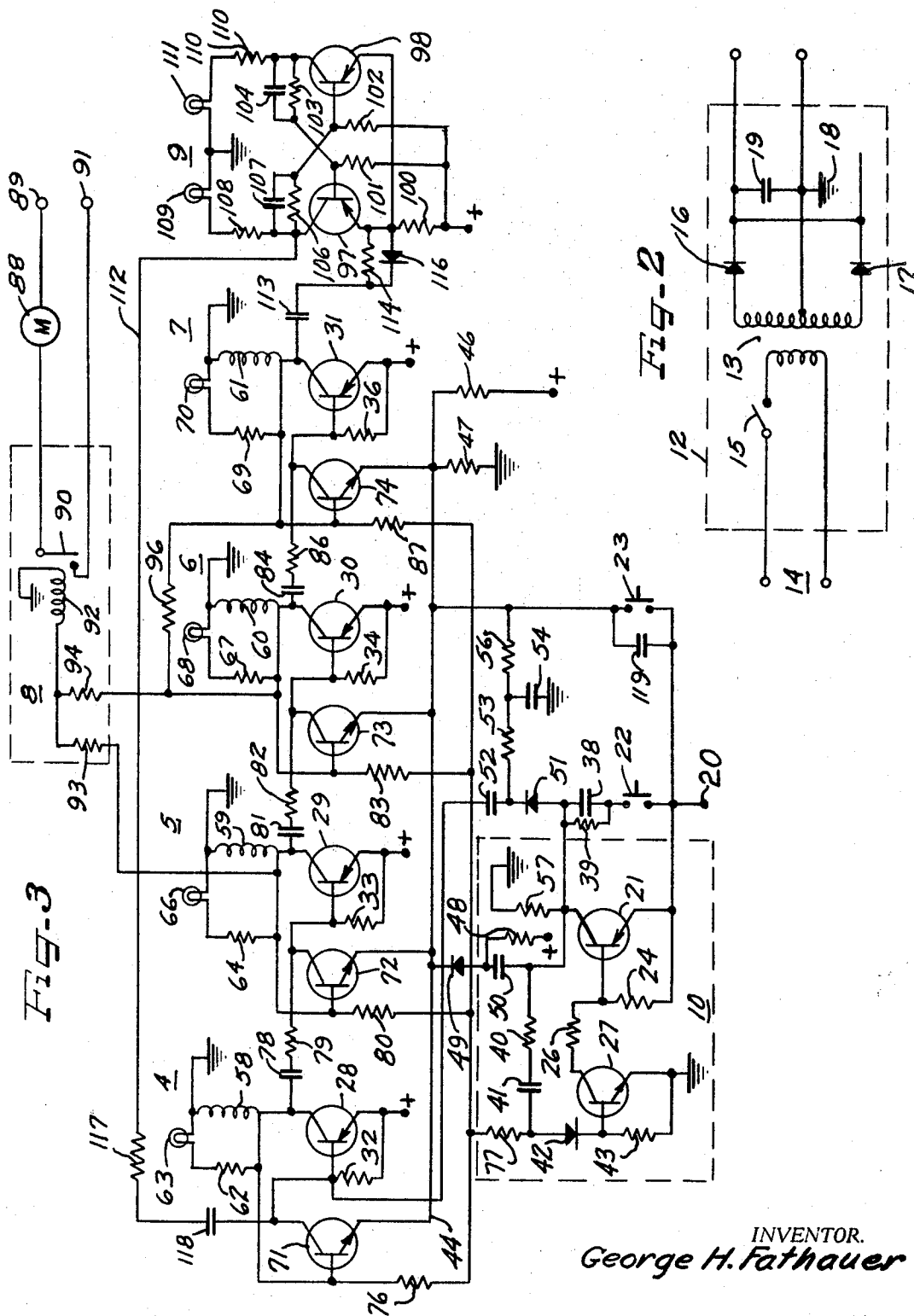
G. H. FATHAUER

3,398,295

ELECTRONIC TIMER

Filed May 5, 1965

2 Sheets-Sheet 2



INVENTOR.
George H. Fathauer

BY

Will, Sherman, Maroni, Gross & Simpson
ATTORNEYS

1

3,398,295

ELECTRONIC TIMER

George H. Fathauer, Decatur, Ill., assignor to Radson Engineering Corporation, Macon, Ill., a corporation of Illinois

Filed May 5, 1965, Ser. No. 453,346
11 Claims. (Cl. 307—141.4)

ABSTRACT OF THE DISCLOSURE

An electronic control circuit including a plurality of electronic switching stages connected in sequence with one another and having a transfer means coupled between the stages for transferring the operation of one stage to a succeeding stage. A common timing circuit is provided for each of the electronic switching stages and includes a timing element which when charged to a specific value causes the generation of a pulse for initiating the transfer of operation from a conducting stage to a succeeding non-conducting stage. This transfer is aided by the transfer means coupling the succeeding stage to the previous stage.

This invention relates to an electronic timer and particularly to one suitable for use in laundry machines.

To understand the novel timer hereinafter to be described, the general cycle of operation of an automatic machine should be borne in mind. In the past there have been two general types of widely used automatic home laundry machines. Most extensively used has been one in which the clothes containing basket, either perforate or imperforate, has been mounted for rotation on a vertical axis and has disposed therein an agitator mounted for oscillatory motion on a vertical axis. An electric motor through a suitable clutch and transmission is provided for selectively oscillating the agitator at a relatively low speed to wash clothes placed in the basket and for rotating the basket at high speed to centrifuge the water from the clothes and cause damp or full drying thereof.

The other general type of automatic clothes washing machine is one in which the clothes receiving drum is mounted for rotation on a horizontal axis. A motor is connected to the drum through a suitable clutch and transmission to rotate selectively the drum at low speed to wash the clothes by tumbling them within the drum and to rotate at a high speed to centrifuge the water from the clothes to cause damp or full drying thereof.

In both general types of machines it has been quite customary to repeat the cycle of operation once for the purpose of rinsing the clothes.

In both types of laundry machines, it will be borne in mind that it is first necessary to deliver a predetermined quantity of water to the tub. The quantity of water is determined by either opening a water supply valve for a predetermined period of time or by a float switch which is actuated upon the water level reaching a predetermined point which causes closing of the water supply valve.

Upon completion of the water filling operation, it is desirable to have the machine immediately go into its next operational phase. This would be the washing cycle which in the first described washing machine involves oscillating the agitator for a predetermined relatively long period of time and in the second machine for slowly rotating the drum for a similar period of time. Thereafter the water must be drained from the tub and after draining the clothes container must be rotated at a relatively high speed for a predetermined period of time to centrifuge

2

the water from the clothes. This period of time is usually substantially shorter than that required for the washing stage. During the time that the water is being centrifuged from the clothes, it is desirable to withdraw the centrifuged water from the tub. At the end of this centrifuging operation it is customary to automatically proceed to a water filling operation to again bring the water level in the tub to some predetermined height. Thereafter the washing cycle is again initiated but in this case it is for rinsing purposes and no soap is used in the water. Thereafter the tub is again drained and the drying cycle initiated to centrifuge the water from the clothes. At the conclusion of this second drying cycle, the machine is automatically shut off.

In the past it has been customary to provide a timer to initiate the various operational stages of the complete cycle of operation by a group of cam actuated switches driven by an electric motor which switches in turn control the energization of solenoid actuated mechanisms which bring about the mechanical operations desired. The cams were usually in the form of cam disks having notches or raised portions thereon whose peripheral extent determined the length of a particular cycle of operation.

It is an object of the present invention to provide an electronic timer of novel design to carry out a series of operational steps of predetermined lengths of time, some of which may be for relatively long periods of time such, for example, as 10 to 20 minutes.

It is a further object of the present invention to provide a novel timing device which is economical to manufacture, rugged and reliable in use and which efficiently carries out a wide variety of timing functions.

Another object of the present invention is to provide a novel transistorized timer in which various timing periods are determined by an R-C network in which the resistance thereof is changed for each timing phase by transistor means and in which the next stage is automatically initiated after the preceding stage has been shut off.

Another and still further object of the present invention is to provide a novel transistorized timer in which a pair of transistors are associated with each operational phase one of which, when triggered on, fires its associated transistor which latter transistor acts as a holding circuit for maintaining the first transistor in a current conducting state for supplying energizing current to a solenoid actuated device.

A still further object of the present invention is to provide a novel transistorized timer for laundry machines which includes means for repeating the entire cycle of operation once and then shutting off the timer.

These and other objects, features and advantages of the present invention will be more fully realized and understood from the following detailed description when taken in conjunction with the accompanying drawings wherein like reference numerals are intended to designate the same or similar structures and wherein:

FIGURE 1 is a block diagram diagrammatically illustrating the different operational stages of a cycle of operation in an automatic clothes washing machine and the necessary power supply and control therefor;

FIGURE 2 is a diagrammatic illustration of a means for obtaining a B+ reference voltage from a conventional 115 volt A.C. public utility power supply line; and

FIGURE 3 is a circuit diagram of a preferred embodiment of the present invention.

Referring to FIGURE 1, wherein a preferred embodiment of the present invention is diagrammatically illustrated and hereinafter to be described, is for use in a clothes washing machine of the type hereinbefore referred

to as employing an agitator for washing the clothes and with a water level control determined by the length of time that a water supply valve or valves are open. Blocks 4, 5, 6 and 7 represent the four principal operational phases of the cycle. Block 8 represents the main washing machine motor which supplies mechanical power to the washing machine. Block 9 indicates that the cycle 4-5-6-7 is repeated once. A timer 10 is illustrated diagrammatically as controlling the operational stages 4, 5, 6 and 7. Block 11 indicates that the user may by-pass the timer and advance the cycle of operation to the next stage even though the present stage has not completed its normal time. Finally, block 12 indicates a means for obtaining a B+ reference voltage such, for example, as 24 volts D.C. from a 115 volt A.C. power supply.

In order to have a desired reference voltage for the transistorized timer of the present invention a suitable full wave rectifier is provided for obtaining D.C. One convenient means for doing this is to provide a transformer 13 energized from a power supply line 14 through a switch 15. Opposite ends of the secondary windings of transformer 13 are connected to two diodes 16 and 17. The secondary winding of transformer 13 is center tapped and grounded as at 18. A filter condenser 19 is preferably provided to reduce the ripple in the D.C.

In the circuit of FIGURE 3, the B+ voltage from the D.C. power supply 12 is applied to a circuit point 20 of the timer control circuit 10. The circuit point 20 is connected to the emitter of a transistor 21 and to one side of a pair of normally open switches 22 and 23. The switch 22 operates initially to start the first cycle constituting the water-fill stage 4 and subsequently to deactivate one cycle and actuate an adjacent cycle in the sequence of operation. The normally open switch 23 is employed as an off switch for deactivating the entire circuit.

The B+ voltage on the circuit point 20 is also connected through a resistor 24 to the base electrode of the transistor 21. The base electrode of the transistor 21 is connected through a resistor 26 to the collector electrode of a transistor 27 which has an emitter electrode thereof connected to ground potential. Since the transistor 27 is initially in a non-conducting state, the base electrode of the transistor 21 will be initially biased to maintain the transistor 21 non-conducting.

A transistor 28 constitutes the switching transistor for the water-fill stage 4; a transistor 29 constitutes the switching transistor for the agitate stage 5; a transistor 30 constitutes the switching transistor for the pump stage 6; and a transistor 31 constitutes the switching transistor for the centrifuge-spin stage 7. The B+ voltage from the D.C. power supply 12 is connected to the emitter electrodes of the transistors 28-31. Connected between the B+ voltage on the emitter electrodes and the respective base electrodes of the transistors 28-31 are resistors 32, 33, 34 and 36, respectively. This connection of the B+ voltage to the emitter and base electrodes of the transistors 28-31 maintains these transistors in a cut-off condition during the initial operation of the circuit. If, however, a negative pulse is applied to the base electrodes of each of the transistors 28-31, these transistors will begin conduction.

However, as will be more fully understood subsequently, only one of the stages 4, 5, 6 and 7 will be actuated at a particular time. More particularly, initial actuation of the timer control circuit 10 from the switch 22 will cause the water-fill stage 4 to be actuated while maintaining the remaining stages 5, 6 and 7 deactive. When, however, the water-fill stage 4 has completed its respective cycle, the subsequent stage 5 will be actuated and the water stage 4 will be deactivated. This same sequence continues with the activation of the pump stage 6 and the centrifuge-spin stage 7.

The necessary negative pulse to trigger the water-fill stage 4 including the transistor 28 is derived from the control circuit 10 after its actuation by the normally open cycle switch 22. Closing the switch 22 applies the B+ volt-

age through a parallel connected capacitor 38 and resistor 39, to the collector electrode of the transistor 21 to trigger the timer 10.

Connected between the collector of the transistor 21 and the base electrode of the transistor 27 is a resistor 40, a capacitor 41, and a diode 42 in series. A resistor 43 is connected between the base and the emitter electrode of the transistor 27 for providing a proper bias thereto. A positive voltage pulse developed by the closing of the switch 22 is conducted through the resistor 40, the capacitor 41, and the diode 42 to develop a voltage pulse across the biasing resistor 43. The voltage developed at the base electrode of the transistor 27 by the closing of the switch 22 is sufficient to cause the transistor 27 to become conductive.

Current flow through the resistors 24, 26 upon the rendering of the transistor 27 conductive provides a proper bias between the emitter and base electrodes of the transistor 21 to render it conductive. Such conduction of the transistor 21 effectively places the B+ voltage across the resistor 40, the capacitor 41, and the resistor 43 to maintain the transistor 27 conductive until the capacitor 41 has charged and blocked further current flow there-through.

A line 44 is disposed at a predetermined voltage determined by its connection intermediate a pair of resistors 46 and 47 which are disposed in series between the P+ voltage and ground potential. B+ voltage is also connected through a resistor 48 and diode 49 to the line 44. The positive pulse developed by the rendering of the transistor 21 conductive is realized on the line 44 through a capacitor 50 and the diode 49. This same positive pulse is also conducted through a diode 51 and a capacitor 52 to the base electrode of the transistor 28 of the water-fill stage 4.

Intermediate the diode 51 and capacitor 52 is connected one side of a resistor 53 which is connected on the other side thereof through a capacitor 54 to ground potential and through a resistor 56 to the line 44. Prior to the actuation of the switch 22, the capacitor 52 is charged from the B+ voltage on the emitter of the transistor 28 through the resistors 32 and 53 to the potential developed on the capacitor 54.

The function of the diode 51 and the capacitor 52 is to cause stage 4 to always come on first after all of the stages have been turned off. The action of diode 51 and capacitor 52 is controlled by the voltage on the capacitor 54 which is charged to the voltage on line 44. This action is such that when all stages are off this voltage is approximately $\frac{1}{3}$ of the supply voltage and in this condition the positive pulse from transistor 21 being essentially full supply voltage causes the diode 51 to conduct transmitting this pulse to the transistor 28. The transistor 28 being PNP requires a negative pulse to be turned on and it is a differentiation of the positive pulse through the capacitor 52 which causes the transistor 28 base to go negative with the turn off of the positive pulse.

Under the condition of any of the stages being in conduction, the line 44 is essentially at the supply voltage due to the full "on" characteristics of the transistor pair in the conducting stage and therefore, the capacitor 54 is charged essentially to the supply voltage. Under this condition the diode 51 is biased off to any positive pulse up to the magnitude of the charge on the capacitor 54 and, therefore, there is no pulse conducted to the capacitor 52.

In order to provide such a negative pulse to render the transistor 28 conductive, the transistor 21 must first be rendered nonconductive. This interaction is accomplished by the RC time constant provided by the resistor 40 and the capacitor 41. When the transistor 21 is first rendered conductive, the transistor 27 is maintained conductive by a current flow through the resistor 40, the capacitor 41, and the diode 42. When, however, the capacitor 41 has charged sufficiently to discontinue current flow there-through, the transistor 27 will be rendered nonconductive,

5

biasing the transistor 21 to nonconduction resulting in the negative pulse being supplied through the capacitor 52 to the base electrode of the transistor 28.

Each of the stages 4-7 contain a work producing unit in series between the respective transistors 28-31 and ground potential. More particularly, the stage 4 includes a water valve solenoid 58; the stage 5 includes a clutch operating solenoid 59; the stage 6 includes a pump operating solenoid 60; and the stage 7 includes a speed changing solenoid 61. The water valve solenoid 58 in the stage 4 is connected in parallel with a resistor 62 and indicator lamp 63 which provides an indication of the actuation of the solenoid 58. Upon actuation of the water valve solenoid 58, water is filled into the washing machine tub until the water-fill stage 4 is rendered inoperative. The solenoid 59 in the agitate stage 5 causes either the agitator in a vertical axis machine to oscillate or causes the drum in a horizontal axis machine to rotate at a relatively low tumble speed. The solenoid 59 performs such operation by actuation of a clutch mechanism within the transmission of the washing machine or by any suitable means well known in the art. A resistor 64 and indicator lamp 66 are connected in parallel with the solenoid 59 to provide an indication of its being actuated.

The solenoid 60 in the pump stage 6 performs to actuate a pump mechanism to drain the water from the tub of the washing machine after either the wash cycle or the rinse cycle have been completed. A resistor 67 and indicator lamp 68 are connected in parallel with the solenoid 60 to provide an indication of its actuation and of the operation of the pump stage 6. Similarly, the solenoid 61 in the centrifuge spin stage 7 actuates a clutching mechanism or other suitable mechanism to provide a high rate of rotation to the clothes basket of the washing machine to extract water from the clothes therein. A resistor 69 and indicator lamp 70 are connected in parallel with the solenoid 61 to provide an indication of the operation of the centrifuge-spin stage 7.

In addition to the switching transistors 28-31, the respective stages 4-7 include respective holding transistors 71, 72, 73 and 74. The emitter electrodes of the holding transistors 71-74 are connected to the line 44 and are biased by the voltage thereon. The collector electrodes of the transistors 71-74 are connected to the base electrodes of respective switching transistors 28-31. Also, the collector electrodes of the switching transistors 28-31 are connected to the base electrodes of the respective holding transistors 71-74. Therefore, when one of the transistors 28-31 is rendered conductive, the base electrode of the respective transistors 71-74 is biased to render such transistor conductive. Conduction of one of the transistors 71-74 biases the base electrode of the respective switching transistors 28-31 to maintain such transistor conductive after a biasing negative pulse at its base electrode has been extinguished. Therefore, when one of the transistors 28-31 is rendered conductive, the respective holding transistor 71-74 is rendered conductive to hold the respective switching transistor 28-31 conductive.

In order to effect proper timing of the cycles, an RC time constant circuit is employed between each of the stages 4-7 and the base electrode of the transistor 27 to render it conductive and cause a subsequent cycle to be initiated. More particularly, when one of the stages 4-7 is operating, the B+ voltage on the emitter electrode of the respective switching transistor is applied to the base electrode of the respective holding transistor. This B+ voltage is connected to an RC time constant circuit which, after a predetermined time for each of the cycles 4-7, causes actuation of the timer 10 by the rendering of the transistor 27 conductive. The base electrode of the transistor 71 is connected through a resistor 76, a resistor 77, and the diode 42 to the base electrode of the transistor 27. Therefore, when the transistor 28 in the water-fill stage 4 is rendered conductive, the B+ voltage supplies a current flow through the resistor 76, the resistor 77, the

6

condenser 41, the resistor 40, and the resistor 57 to ground potential. As the capacitor 41 begins to develop a charge thereacross, current will begin to flow through the diode 42 and the resistor 43 creating a bias potential for the transistor 27. When the charge on the capacitor 41 reaches a predetermined level, the transistor 27 will be rendered conductive causing the transistor 21 to also be rendered conductive.

When the transistor 21 is rendered conductive, a positive pulse is supplied to the base electrode of the transistor 28 rendering it nonconductive and to the emitter electrode of the transistor 71 rendering that transistor nonconductive.

When the transistor 28 is rendered nonconductive, a negative pulse is developed through a capacitor 78 and resistor 79 connected in series between the collector electrode of the transistor 28 and the base electrode of the transistor 29. Such a negative pulse on the base of the transistor 29 renders that transistor conductive to bias the transistor 72 conductive also.

Before the negative pulse is extinguished through the capacitor 78 to the base electrode of the transistor 29, the capacitor 41 in the timer circuit 10 becomes fully charged rendering the transistor 27 and the transistor 21 nonconductive. Rendering of the transistor 21 nonconductive produces a negative pulse through the capacitor 52 to the base electrode of the transistor 28 which is, however, not sufficient to render the transistor 28 conductive. When none of the stages 4-7 were rendered operative, such a negative pulse through the capacitor 52 would be sufficient to render the transistor 28 conductive. However, since the stage 5 is operative during the recycling operation, the B+ voltage on the emitter of the transistor 29 is connected through the resistor 33 and the transistor 72 to the line 44 causing an increase of the potential thereon. This increase in potential alters the charge on the capacitor 52 through the resistors 53, 56 such that a subsequent negative pulse by the rendering of the transistor 21 nonconductive will not be of sufficient value to render the transistor 28 conductive. A similar condition exists during initial operation of the stages 6 and 7.

The charge on the capacitor 52 is also altered by the rendering of the transistor 21 conductive during the cycling operation from one stage to a subsequent stage. Under the condition of any of the stages being in conduction, the line 44 is essentially at the supply voltage due to the full "on" characteristics of the transistor pair in the conducting stage and therefore, the capacitor 54 is charged essentially to the supply voltage. Under this condition the diode 51 is biased off to any positive pulse up to the magnitude of the charge on the capacitor 54 and, therefore, there is no pulse conducted to the capacitor 52.

In addition, the negative pulse developed on the base of the respective switching transistor in one of the stages 5-7 is not only of a larger magnitude, but of longer time duration than that developed at the base of the transistor 28 after a subsequent stage has been initiated. This is achieved by a "memory" function accomplished by the respective solenoids in the stage being rendered inoperative. For example, when the B+ voltage is removed from the solenoid 58, a back e.m.f. is produced which aids the negative pulse generated through the capacitor 78 to the base of the transistor 29. A similar function exists with respect to the rendering of the stages 6 and 7 operative.

When the transistor 29 is rendered conductive, the B+ voltage at the emitter electrode thereof is developed across the solenoid 59 and supplied to the base electrode of the transistor 72. A resistor 80 connected between the base of the transistor 72 and the resistor 77 determines the length of time in which the stage 5 will remain operational. That is, the B+ voltage on the base of the transistor 72 will cause a charge to be developed across the capacitor 41 by a current flow through the resistors

80, 77. When this charge is of a sufficient value, the transistor 27 will be rendered conductive.

The timing circuit again provides a positive pulse on the line 44 rendering the transistor 72 nonconductive and removing the bias voltage from the transistor 29. The collector of the transistor 29 is connected through a capacitor 81 and resistor 82 to the base of the transistor 30. When the transistor 29 is rendered nonconductive, a negative pulse is supplied through the capacitor 81 and resistor 82 to the base of the transistor 30 rendering it conductive. The identical timing operation is performed within the stage 6 by the connection of a resistor 83 from the base of the transistor 73 to the resistor 77. Also, the collector of the transistor 30 is connected through a capacitor 84 and resistor 86 to the base of the transistor 31 to supply a negative pulse thereto when the transistor 30 is rendered nonconductive. The centrifuge-spin stage 7 is controlled in its time of operation by the connection of a resistor 87 from the base of the transistor 74 to the resistor 77.

During operation of the agitate, pump, and spin cycles, it is necessary to provide energization of a motor 88 for providing the necessary drive to the washing machine tub and/or agitator. The motor 88 is connected on one side thereof to a terminal 89 of an A.C. supply and on the other side thereof through a switch 90 to another terminal 91 of the A.C. supply. The switch 90 is controlled by a solenoid 92 which is connected on one side thereof to ground potential and on the other side thereof through a resistor 93 to the collector of the transistor 29, through a resistor 94 to the collector of the transistor 30, and through the resistor 94 and a resistor 96 to the collector of the transistor 31. Therefore, when the stages 5, 6 and 7 are operational, the motor will be activated by the energization of the relay coil 92. It will further be noted that the resistor 96 is connected between the collector electrodes of the transistors 30, 31. This connection allows the pump solenoid 60 to be energized during the centrifuge-spin operation to allow for removal of any water extracted during the spinning operation from the clothes in the washing machine tub.

After one complete cycle of the operation for washing the clothes, it is desired to provide another complete cycle for the rinsing of the clothes within the machine tub. Complete recycling of the stages 4-7 is accomplished by a multivibrator circuit in the repeat stage 9. The multivibrator 9 includes a pair of transistors 97 and 98. B+ voltage is connected through a resistor 100 to the emitter electrodes of the transistors 97, 98; through a resistor 101 to the base of the transistor 97; and through a resistor 102 to the base of the transistor 98. The base of the transistor 97 is connected through a resistor 103 and capacitor 104 in parallel to the collector of the transistor 98. Similarly, the base of the transistor 98 is connected through a resistor 106 and a capacitor 107 in parallel to the collector of the transistor 97. The collector of the transistor 97 is connected through a resistor 108 and an indicator lamp 109 to ground potential and the collector of the transistor 98 is connected through a resistor 110 and indicator lamp 111.

The transistors 97, 98 of the multivibrator 9 are normally biased such that one of the transistors will be conducting while the other is nonconducting. In the preferred embodiment, the resistor 101 is of a larger value of resistance than that of the resistor 102 such that initial application of the B+ voltage to the multivibrator 9 will render the transistor 97 conductive while maintaining the transistor 98 nonconductive. If, however, a negative pulse is supplied to the emitters of the transistors 97, 98, the multivibrator 9 will change its output stage on an output line 112 by the rendering of the transistor 97 nonconductive and the rendering of the transistor 98 conductive. Such a negative pulse is supplied to the multivibrator 9 through a capacitor 113 and resistor 114 connected in series between the collector of the

transistor 31 and the emitter of the transistor 97. A diode 116 is connected as shown in parallel with the resistor 114.

When the multivibrator changes its output state, a pulse is supplied from the line 112 through a resistor 117 and a capacitor 118 to the base electrode of the transistor 28. Rendering of the transistor 97 nonconductive produces a negative pulse on the base of the transistor 28 while rendering of the transistor 97 conductive provides a positive pulse to the base of the transistor 28. When the circuit is initially turned on, the transistor 97 is favored for conduction and the transistor 98 is maintained nonconductive. Therefore, when a negative pulse is supplied from the collector of the transistor 31 to the multivibrator 9, the transistor 97 is rendered nonconductive and a negative pulse is supplied to the base of the transistor 28, causing it to be rendered conductive.

When each of the cycles 4-7 has been completed for the second time, a second negative pulse is supplied to the multivibrator 9 causing the transistor 97 to become conductive to provide a positive pulse through the capacitor 118 to the base of the transistor 28. Such a positive pulse will not render the transistor 28 conductive. Therefore, each of the cycles 4-7 are placed in operation twice; in the first instance for washing the clothes in the machine tub and in the second instance for rinsing the clothes in the machine tub. After the second complete cycle of the circuit, the output from the multivibrator 9 does not re-trigger the water-fill stage 4 and the circuit becomes inoperative. Since none of the stages are operating after a complete cycle of the circuit, the potential on the line 44 is altered to allow a subsequent negative pulse through the capacitor 52 and a negative pulse from the multivibrator 9 to trigger the transistor 28. However, after the second complete cycle of operation, the negative pulse supplied through the capacitor 52 is negated or cancelled by the positive pulse produced at the output of the multivibrator 9 on the line 112.

In order to completely stop the operation of the circuit, B+ voltage is supplied to one side of the normally opened switch 23 which is connected on the other side thereof to the line 44. A capacitor 119 is connected in shunt with the switch 23. Closing of the switch 23 places the B+ voltage on the line 44 and biases the holding transistors 71-74 nonconductive.

Therefore, operation of the circuit of the present invention is initiated by actuation of the switch 22. The water-fill stage 4 remains operative for a predetermined time before the subsequent stage 5 is rendered operative. If it is desired to move the operation of the washing machine from one stage to another, the switch 22 is actuated and the operative stage is rendered inoperative while a subsequent stage is rendered operative. The circuit constants and parameters are such that only one of the stages 4-7 will be operative at a particular time. One preferred form of the present invention employs the following values for the components illustrated in FIGURE 3.

Resistors:	Ohms
24, 79, 82, 86	10K
26, 108, 110	270
32, 33, 34, 36, 47	2.2K
39, 56	470K
40	68
43	2.2M
46	4.7K
53, 101	68K
57, 62, 64, 67, 69	470
77	10M
100	220
102	47K
103, 106	6.8K
114	33K
117	39K

Capacitors:	Microfarads
38 -----	0.0047
41 -----	9.0
50, 78, 81, 84, 113, 118, 119 -----	0.01
52, 104, 107 -----	0.001
54 -----	0.22

The principles of the invention explained in connection with the specific exemplifications thereon will suggest many other applications and modifications of the same. It is accordingly desired that, in construing the breadth of the appended claims they shall not be limited to the specific details shown and described in connection with the exemplifications thereof.

What is claimed is:

1. A circuit for selectively controlling a plurality of stages comprising

- (a) a source of power,
- (b) a plurality of switching transistors each connected between said source of power and a respective one of the stages,
- (c) means for providing a biasing pulse to a first of said switching transistors for rendering it conductive,
- (d) means connecting said switching transistors in succession from a first to a last one thereof for providing a biasing pulse to a succeeding switching transistor to render it operative in response to the rendering of the respective preceding switching transistor inoperative, holding transistors,
- (e) means connecting each of said holding transistors to respective ones of said switching transistors for maintaining said switching transistors conductive after receipt of a biasing pulse thereto, and
- (f) a timing circuit connected to each of said stages for rendering respective holding transistors inoperative after a respective predetermined time duration for each stage.

2. In a machine having a plurality of electronic switching stages wherein the consecutive operation of a number of stages comprises a completed cycle, an electronic timing circuit comprising

- (a) means for activating one of said electronic switching stages,
- (b) means for sensing the activation time of said electronic switching stage,
- (c) means connected to said sensing means for transferring actuation to a second operational phase after lapse of a time interval as determined by said time sensing means, and
- (d) a bistable circuit having a first stage connected for repeating said cycle of operation and a second stage connected for prohibiting a further repeat of said cycle of operation, said bistable circuit having means for providing an initially higher forward bias to said first stage relative to said second stage, whereby conduction of said first stages is initially favored relative to said second stage.

3. An electronic timing circuit as described in claim 2 wherein said first and said second stages include a first and a second transistor respectively and wherein said means for providing an initial high forward bias to said first stage relative to said second stage comprises

- (1) a relatively high value resistance for coupling the base and emitter of said first transistor, and
- (2) a relatively low value resistance for coupling the base and emitter of said second transistor.

4. In a device having a series of operation stages, an electronic control circuit for sequencing the initiation of said operation stages comprising:

- an electronic switching means associated with each of said operation stages for actuating and deactuating the same,
- each of said electronic switching stages having an input and an output,
- at least one of said electronic switching means being actuable and deactuable by a signal at its input,

transfer means coupling the output of said one electronic switching means with the input of another of said electronic switching means,

said transfer means being responsive to the deactuation of said one electronic switching means for actuating said other electronic switching means,

a common timing circuit coupled to each of said electronic switching means and being responsive to the conduction of said one electronic switching means for generating a signal after the lapse of a predetermined time interval,

and means for coupling said signal so generated to the input of said one electronic switching means.

5. An electronic control circuit in accordance with claim 4 wherein a separate timing element is associated with each of said operation stages and is coupled to said common timing circuit during the conduction of each of said respective operation stages, whereby the time of operation of said operation stages is determined by the cooperative functioning of the timing element associated with the indicated operation stage and the common timing circuit.

6. An electronic control circuit in accordance with claim 4 wherein means are provided for rendering the first in a sequence of electronic switching means operative in response to the last in the sequence of switching means being rendered inoperative after the completion of one cycle of operation and for maintaining said first switching circuit inoperative in response to the last of said switching means being rendered inoperative after the completion of at least two cycles of operation.

7. An electronic control circuit in accordance with claim 6 wherein said timing elements associated with each of said switching means comprises a resistor and wherein said common timing circuit includes a capacitor and wherein the conduction of each of said operation stages couples the associated resistor of said stage to said capacitor for charging said capacitor through said resistor thereby determining the time of operation of said associated operation stage.

8. In a device having a series of operation stages, an electronic control circuit for sequencing the initiation of said operation stages comprising:

an electronic switching means associated with each of said operation stages for actuating and deactuating the same, each of said electronic switching stages having an input and an output,

at least one of said electronic switching means being actuable by a first type of signal at its input and deactuable by a second type of signal at its input,

means for applying a first type signal to the input of said one electronic switching means,

transfer means coupling the output of said one electronic switching means with the input of another one of said electronic switching means,

said transfer means being responsive to the deactuation of said one electronic switching means for actuating said other electronic switching means,

a common timing circuit coupled to each of said electronic switching means and being responsive to the conduction of said one electronic switching means for generating a second type signal after the lapse of a predetermined time interval, and

means for coupling said second type signal of said common timing circuit to the input of said one electronic switching means.

9. An electronic control circuit in accordance with claim 8 wherein means for providing a first type of signal comprises means for providing a negative and wherein means for providing a second type of signal or means for providing a positive signal, said means actuating and deactuating said operation stages, respectively.

10. An electronic control circuit in accordance with claim 8 wherein said common timing circuit includes a capacitor for being charged during the operation of each

11

of said individual operation stages and includes an electronic switching device responsive to a given level of charge on said capacitor for generating a second type of signal at the input of said electronic switching stages.

11. An electronic control circuit in accordance with claim 8 wherein said transfer means includes a capacitor coupled between the outputs of respective electronic switching stages for being charged during the conduction of one of said stages and for being discharged after the ceasing of conduction of said one stage to initiate the conduction of the second of said electronic switching stages in sequence therewith.

12

References Cited

UNITED STATES PATENTS

2,881,832	4/1959	Leonard	307—41
3,099,962	8/1963	Smith	307—41 XR
3,124,722	3/1964	Steiner	317—142 XR
3,125,692	3/1964	Fennick et al.	307—88.5
3,200,303	8/1965	Maxwell	307—141 XR
3,289,783	12/1966	Buhler	307—88.5

10 ROBERT K. SCHAEFER, *Primary Examiner*.
T. B. JOIKE, *Assistant Examiner*.