Aug. 8, 1961 D. M. STRATHEARN ET AL 2,995,143

TIMER

Filed March 16, 1959 6 Sheets-Sheet 1

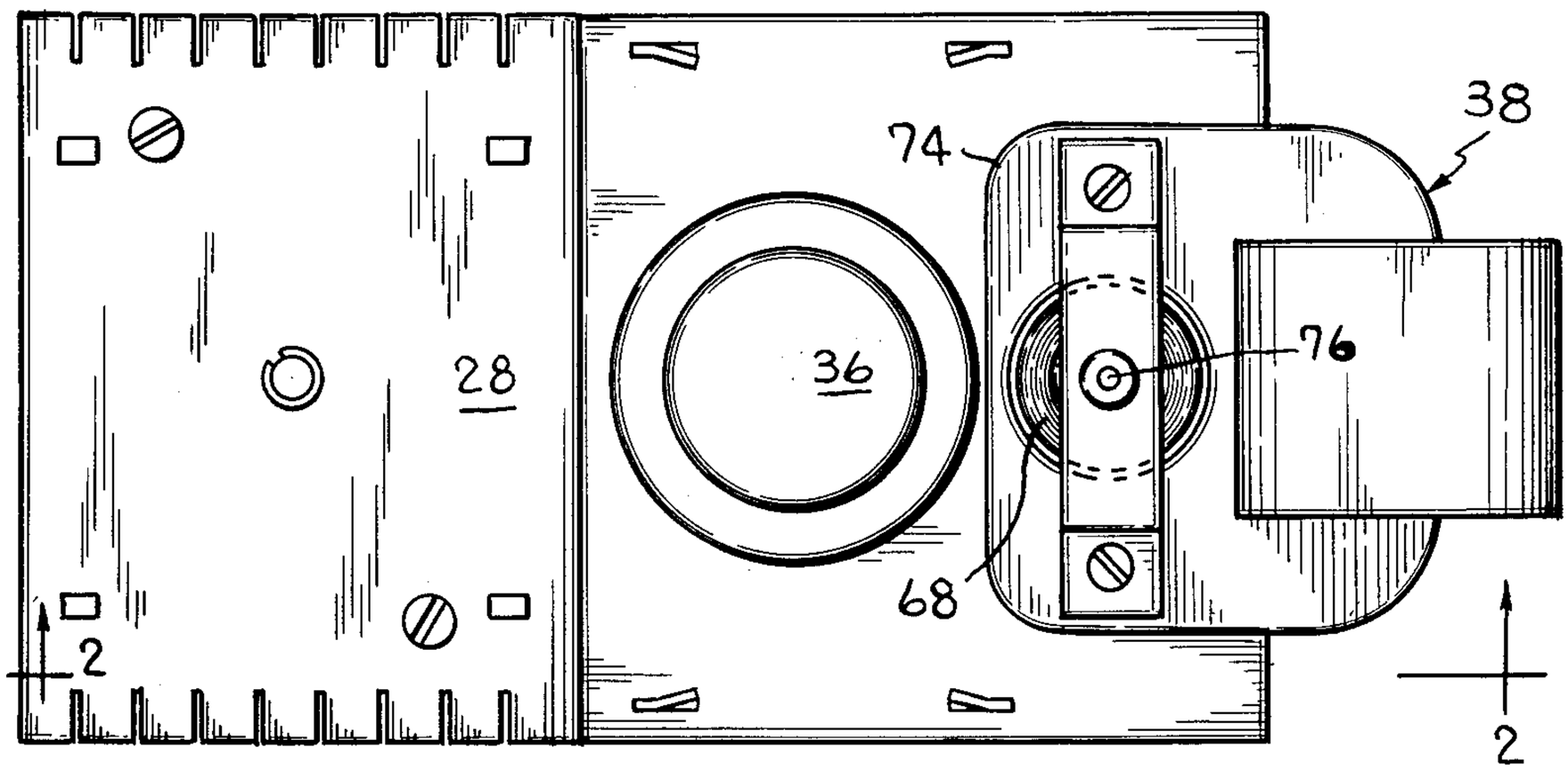

FIG. 1

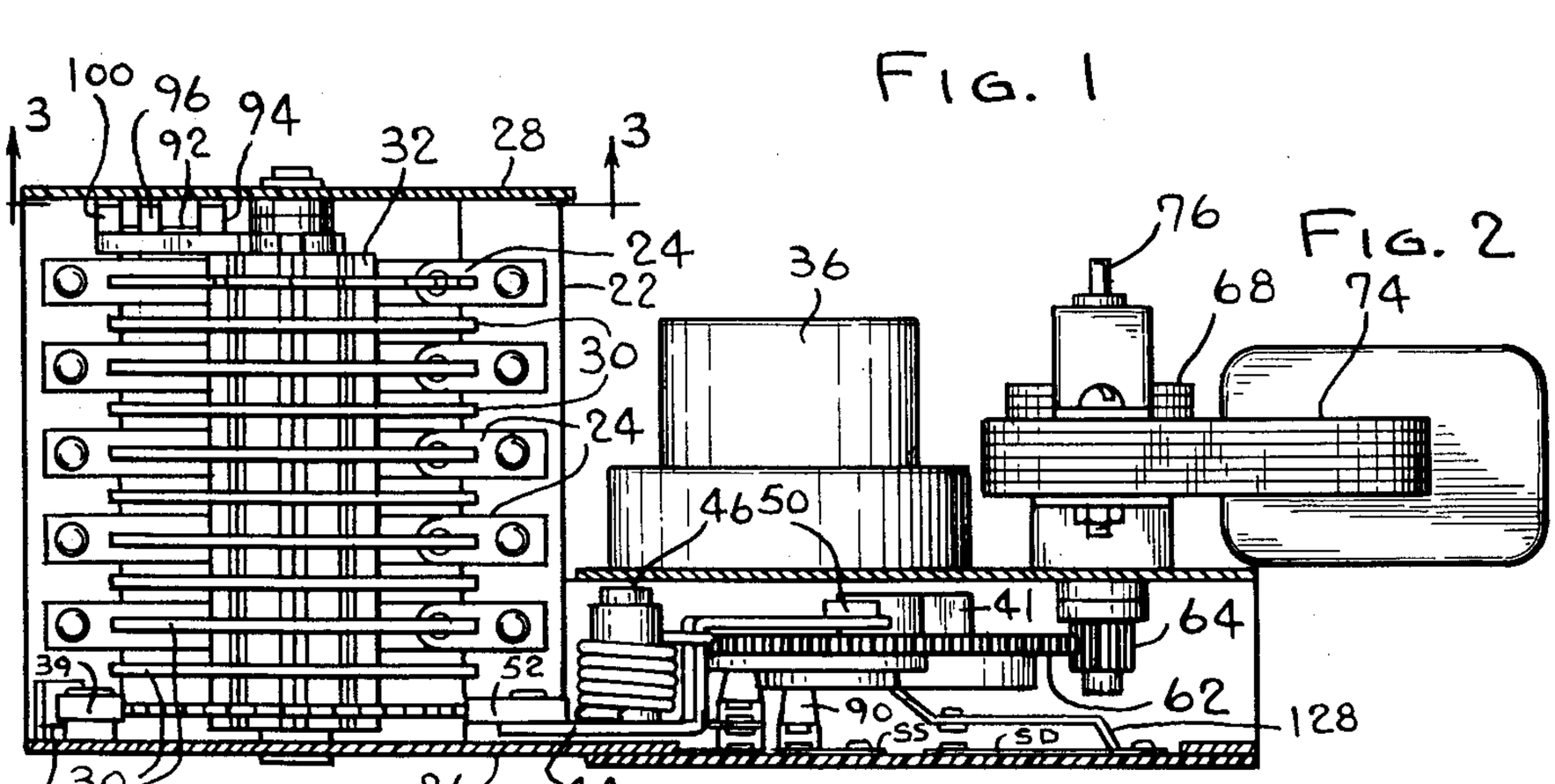

FIG. 2

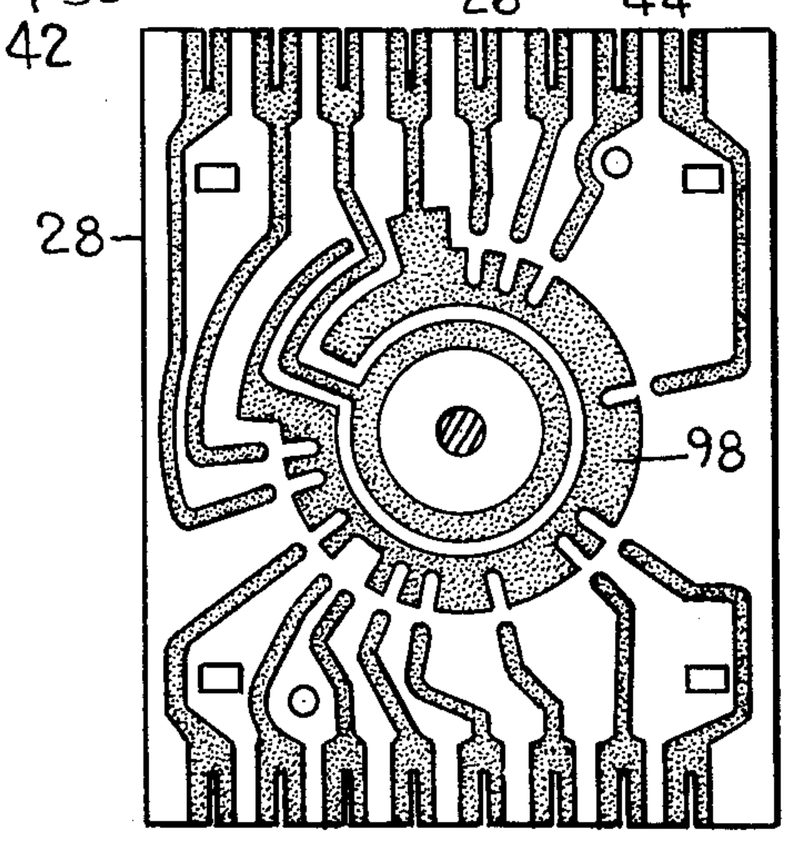

FIG. 3

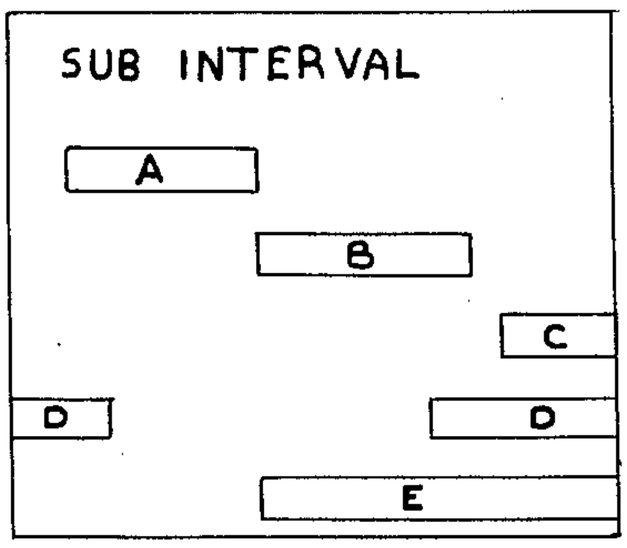

FIG. 10

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TIMER

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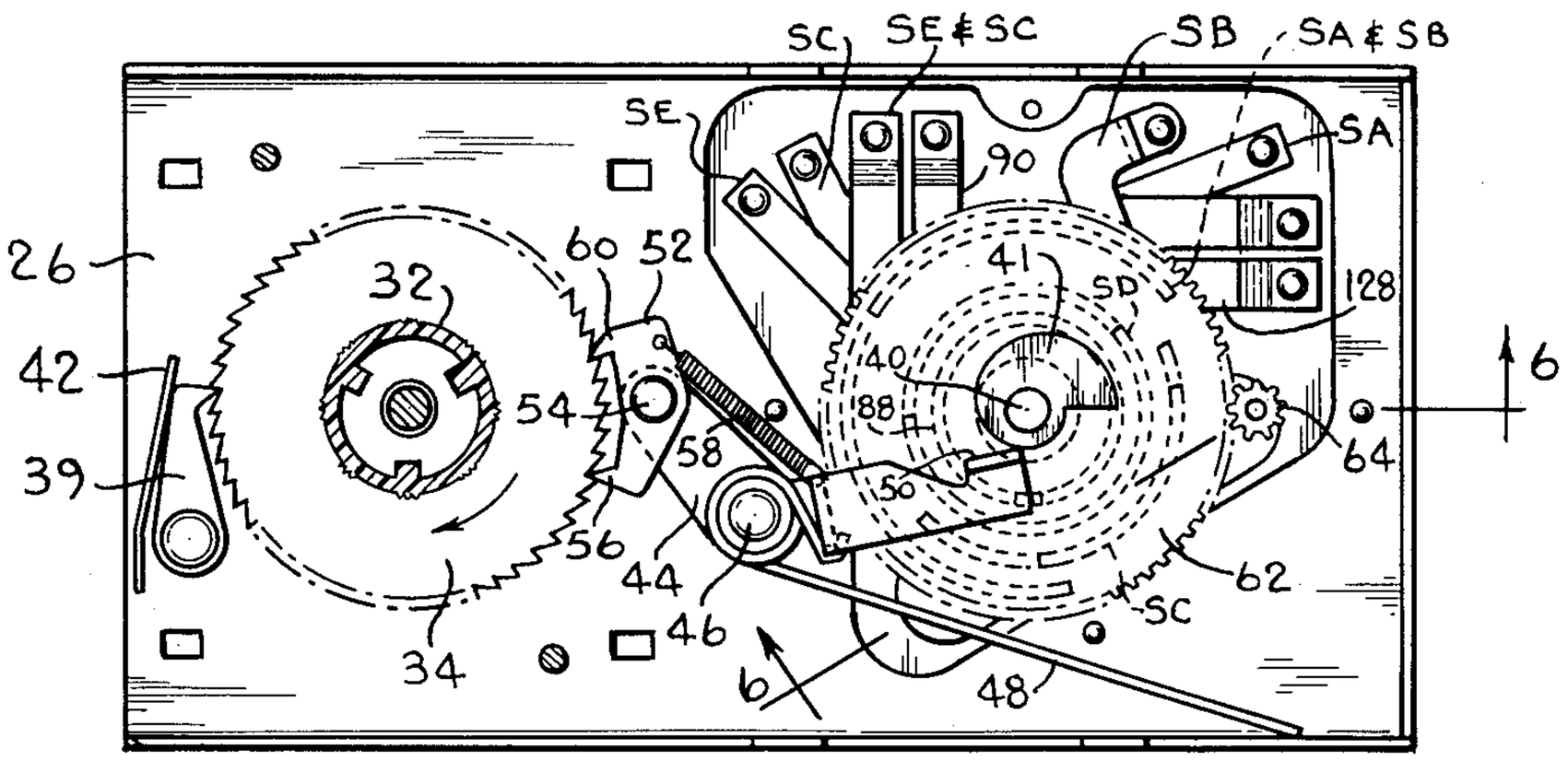

FIG. 4

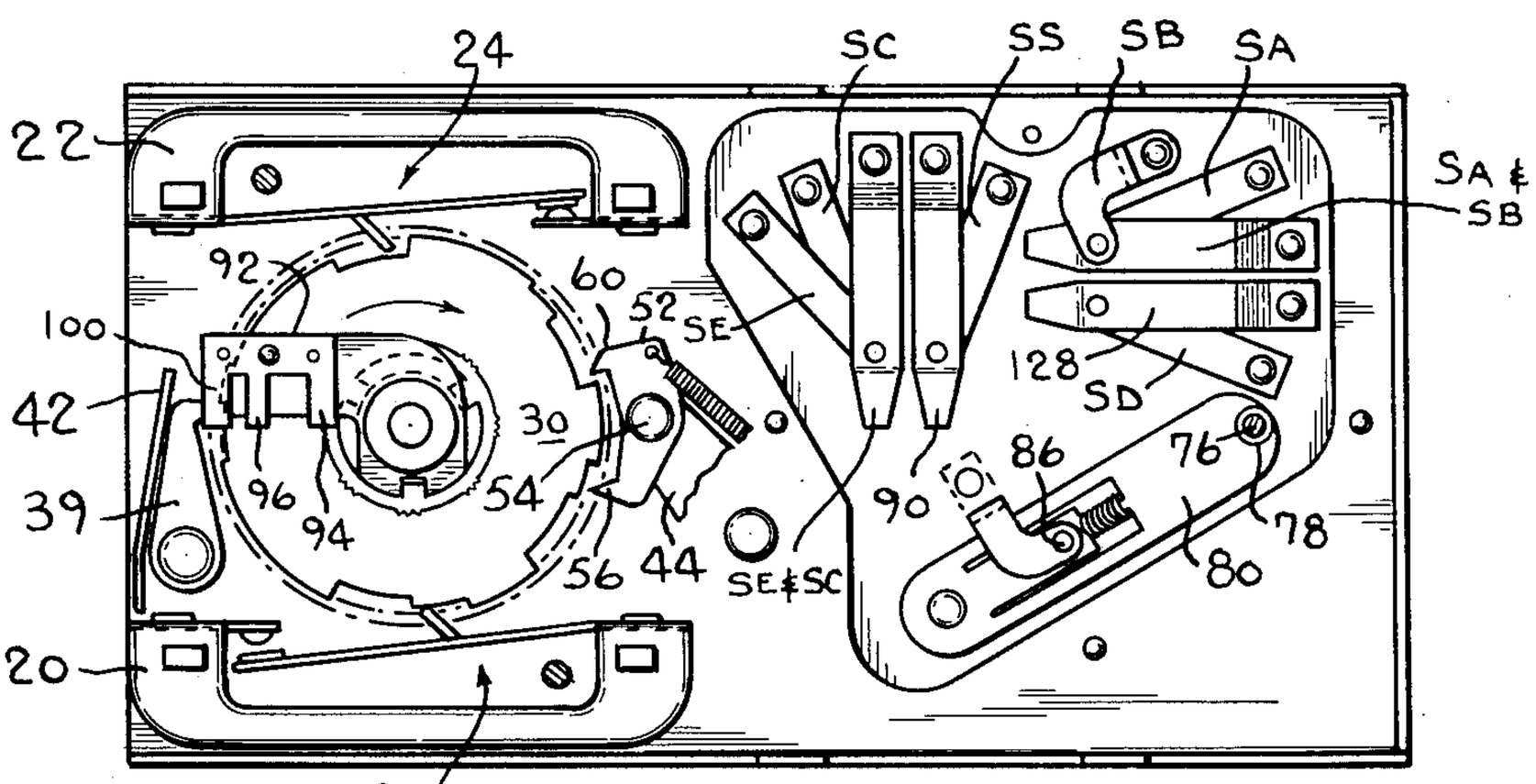

FIG. 5

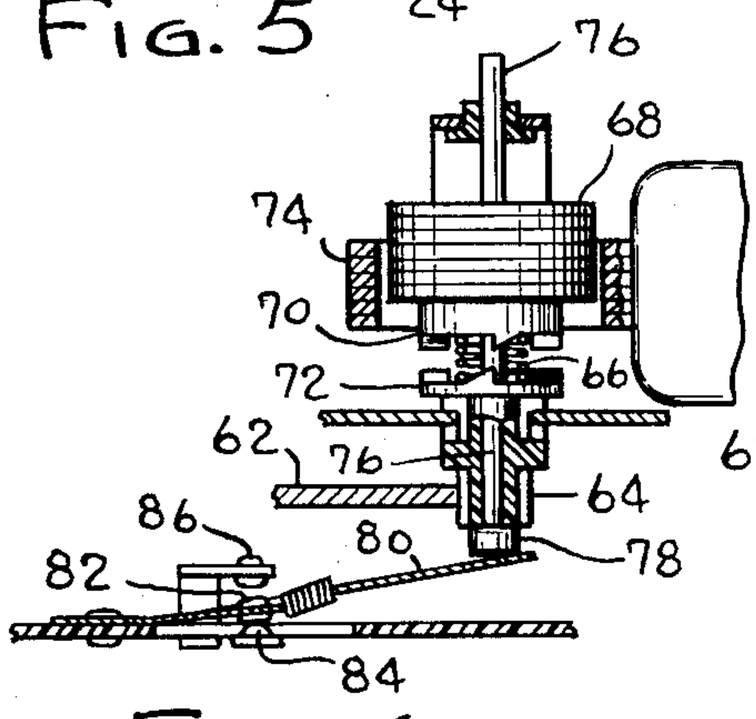

FIG. 6

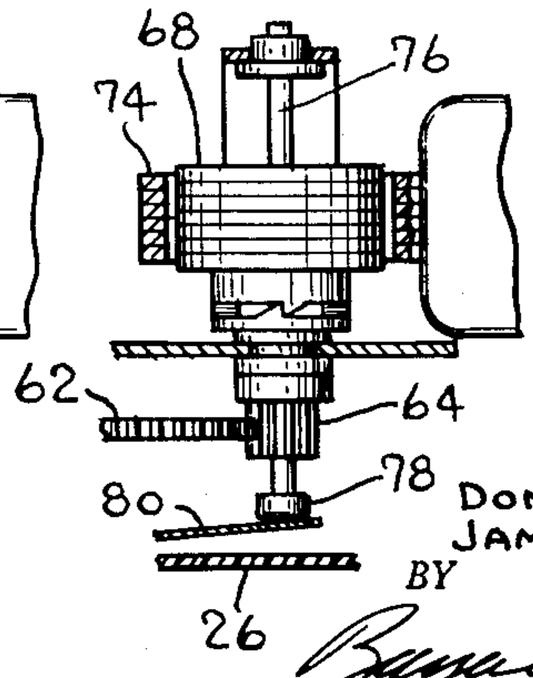

FIG. 7

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TIMER

Filed March 16, 1959 6 Sheets-Sheet 3

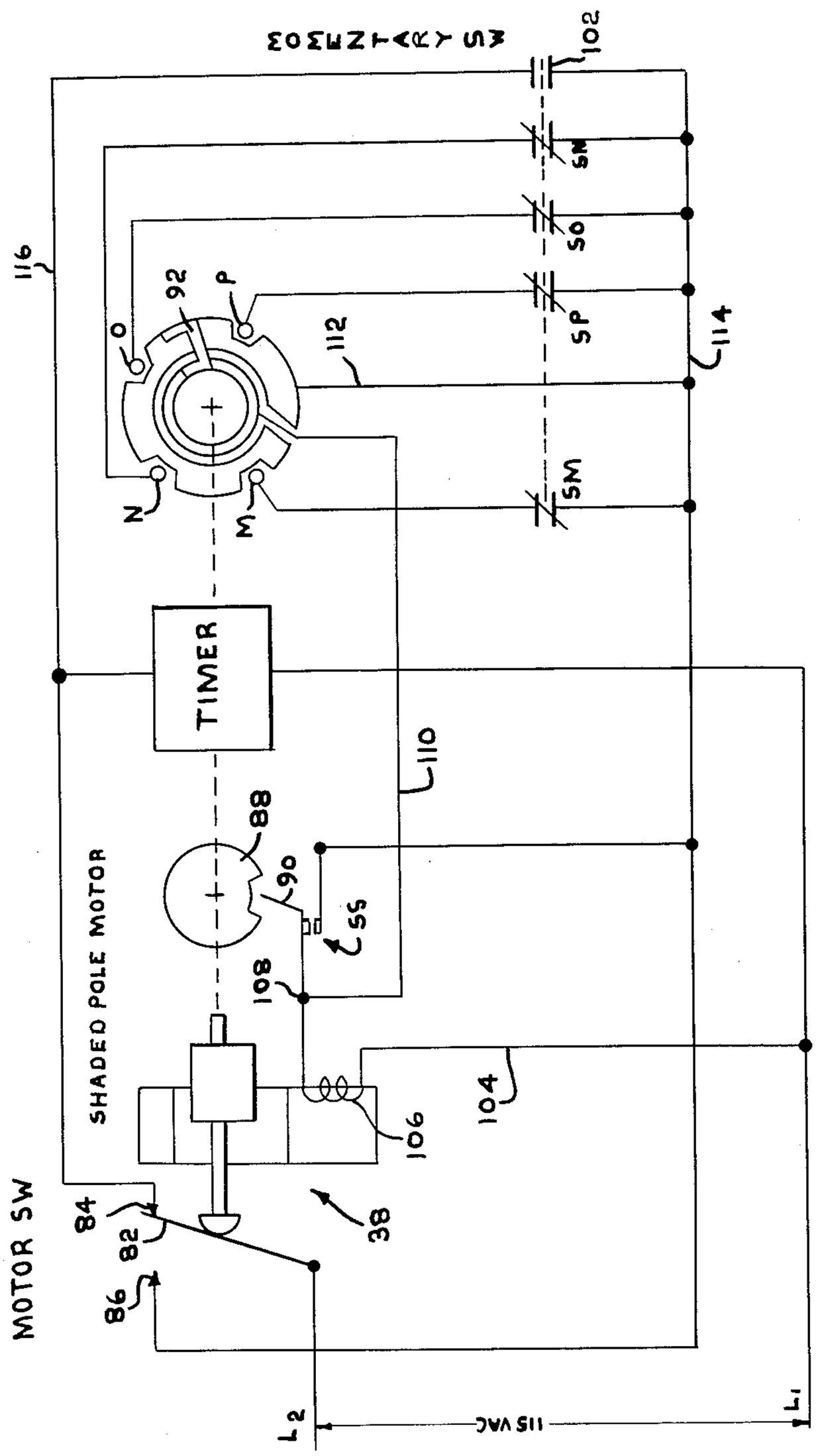

FIG. 8

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TIMER

Filed March 16, 1959 6 Sheets-Sheet 4

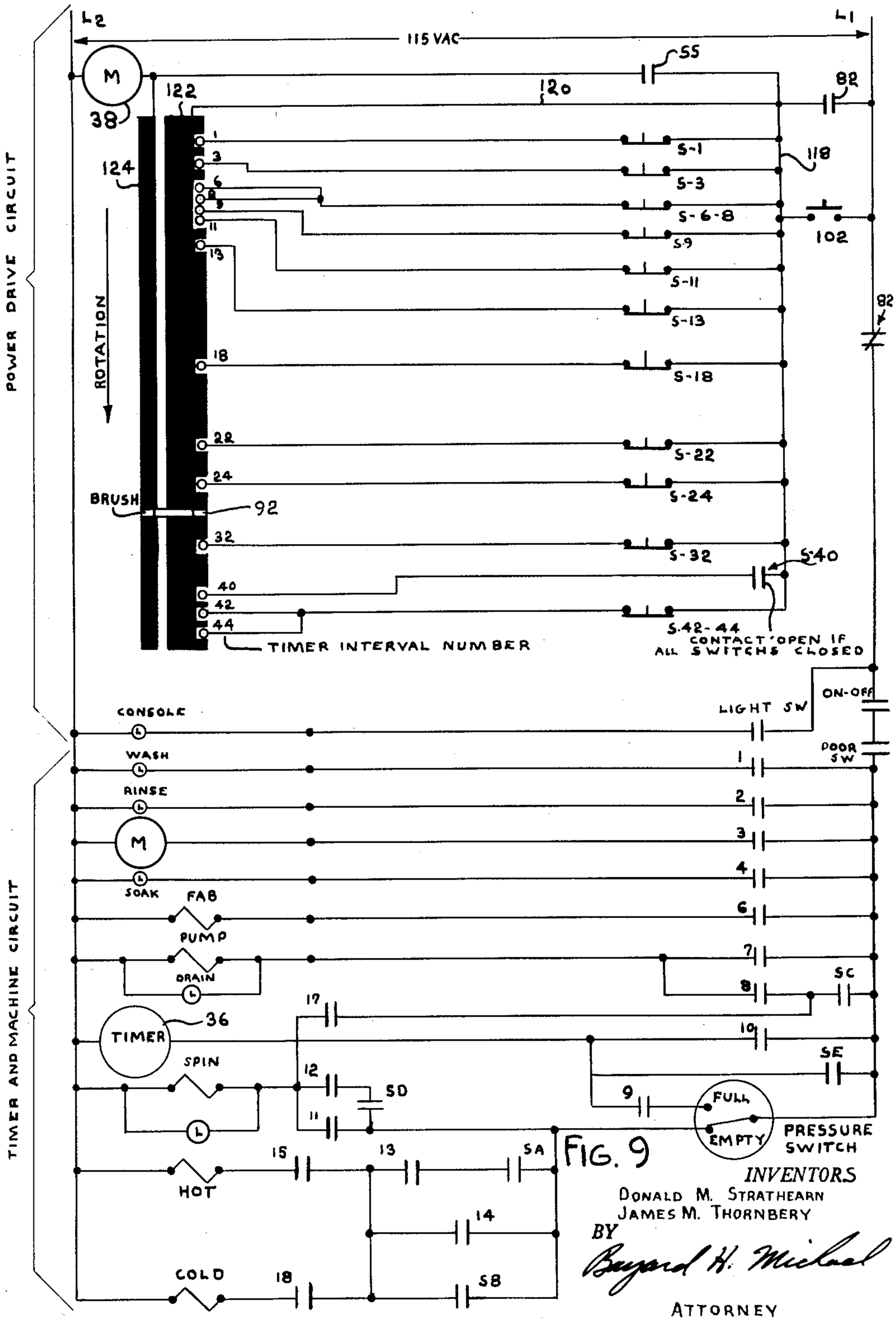

FIG. 9

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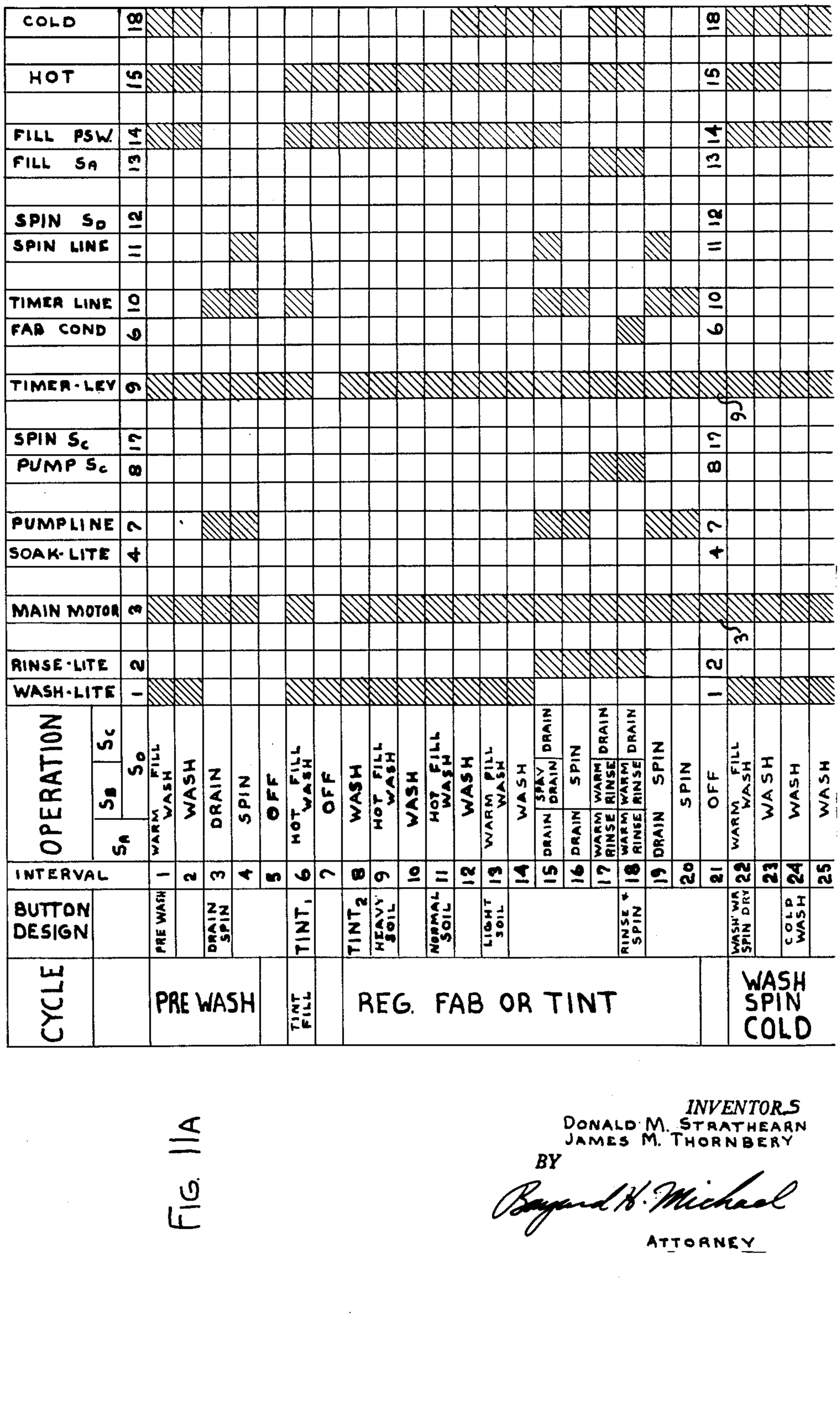

FIG. 11A

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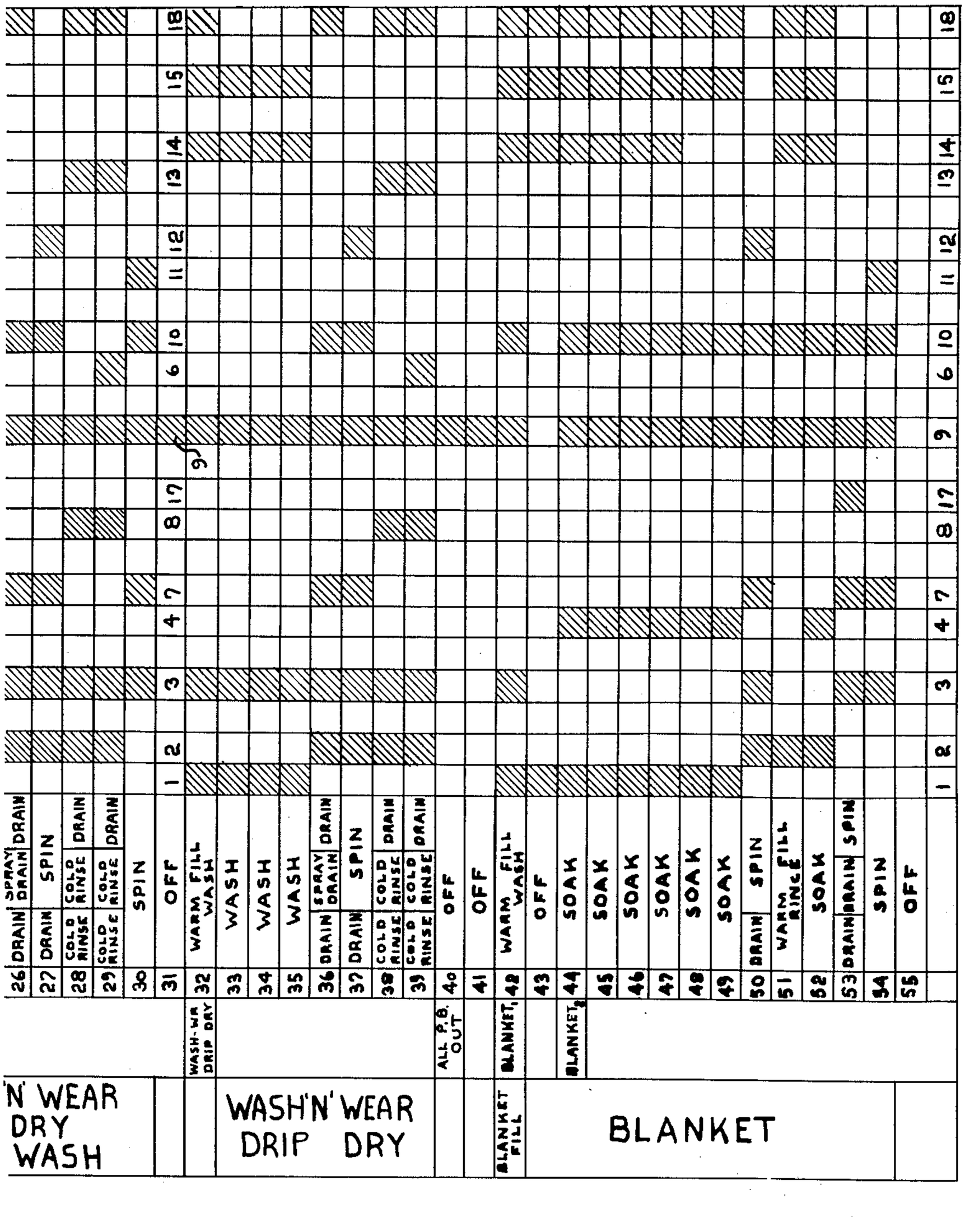

FIG. 11B

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United States Patent Office

2,995,143
Patented Aug. 8, 1961

2,995,143

TIMER

Donald M. Strathearn, Arlington Heights, and James M. Thornbery, Morton Grove, Ill., assignors to Controls Company of America, Cook County, Ill., a corporation of Delaware

Filed Mar. 16, 1959, Ser. No. 799,780
5 Claims. (Cl. 137—387)

This invention relates to sequence timers and particularly to such timers affording a plurality of programs.

Sequence timers operating on rotation of a drum can be visualized as having 360° rotation available for containing the desired programs. Each program requires a portion of the 360° available and it will be obvious that the greater the number of programs provided, the less space is available between programs. This space is utilized as a starting point and as the space is reduced the manual selection of the desired space becomes increasingly difficult until it becomes unreasonably difficult without mechanical or electro-mechanical assistance. To further simplify the process, it has become desirable to automatically position the timer at the desired starting point electro-mechanically in response to selection of a desired program by the operator actuating one (or more) switches which energize a positioning motor to drive the timer at high speed to the starting point. This has been done in co-pending Thornbery et al. application Serial Number 799,781, filed March 16, 1959 (assigned to applicants' assignee), with an interval timer combined with a seeking circuit and a separate high speed drive for the timer.

An object of this invention is to simplify the structure of Thornbery et al. and particularly to simplify the high speed drive. This has been done by having the high speed positioning motor drive the timer cam drum through the slow speed drive mechanism as compared to the Thornbery et al. arrangement utilizing two separate drives.

In order to provide a step (in the stepping drive) adequate to insure good switching on the cam drum periphery while retaining a workable size and torque requirement, it is generally found that a 6° or 7.2° step is desirable. With this limitation on the interval and with commercial requirements for more programs in the available intervals it becomes increasingly desirable to find some way to increase the functions which can be provided for by the timer. Reduction of the interval leads to switching problems and does not appear to be an attractive solution. Furthermore, often an entire interval must be devoted to an operation not requiring the entire interval (in time) for completion.

Another object of this invention is to provide means for increasing the functions possible within an interval of a timer sequence. This has been accomplished by what is called sub-interval switching which in a sense is like a separate timer having a switching sequence which may be selected by the main timer during any desired interval to thereby provide a sub-sequence within a given interval of the sequence provided by the main timer. This makes possible the maximum utilization of an interval. Thus, while the timer remains at an interval for one minute, for example, the function may take less time and the remainder of the interval is, in effect, wasted. However, with sub-interval switching the first portion of an interval may provide for (in a washing machine) "rinse" the remainder may be "drain." This may be accomplished in one interval. Other possibilities are pointed out hereinafter and many others will be apparent to those skilled in the art. Sub-interval switching has the effect of increasing the number of intervals without having to reduce the increment. Therefore, the sub-interval switching makes

possible more programs in a timer of given size and interval.

In connection with the high speed drive of the timer to its starting point, it is necessary to preclude advancing more than one step at a time.

It is another object of this invention, therefore, to provide a drive which is useable at high speed and prevents over-stepping. This has been accomplished through use of a verge drive mechanism resulting in a drive suitable for both high and low speed operation. When combined with an anti-reverse ratchet, a further advantage is realized in that the timer can not be advanced or reversed manually by actuation of the timer shaft. The latter feature allows an indicator to be mounted on the shaft, if desired, without fear that the operator will attempt to set the timer manually.

Another object of the invention is to provide a seeking circuit incorporating novel features of program selection whereby one selection switch can sequentially select two programs which should follow each other. Another feature of the circuit is the automatic selection of an "off" position in the event the selection switches are improperly actuated.

Other objects and advantages will be pointed out in or be apparent from the specification and claims, as will obvious modifications of the single embodiment shown in the drawings, in which:

FIGURE 1 is a top plan view of the timer;

FIGURE 2 is a front elevation, partly in section;

FIGURE 3 is a view of the printed circuit board utilized in connection with the searching circuit;

FIGURE 4 is a view of the drive mechanism;

FIGURE 5 is another view taken to show the general switching arrangement of both the main timer and of the sub-interval switching;

FIGURE 6 is a view through the shaded pole motor and showing the switch operated by the motor when energized;

FIGURE 7 is similar to FIGURE 6 but shows the motor in its energized position;

FIGURE 8 is a schematic representation of the searching circuit and mechanism;

FIGURE 9 is a wiring diagram for both the searching circuit and the entire washing machine and timer circuit;

FIGURE 10 is a schematic representation of the sub-interval switching sequence; and

FIGURES 11, A and B show the program achieved by the present arrangement.

The structure shown is built around a basic interval timer different from the usual timer only in that it has a great number of programs available within the 360° of rotation. Thus, the timer is provided with a pair of terminal boards **20**, **22** which carry the program switches generally designated **24**. The terminal boards are carried between end plates **26**, **28** and the switches are provided with cam followers which act on cams **30** carried on arbor **32**. As will appear hereinafter, the end plate **28** has a printed circuit thereon as indicated in FIGURE 3. The arbor **32** is journalled in the end plates for rotation and carries a drive ratchet **34** which is adapted to receive the impulses from the timer motor **36** or from the shaded pole motor **38**. It will be noted that end plate **26** carries pawl **39** loaded by spring **42** into engagement with the teeth on the drive ratchet **34** to prevent reverse rotation of the timer arbor. Of course, since the timer is not manually actuated, there is no danger of manual reverse rotation but there is some possibility of the drive mechanism to the ratchet **34** tending to drag the arbor back and the pawl **39** prevents such action.

With the exception of the printed circuit board, the mechanism described thus far is quite customary. The timer motor drives the ratchet through a novel drive

mechanism. The motor **36** includes, as is customary, a gear reduction in the larger part of the motor housing and also includes an overrunning clutch (not shown) which may be of any desired construction, to turn the motor shaft **40** in a counter-clockwise direction. The shaft carries a molded disc including the cam **41**. The purpose of this cam is similar to that of the prior art in that it gradually builds up energy in the drive mechanism and at its drop permits a rapid delivery of this energy through the drive to the arbor. Thus a low torque motor can be used to deliver a high torque impulse. The cam drop is preferably of the slow drop type described more fully in co-pending application Serial Number 520,946, now Patent Number 2,934,618. Lever or link **44** is pivoted on post **46** and is biased by spring **48** bearing against the frame and wound around the post to act against the vertical portion of the link (FIGURE 2) to force the follower portion **50** into contact with the periphery of the cam **41**. The left end (FIGURE 4) of lever **44** carries verge **52** pivoted on pin **54**. The toe or leading tooth **56** of the verge is biased into constant contact with ratchet **34** by spring **58**. The heel or trailing tooth **60** will lift out of the teeth after each impulse. As the cam **41** rotates (usually at 1 r.p.m.) the lever **44** will rock in a clockwise direction slowly and the toe **56** of verge **52** will ride up the sloping portion of the next rearward ratchet tooth and shortly before the impulse is given to the lever the toe will drop into the next notch on the ratchet ready for delivery of the power stroke or impulse. When the follower reaches the drop portion of the cam **41**, the lever will rapidly rock in a counter-clockwise direction about its pivot **46** and drive the toe **56** against the ratchet. Simultaneously with this action, the verge **52** will rock about its pivot in a clockwise direction to jam the heel **60** into a corresponding ratchet tooth as may be seen in FIGURE 4. With both the leading and trailing teeth engaged, it is impossible for the ratchet to rotate more than one step as imparted by the link and thus, the trailing tooth serves to prevent overstepping. This is of great importance in the present drive where the impulses are given rapidly and frequently during the high speed drive to be described hereinafter. Overstepping cannot, of course, be tolerated in this situation and the present drive prevents any overstepping and limits the indexing of the arbor to one step per impulse from the drive.

As mentioned above, the cam **41** is carried on a disc **62**, the periphery of which is in the form of a gear engaging pinion **64** which is adapted to be driven by the shaded pole motor **38**. When the shaded pole motor is de-energized as shown in FIGURE 6, the pinion is not connected to the motor since spring **66** biases the rotor **68** upwardly to move the clutch half **70** out of engagement with the clutch half **72** connected to the gear **64**. When the motor is energized, as shown in FIGURE 7, the rotor is pulled between the shaded poles **74** with a solenoid action and the upper clutch half **70** is pulled down into engagement with the lower clutch half **72** and the rotor of the shaded pole motor is connected to gear **64** to, in turn, transmit power to gear disc **62**. This will, of course, rotate the cam **41** and deliver impulses to the ratchet on the arbor as before except that the impulses will be delivered quite rapidly (generally in the neighborhood of six per second). When the shaded pole motor is de-energized, the clutch spring **66** will immediately move the rotor back to the position shown in FIGURE 6 in which the rotor is disengaged from the pinion **64**. Thus, the inertia of the rotor is immediately removed from the drive when the shaded pole motor is de-energized and, hence, the inertia of the motor will not tend to over drive the timer past the desired point.

A further feature to be noted in FIGURES 6 and 7 is that the lower end of the rotor shaft **76** is provided with a switch actuating boss **78** bearing on the actuating end of the switch blade **80** of a rather conventional snap acting switch. In the position shown in FIGURE 6, the switch

contact **82** is acting on the lower stationary contact **84**. When the shaded pole motor is actuated as in FIGURE 7, the switch blade **80** is moved down and throws the switch overcenter so the contact **82** now contacts the upper fixed contact **86**. The purpose of this transfer switch will be pointed out more fully hereinafter in connection with the wiring diagram.

In FIGURE 4 it will be noted that there is shown in dotted lines on disc **62**, a number of face cams which are on the underside of the disc and may be seen in part in FIGURE 2. These cams actuate a group of switches only one of which need be considered at this moment. Thus, the inside cam **88** is designed to actuate follower **90** (FIGURE 5) which, in turn, actuates the searching switch SS to open the switch SS once for each revolution of the disc.

Returning now to FIGURE 3 which illustrates the printed circuit found on the end panel **28**, it should be noted that the brush wiper **92** carried by the arbor for rotation therewith (FIGURES 2 and 5) wipes three circular paths on the printed circuit. Thus, while the middle arm **94** runs on the inner circular track while the middle wiper arm **96** runs on the outer portion of the nearly circular path **98** so as to overlie the cutout portions of the track. The outer wiper arm **100** wipes on the inner end of the various fragments which generally line up with the notches in the middle track **98**. By a switching arrangement which will be more fully explained in connection with FIGURES 8 and 9 the slender portions opposite the notches are, in effect, placed into the notch (electrically speaking) when the corresponding switch is closed and, hence, the brush running on the inner track can complete the circuit across the inner and middle track. If the switch to one of the finger-like circuit portions printed opposite a notch in the middle track is open, there can be no completed circuit and this will constitute an open circuit which the system is designed to seek.

This seeking circuit is readily understood in connection with FIGURE 8 which shows the essential portions of the circuit. This figure, incidentally, shows the circuit relationship of the printed circuit and the brush **92** rather clearly and demonstrates that the brush merely acts as a jumper in the circuit arrangement. The small circular segments on the periphery of the representation of the printed circuit correspond to the fingerlike projections opposite the notches in FIGURE 3. Due to space, they cannot actually be placed as in FIGURE 8 and, hence, it is necessary to have the brush provided with two wipers. The printed circuit here is shown with four possible stopping points which are referred to as M, N, O and P which are regulated by normally closed switches as SM, SN, SO, and SP. These switches constitute the cycle selection switches. There is also a normally open momentary switch **102** and the cycle selection switches are so designed that actuation of one of these switches will also actuate the momentary switch **102**. When switch SM, for example, is actuated, the momentary switch will be closed and the switch SM will be opened. Closure of the momentary switch will energize the shaded pole motor through the printed circuit and the brush. This circuit is as follows: L1 to the lead **104** through the motor winding **106** to junction **108** and from there through lead **110** to the printed circuit board, through the wiper, to lead **112** and line **114** to the momentary switch **102** and from thence to line **116** to contact **84** on the motor switch **82** to line L2. This energizes the shaded pole motor and the solenoid action of the rotor throws the switch **82** to contact **86** to establish a holding circuit shunting the momentary switch and breaking the circuit to the timer motor. At this time the shaded pole motor drives the timer at high speed to advance the wiper **92** around the printed circuit. The advance will, of course, be step by step. After each step the cam **88** allows the search switch SS to open. The searching switch SS is normally closed and in parallel with the printed circuit

switches. If the circuit through printed circuit is complete when the searching switch opens the shaded pole motor will continue to advance the timer at the rate of about six impulses per second. When the brush on the printed circuit reaches the contact segment M which is in series with the open cycle selection switch SM, opening the searching switch will cause the shaded pole motor to be deenergized since the circuit through the motor coil **106** is broken. Immediately upon de-energization of the shaded pole motor, spring **66** returns the rotor to the position in which it disengages the drive and also restores the rotor switch **82** to its normal position. In this position the timer will now be energized by reason of the fact cams driven by the timer have caused closure of the circuit including the timer motor. This will appear more fully in connection with FIGURES 9 and 11.

The simplified diagram of FIGURE 8 should make the operation of the searching circuit quite clear. It should be noted that due to the fact that the searching switch SS is normally closed and is closed during the advance of the brush, the printed circuit is, during the impulse, shunted by the searching switch. Between each impulse imparted to the timer and its brush **92**, the searching switch opens and, hence, the testing of the circuit condition is, in effect, accomplished at the searching switch rather than at the brush and thus avoids switching on the printed circuit board which could conceivably have adverse affects. It should be noted, however, that as further experience is gained both with respect to printed circuit boards and with respect to the capacities of a timer arrangement of this type, it appears more and more likely that the searching switch can be eliminated if desired.

With the understanding of the searching circuit gained from the consideration of FIGURE 8, the complete wiring diagram of the timer, the searching circuit and the washing machine can now be considered, noting, however, that the circuit to be described now is merely representative of one type of circuit and the present invention can be applied to many types of control circuits. Furthermore, it should be noted that in the system shown here the searching arrangement seeks an open circuit. The system can readily be modified to seek a closed circuit when desired. Such a circuit is shown in the co-pending application of Thornbery et al. Serial Number 799,781.

Turning now to FIGURE 9 and particularly to the upper portion thereof, the printed circuit is here represented by the dark strip over which the brush **92** travels in the direction indicated by the arrow labeled "rotation." Along the right-hand of the side of the wider of the two printed circuit strips, there is indicated the various starting points which may be selected by operating one of the cycle selection switches. These switches bear the legend **S1, S3** etc. with the S standing for cycle selection switch and the nuumeral **1** indicating the starting point at interval number **1**, for example. It will be noted that there is shown a switch **S6–8** and this indicates the same switch may be actuated to position the brush and, hence, the timer to start at either interval **6** or **8** and the purposes underlying this will be explained more fully hereinafter. It will be noted that this wiring diagram illustrates the searching switch SS and the shaded pole motor switch **82**, the latter being shown in two locations in order to indicate its functions completely. The momentary switch **102** is also shown. With the showing of FIGURE 8 in mind, it will be easy to determine the manner of operation. For example, actuation of one of the normally closed cycle selection switches will, as mentioned above, also actuate the momentary switch **102.** Since the timer is designed to stop at the end of a cycle or program in an "off" position with the brush bridging the printed circuit so as to result in closing the circuit at this point, this will result in current flow to the shaded pole motor from line **L1** through the momentary switch to the common line **118** and from thence to line **120** and

the printed circuit strip **122** through the brush to printed circuit strip **124** and from there through the motor **38** to line **L2**. This, of course, energizes the motor and changes the position of the shaded pole motor switch **82**. Thus, the shaded pole motor switch in line **L1** will open to de-energize the entire washing machine circuit, while the shaded pole motor switch also closes the circuit from line **L1** to line **118** to shunt the momentary switch and establish a holding circuit. Now then, the shaded pole motor will rapidly advance the timer and its brush through the sequential intervals searching for the open circuit. After each impulse to advance the timer, the searching switch SS will open to allow the circuit condition to be tested. For example, if the selection switch **S11** had been opened, the brush would continue around the timer until it landed at **S11** and the searching switch SS opens so that the circuit through the shaded pole motor would have to pass through the printed circuit board. At this time, since the switch **S11** is open, the current flow to the shaded pole motor will be interrupted and the rotor will retract to reverse the position of the switch **82**. This, in turn, will allow current flow to the timer motor **36**.

At this point it is well to consider the chart in FIGURES 11A and B which show a sample program available with this arrangement. It will be noted that the cycle selection switches (FIGURE 9) bear the numerals indicating the interval at which the timer will be stopped in its rapid advance. These intervals correspond to those intervals shown on FIGURE 11 under the interval column and constitute the start of different programs. It will be noted that FIGURE 11 also shows, in the various labeled columns, the condition of the various switches operated by the timer cams. These switches **1, 2, 3, 4** etc. appear in the lower portion of FIGURE 9 and control the washing machine apparatus or functions associated therewith as indicated on the diagram (FIGURE 9) as well as on the chart of FIGURE 11. The chart is easy to read. For example, in the situation given above with the starting point at interval **11**, the wash light (merely an indicator light) will be energized as will be the main motor through timer cam switch **3**, the timer will be in circuit with the closed switch **9** and switches **14** and **15** will also be closed. It will be noted that the washing machine is provided with a pressure switch **126** and, of course, at the start of this cycle, the "empty" contact will be made. Hence, the timer motor **36** will not be energized until such time as the pressure switch acts to make the "full" contact. However, with the energization of switches **14** and **15**, the solenoid actuating the hot water valve will be open and the tub will start to fill. When the desired level has been reached, the pressure switch will transfer to the "full" contact whereupon the timer motor will start operation. Thus, even though the tub may take four minutes to fill, only one interval has been utilized for the fill operation and a full minute of time remains to be used after the filling before the next step of the stepping mechanism.

Reference to the chart will show that the timer could have been started, for example, at interval **13** which would result in a warm fill rather than a hot fill. If started at interval **11**, however, as the timer steps through interval **13**, nothing will happen as regards filling since the pressure switch will have already transferred to the full contact and, hence, the mere fact that solenoid switch **18** is closed in interval **13** will have no effect and no cold water will be taken into the tub. The timer will continue stepping until it reaches interval **21** at which time the timer is turned off.

Before going on with other aspects of the present invention, it should be noted that the cycle selection switches are coupled with a switch **S40** which will be open if all the selection switches are closed. For example, if the operator presses a latching type selection switch with an over-travel mechanism for establishing the momentary

switch **120** and then releases the switch which fails to latch in its open position, it will be appreciated the motor would now be energized and could go on searching for an open circuit not existing. Therefore, the switch arrangement is so designed that if all the cycle selection switches are closed, the switch S**40** will be open and this, as can be seen by reference to the chart in FIGURE 11, is an "off" position and, hence, no harm has been done and the machine will not continuously run searching for a condition which does not exist.

Reference was made earlier to the provision of multiple sequential functions within a given interval. This arrangement will now be explained. As was mentioned earlier, the gear disc **62** was provided with a plurality of circular face cams, the inner one of which operates the search switch SS. There are additional cams on the disc which operate what we term "sub-interval switches." Now then, starting from the inner cam, which operates the searching switch, the next cam track (progressing outwardly towards the periphery of the disc) will operate the sub-interval switch D through the follower **128** cooperating with switch labeled SD. The next cam track (progressing outwardly) operates switches SC and SE while the outermost cam track operates the sub-interval switches SA and SB. Now then, in FIGURE 10, there is shown a chart of the sequence of operation of the sub-interval switches. The rectangle in which the labeled rectangles appear represents, from left to right, one interval as a matter of time and thus progressing from the lefthand margin, it will be noted that shortly after the start of an interval, switch SA is made and remains closed for approximately ⅓ of a cycle. Switch SA is thereupon opened and switch SB closes. At this time, switch SE also closes. SB remains closed for approximately ⅓ of a cycle and then opens, followed shortly by the closure of SC. SD closes shortly before the opening of SB and SD remains closed into the next interval as indicated by the small portion on the lefthand margin.

The sub-interval switches are included in the main timer circuit as indicated in FIGURE 9 and consideration of FIGURE 9 in combination with the chart of FIGURE 11 will now demonstrate the novel functions possible through such an arrangement. Refer, for example, to the operations achieved at interval **17**. Here, it will be noted, the same interval is used both for a rinse and for draining. Under former practice, this was obviously incompatible since the drain pump would have to be energized at the same time it was desired to fill the tub. However, an analysis will show the practicality of the present arrangement. At interval **17** the pump solenoid switch **8** is closed but it cannot operate the pump until SC also closes. Hence, the pump cannot operate until the last third of the interval. Now then, the timer motor **36** is connected to the power supply through the level switch and cam switch **9** which means that upon the timer dropping into interval **17**, the timer motor will turn off and will stay off until the tub has been filled. This has the effect of stretching the interval to one long enough to allow the tub to fill regardless of the time required. It is obvious that the draining operation which, as explained before, can only occur during the latter third of the interval, would not be very effective if the tub were simultaneously undertaking to fill. Therefore, the fill is controlled through timer switch **13** which is in series with switch SA. Also closed at this time are the hot and cold solenoids **15** and **18**. However, to fill the tub after the timer drops into this interval, the circuit passes through the pressure switch and switch SA and the timer switch **13** to the solenoids and causes filling which will continue with the timer totally at rest until the pressure switch trips to close the full contact and this will then reenergize the timer. The timer having been re-energized, the sub-interval switching resumes operation and, before long, the switch SA will open and no more filling can occur. When sub-interval switch SC closes in series with timer switch **8**,

the pump will go into operation and start pumping down the contents of the tub. Obviously this would affect the pressure switch and would turn off the timer motor with the result that the timer could not get out of this interval. This is accommodated by sub-interval switch SE which is in circuit with the timer **36** shunting the timer line switch **10**. Obviously the line switch **10** could not have been closed during all this operation since a complete fill for the rinse purposes would not have been accomplished. It will be apparent, therefore, that the use of the sub-interval switching has accomplished within one interval, the functions which would normally require at least two intervals. Furthermore, due to the arrangement of the sub-interval switching, a greater period of time has been spent in the interval than the actual theoretical duration of the interval. Thus, the fill alone could take four or five minutes and there is still time within this interval to effect the draining operation. Another advantage in this system is that where the function desired requires less time than a complete interval, the complete interval need not be devoted to accomplishment of the function. Thus, the draining can be accomplished within about ⅓ of the interval.

When the timer advances to step **18**, this function is again repeated. In going into interval **19**, the pump is connected across the line by closure of switch **7** and the washer continues to pump down until sub-interval switch SD closes in series with timer switch **12** to energize the spin. It will be noted that interval SD extends into the subsequent interval and this is to insure against the spin solenoid and the associated transmission being de-energized and re-energized between intervals.

The multiple functions thus afforded by sub-interval switching are much the same in the other intervals where the sub-interval switches are cut into the circuit except that in interval **36**, for example, during which the drain pumps are working constantly, there is a spray during sub-interval B. Thus, in the first portion of the interval, the pump pulls down the water level so that the pressure switch will trip over to the empty contact and when SB is made the circuit through the closed timer switch **18** will be made to energize the cold solenoid and give a cold spray. With the provision of the pressure switch, the sub-interval switch SB is not effective unless the pressure switch is in the empty position and either or both of the water solenoids **15** and **18** are closed.

One further feature afforded by the present arrangement should now be pointed out. As mentioned above, the cycle selection switch S**6–8** in effect, provides two stopping points, reference to the chart will demonstrate the purposes of the two starting points. When this switch is first actuated, the tub gets a hot fill and agitation for the interval (**6**) period and then in interval **7**, the machine turn off. This permits the clothes to be soaked . . . the machine may be loaded and the S**6–8** actuated and the housewife may then leave the scene with the knowledge that the machine will turn off and allow the clothes to soak. When she presses the same button again, it will advance to interval **8** and then go into the timing speed to the "off" position at interval **21**. It will be noted that one additional cycle selection switch has this feature. This is switch S**42–44** where when the blanket button is first depressed, a warm fill will be obtained and the blanket may be soaked. Depressing the button again will start a timed soaking operation as indicated in intervals **44** through **49** whereupon the machine will go into the drain and rinse operation etc. finally turning off at interval **55**. One switch, therefore, selects a sequence as it is operated sequentially. S**6–8** when first actuated must stop at interval **6** and when again actuated will stop at interval **8**. The added versatility in programming at virtually no cost is readily apparent.

The present invention constitutes an improvement over Thornbery et al. application Serial No. 799,781 insofar as the timer motor and the shaded pole motor use a com-

mon drive mechanism to step the timer. The drive includes an improved stepping mechanism preventing overstepping as explained more fully above. This invention also includes the sub-interval switching which, as explained above, greatly adds to the versatility of the machine. Heretofore, it was necessary to devote an entire interval to accomplishing a given function even though the function did not require the entire interval. By utilizing sub-interval switching, multiple functions can be performed within a given interval. A further feature is to be noted in connection with the sub-interval switching. It is possible with this system, to combine the better features of the stepping or interval timer and the creep type timer, the sub-interval switching arrangement being essentially a creep type timer. In the customary interval timer, a plurality of circuits are theoretically made simultaneously upon the timer being stepped. In practice, however, there are manufacturing tolerances and there will be some slight spread in the switch closing and, with certain circuits, it is possible to have a momentary short circuit as a result of improper operation of the switches. This is true in a switch which passes all manufacturing inspection since it is a result of a very slight variation still within manufacturing tolerances. With the present arrangement, however, it is possible to close a circuit prior to the normal interval for the closure and upon stepping to then transfer the control from the sub-interval switch to the main timer. This will insure the proper sequencing and, as can be seen, frees the designer from the strict parameters laid down by the usual stepping arrangement. Now the designer is able to sequence a circuit independently of the interval timer and to later transfer control of the circuit back to the interval timer.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

We claim:

1. In a washing machine, an interval timer having a timer motor, a cam bank driven by the timer motor in a step-by-step manner with the cam bank operating interval switches according to a prescribed sequence, and a creep timer including a plurality of sub-interval switches sequenced once for each interval of the prescribed sequence, said sub-interval switches being connected in circuit with certain of the interval switches to modify circuits controlled by the interval switches in accordance with the operation of the sub-interval switches, and a

switch responsive to a desired water level in the washing machine, including a circuit connecting the timer motor and the water level switch, and a sub-interval switch operative to shunt the level switch and connect the timer motor to a circuit, said sub-interval switch being operative at a predetermined interval in the prescribed sequence to make energization of the timer motor dependent upon the level switch indicating the desired level in the machine.

2. A washing machine according to claim 1 including a pump for draining the machine, a sub-interval switch connecting the pump to a circuit to empty the machine, the timer motor sub-interval switch and the pump sub-interval switch both being closed during a portion of the time that the timer motor sub-interval switch is closed.

3. A washing machine according to claim 2 including a water supply means, a sub-interval switch in circuit with the water supply means and the level switch whereby to effect filling the machine in said predetermined interval, the water supply means sub-interval switch being closed in the first portion of the interval, and the pump and motor sub-interval switches being closed in a later portion of the interval.

4. A washing machine according to claim 3 wherein one of said interval switches is in series with the pump sub-interval switch to control the intervals in which the pump sub-interval switch will be effective.

5. An interval timer including a cam bank driven by a timer motor in a step-by-step manner with the cam bank operating interval switches according to a prescribed sequence, a creep timer including a plurality of sub-interval switches sequenced once for each interval of the interval timer, said sub-interval switches being connected in circuit with certain of the interval switches to modify circuits controlled by the interval switches in accordance with the operation of the sub-interval switches, one of said sub-interval switches being connected in circuit with the timer motor, and a circuit in parallel with the timer motor sub-interval switch and including a water level switch responsive to a desired condition, whereby to shunt the sub-interval switch when the desired condition obtains.

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