

Nov. 8, 1960

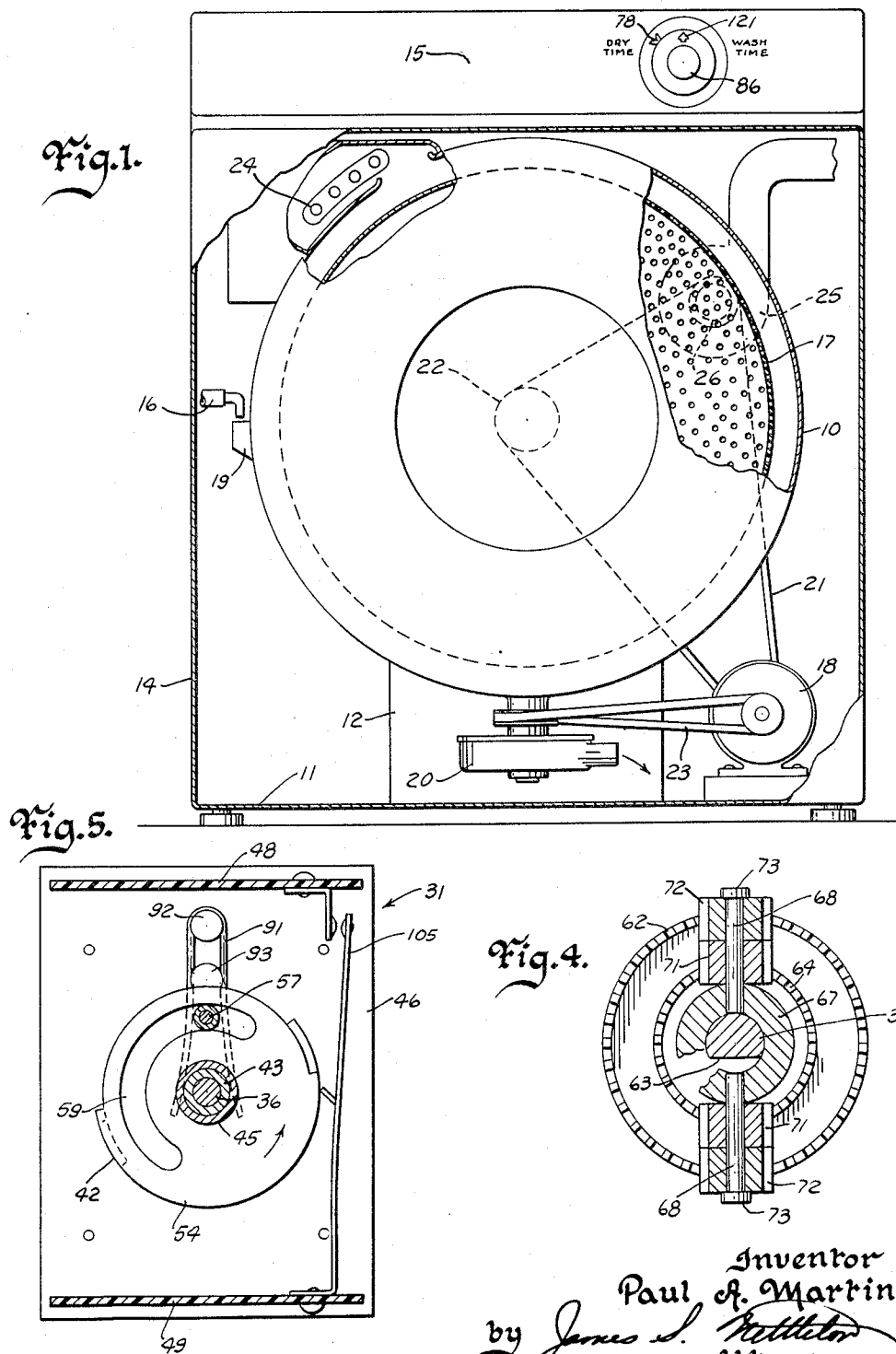
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2,959,646

INDEXING INTERVAL TIMER

Filed Nov. 13. 1956

5 Sheets-Sheet 1



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5 Sheets-Sheet 2

Fig. 2.

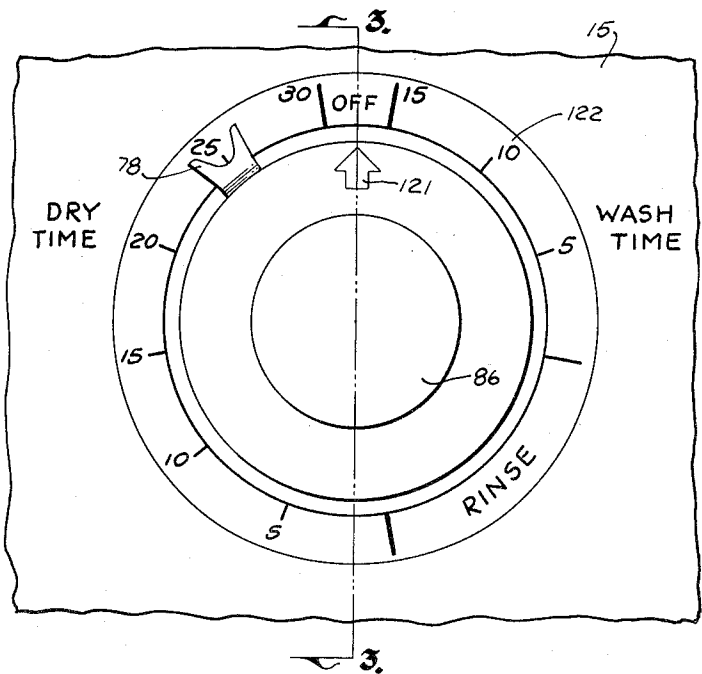
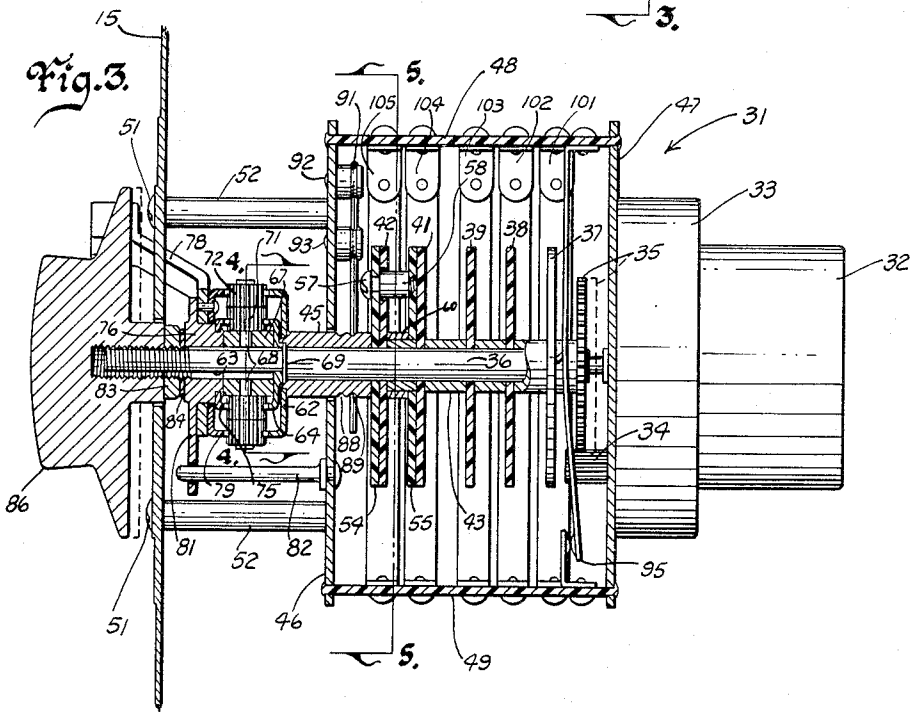


Fig. 3.



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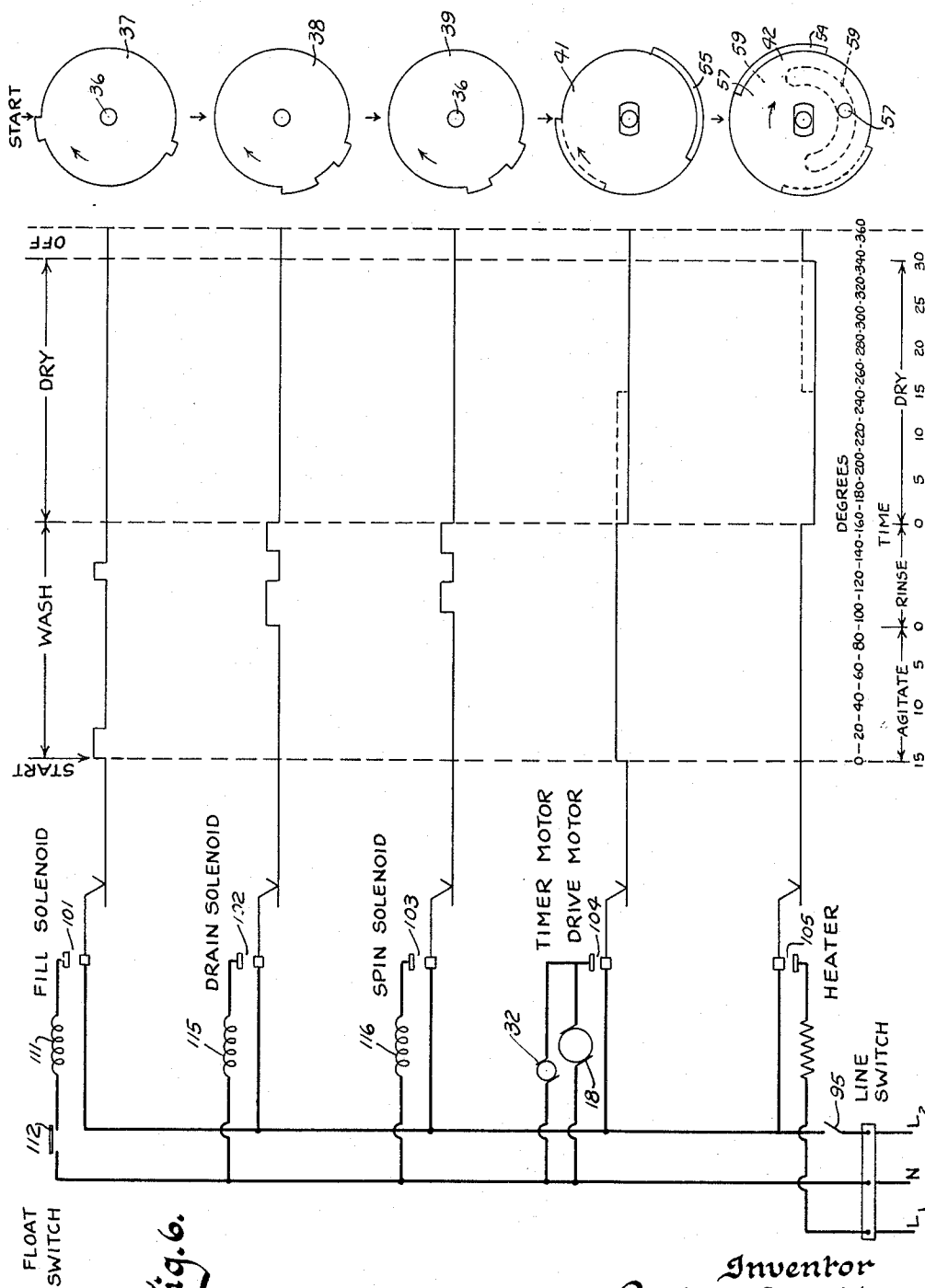
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5 Sheets-Sheet 3



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INDEXING INTERVAL TIMER

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5 Sheets-Sheet 4

Fig. 7.

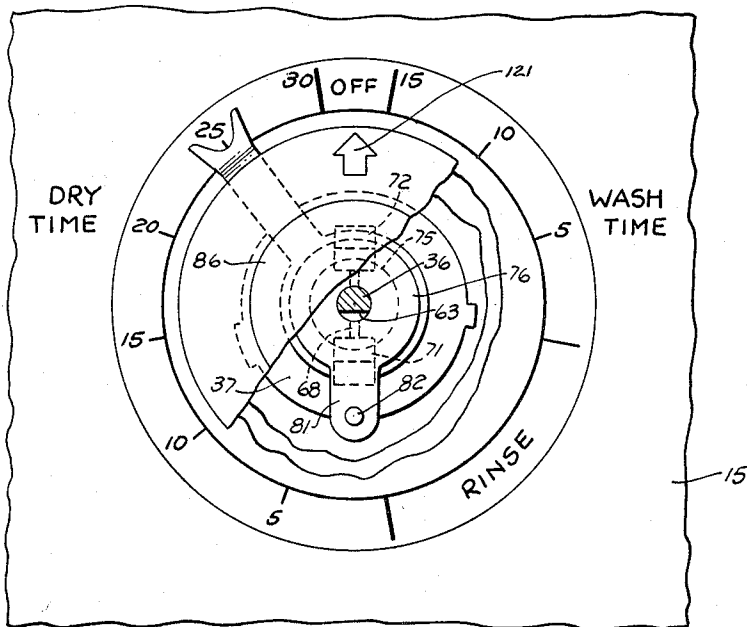
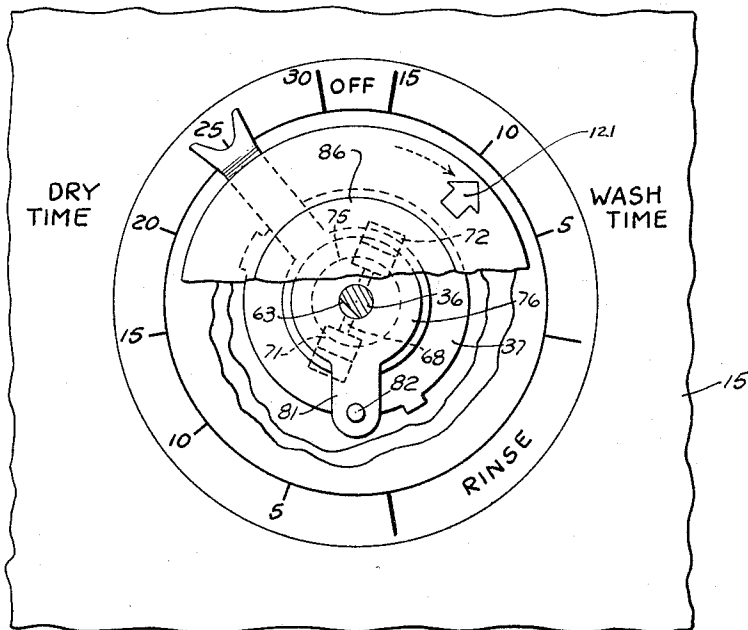


Fig. 8.



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5 Sheets-Sheet 5

Fig. 9.

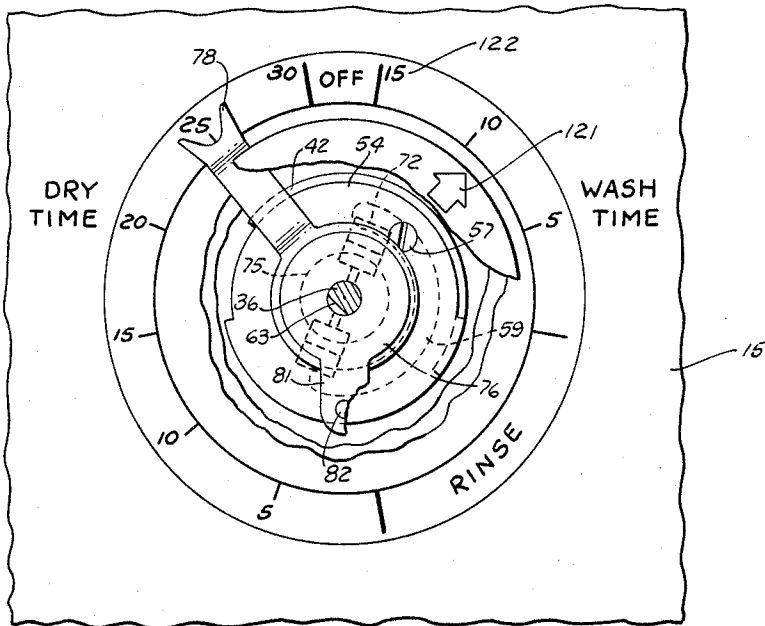
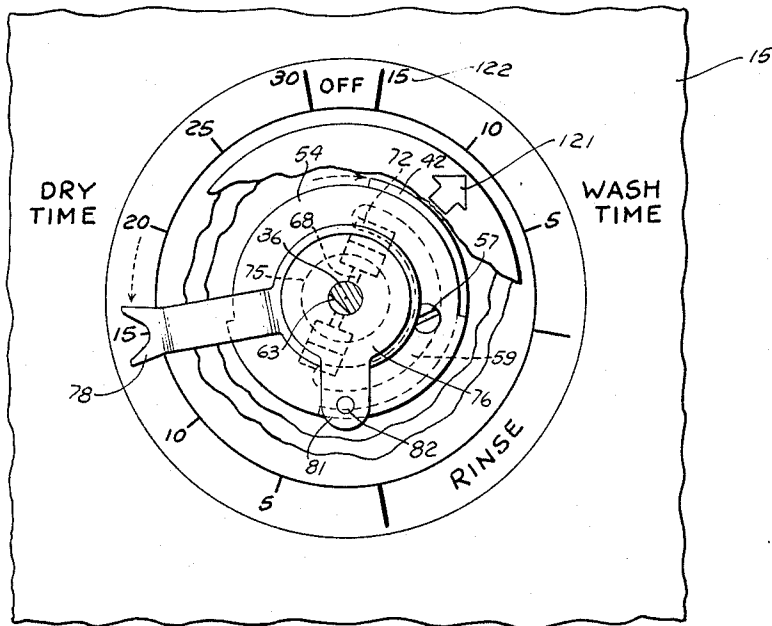


Fig. 10.



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1

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INDEXING INTERVAL TIMER

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11 Claims. (Cl. 200—38)

This invention relates to a timer apparatus for sequentially energizing or de-energizing one or more electric circuits. It specifically relates to a sequential controlling mechanism with which the programming of one or more sequentially operated circuits may be relatively adjusted with respect to the programming of another group of sequentially operated circuits. The specific timing apparatus disclosed hereinafter is particularly suitable for controlling the operation of a combination washer-drier in which either or both of the washing and drying operations may be preset to operate over predetermined timed intervals.

The timer mechanism disclosed hereinafter incorporates a motor driven shaft to which one or more cams regulating the washing operation of a combination washer-drier are affixed and to which one or more main cams regulating the drying operation in this combination washer-drier are also affixed. In the disclosed embodiment of this timer mechanism, the main cams regulating the drying operation are provided with secondary cams or cam segments which are revolvably mounted adjacent the main dry cams on the timer drive shaft.

Manual variation of the secondary cams to vary the effective cam profiles of the drying cams thereby adjusting the programming between the wash and dry circuits is achieved by movement of a control lever which rotates the secondary cams relative to the main drier cams through a differential gear mechanism mounted on the timer drive shaft. By co-ordinating the positioning of the timer cams with appropriate indicia corresponding to the functions controlled by those cams as indicated by the positioning of the control lever and the timer control knob attached to the timer drive shaft, a washer-drier incorporating this invention may be preset to control and indicate the duration of the wash and dry cycles, the starting and stopping points for the machine and the precise stage being performed by the machine as it progresses through its complete fabric treatment operational cycle.

In the accompanying drawings:

Figure 1 is a front elevation, partially broken away, showing a washer-drier incorporating my invention;

Figure 2 is an enlarged fragmentary view of the control panel of the washer-drier shown in Figure 1 showing the cooperation between the timer control knob, the differential control lever and the indicia on the control panel;

Figure 3 is an enlarged cross-sectional view of the sequential controller forming the basis for this invention;

Figure 4 is an enlarged sectional view taken on line 4—4 of Figure 3;

Fig. 5 is a cross-sectional view taken on line 5—5 of Figure 3 showing the relationship between one of the main drier cams and its adjustable secondary cam;

Figure 6 is an illustrative wiring diagram (left side of figure) for the washer-drier shown in Figure 1 together with the control cams (right side of figure) for the actuation of the various circuits as diagrammatically illustrated by the developments of the respective control cams (center of figure);

Figure 7 is a view similar to that of Figure 2 but illustrated with parts broken away to show the positioning of certain main timer cam parts controlled by the timer control knob;

Figure 8 is a view similar to that of Figure 7 show-

2

ing the repositioning of those same timer cam parts shown in Figure 7 by clockwise movement of the timer control knob into the agitation portion of the washing cycle of the machine shown in Figure 1;

5 Figure 9 is a view similar to that of Figure 2 but illustrated with parts broken away to show the relative positioning between a main drier cam and its secondary cam with the differential control lever preset in one position; and,

10 Figure 10 is a view similar to that of Figure 9 showing the effect on the relative positioning between the main and secondary drier cams shown in Figure 9 by a counterclockwise movement of the differential control lever to a shorter drier time setting.

15 Now referring to the accompanying drawing, Figure 1 shows a diagrammatic drawing of a combination washer-drier embodying my invention. To simplify the explanation and understanding of this combination washer-drier in its operation with my invention, the drier 20 portion of this washer-drier is pictured as having an air-flow path which does not recirculate within the drier chamber but rather receives air from the ambient atmosphere, passes this air over a heating unit prior to its entry into the drying chamber and then exhausts this hot 25 humid air again into the atmosphere through external ductwork. As the timer forming this invention is not dependent upon the precise construction of the machine which it controls, it should be apparent that machines of the recirculating air type incorporating a vapor condenser can also be readily used with this invention.

Figure 1 shows the illustrative washer-drier as including a casing 10 mounted on base frame 11 by means of the upstanding support members 12. A cabinet 14 having a control panel 15 is connected to base frame 11 35 to completely enclose the entire washer-drier structure.

A revoluble drum 17 having perforate side and back walls is mounted on the rear wall of the stationary casing 10 and is driven by the rear pulley (not shown) of the double-ended motor 18 through belt 21 and the transmission 22 carried on the rear wall of casing 10. A shifter mechanism (not shown) within transmission 22 40 regulates the speed of drum 17 at approximately 50 r.p.m. for tumbling during the agitation and dry periods or 200 r.p.m. for spinning during the extraction period.

45 Water for the washing operations of this washer-drier is supplied through mixing valve 16 which discharges into the casing 10 through the liquid receiving cup 19 formed on the cylindrical side wall of that casing. Washing fluid discharged from casing 10 is pumped therefrom by means of the water pump 20 connected to the lower portion of casing 10 and communicating with the drain valve (not shown) connected to the intake of pump 20. The water pump 20 is connected to the front end of motor 18 by means of the V-belt 23.

55 Evaporation of moisture from clothing placed within drum 17 is accomplished by drawing air from the ambient atmosphere into casing 10 past heating element 24 and then exhausting the resulting hot moisture vapor from casing 10 through the air exhaust opening 26 which is located on the rear wall of casing 10 in communication with the suction fan 25. Suction fan 25 is preferably attached to the rear wall of casing 10 and is also driven by means of motor 18 and belt 21.

60 The back panel 15 serves as the supporting structure for the sequential controller, generally indicated by the arrow 31, which controls the operation of this illustrative washer-drier and forms the basis for this invention.

As shown in Figure 3, the sequential controller or timer control mechanism 31 is driven by a synchronous motor 32 through an appropriate speed reducing unit 33 having an output pinion gear 34 driving the spur gear 35 affixed to the timer rotor shaft 36. In this embodiment, timer 70

3

rotor shaft 36 is rigidly attached to the three wash cams 37, 38 and 39 as well as to the main dry cams 41 and 42. Short spacer sleeves 43 concentrically mounted on shaft 36 separate these primary cams from each other.

While the rear end of timer drive shaft 36 is journaled in the speed reducing mechanism 33, the forward end of timer shaft 36 is journaled in a revoluble sleeve 45 which in turn is supported by the front timer housing plate 46. Plate 46 cooperates with rear timer housing plate 47 to support upper and lower terminal boards 48 and 49 respectively. The housing formed for the timer cams by plates 46 and 47 and by the terminal boards 48 and 49 is connected to the cabinet back panel 15 by means of the metal screws 51 which protrude through the back panel 15 and the spacer sleeves 52 and are threaded into front plate 46 to form a rigid support assembly for the sequential controller unit 31.

Mounted contiguously to drier cam 42 and affixed to sleeve 45 is the secondary or auxiliary dry cam 54 which is revolubly mounted on the timer drive shaft 36 by means of its connection with sleeve 45. A second auxiliary dry cam 55 is contiguously mounted with respect to dry cam 41 and is revolubly mounted with respect to timer drive shaft 36 for movement with the auxiliary dry cam 54 to which it is attached by means of the small screw 57 interconnecting the auxiliary dry cams 54 and 55. The short spacer sleeve 58 encircles screw 57 and aids in spacing these secondary dry cams 54 and 55 from each other by means of its protrusion through the 180° kidney-shaped slot 59 provided in the main drier cam 42. An additional spacer sleeve 60 also aids in spacing these auxiliary cams from each other. From this, it will be seen that the effective cam profiles of dry cams 41 and 42 may be varied by rotation of the auxiliary or secondary dry cams 54 and 55 through sleeve 45.

Sleeve 45 extends through the front plate 46 and is attached to the rear external crown gear 62 forming part of a differential gear mechanism used to vary these cam profiles. Concentrically located within crown gear 62 and fastened to the timer drive shaft 36 by means of its cooperation with flat 63 located on that timer drive shaft is the rear internal crown gear 64. Encompassing the timer drive shaft 36 and abutting the front face of the internal crown gear 64 is the planetary carrier spacer hub 67 which is pierced by a pair of cross-pins 68 which terminate short of the outer periphery of timer drive shaft 36 and which extend radially outwardly to support the inner planetary pinions 71 meshing with the internal crown gear 64 and the abutting planetary pinions 72 meshing with the external crown gear 62. Each of the cross-pins 68 is provided with an enlarged head 73 (Figure 4) to prevent pinions 71 and 72 from any axial movement relative to the cross-pins 68. The C-shaped retaining ring 69 carried in an annular groove of shaft 36 also aids in maintaining these parts in their assembled positions.

Spacer hub 67 is restrained axially by means of the front internal crown gear 75 which has the same diameter as internal crown gear 64 and, like internal crown gear 64, also meshes with pinions 71. The internal crown gear 75 in turn is affixed to a sleeve member 76 which is revolubly mounted on timer drive shaft 36.

Revolubly mounted on this sleeve member 76 by means of its rigid connection with the differential control lever 78 encircling sleeve 76 is the front external crown gear 79 which meshes with the outer pair of pinions 72.

Sleeve member 76 is provided with a flange 81 to restrain any axial movement of the differential control lever 78 and thereby maintain pinions 71 and 72 in engagement with gears 75, 64, 79 and 62 at all times. The lower depending portion of flange 81 is pierced by a guide pin 82 affixed to the front plate 46 to thereby allow axial movement of flange 81 and the described differential gearing or transmission relative to the front plate 46 while restraining it against rotation.

Sleeve member 76 itself is restrained against any axial

4

movement relative to the timer drive shaft 36 by the reaction force exerted by the rear external crown gear 62 carried on sleeve 45 and by means of the nut 83 threaded on timer drive shaft 36 against the washer 84 abutting the front face of sleeve member 76. Timer control knob 86 is threaded on the timer drive shaft 36 and thereby prevents nut 83 from working loose from its position. Timer shaft 36 is also restrained against axial movement relative to the differential mechanism set forth by means of the C-shaped retaining ring 69 carried by a notched portion of shaft 36.

Sleeve 45 is provided with a pair of annular detent notches 88 and 89 which are selectively engaged by a U-shaped spring wire member 91 which is carried by the abutment pedestal members 92 and 93 connected to the front timer plate 46. Wire 91 does not interfere with the rotation of sleeve 45 during normal operation of timer assembly 31.

Axial movement of timer control knob 86 to the right from the position shown in Figure 3 moves timer shaft 36 to the right with a snap action as the wire detent member 91 moves from the right notch 89 to the left notch 88. This movement of timer shaft 36 is accompanied by a similar movement of the differential gear structure and all timer cams. The axial movement of rear cam 37 to the right separates the contacts of the line or master switch 95 without affecting movement of the switches 101, 102, 103, 104 and 105 which are controlled by the cams 37 to 39, 41 and 42, respectively.

The axial movement of the differential control lever 78 carried by the differential gear mechanism relative to the control panel 15 is permitted by reason of the fact that the control panel 15 is provided with a large arcuate 180° slot (not shown) through which lever 78 protrudes and relative to which it is movable both axially and arcuately. During this axial movement, flange member 81 is restrained against any rotational movement by means of its connection with guide pin 82 to prevent the differential gearing from being rotated.

Figure 6 shows a combination washer-drier schematic diagram (left side of figure) together with the control cams 37 to 39, 41 and 42 (right side of figure) for the actuation of the various circuits as diagrammatically illustrated by the developments of the respective control cams (center of figure). Since the switches actuated by these various control cams are positioned on the left side of the illustrative timer assembly 31 (see Figure 3) as it would appear from the front of the assembly, these control cams have been rotated approximately 100° in a clockwise direction from the position that would normally be assumed by these cams in the "OFF" position of Figure 2.

From Figure 6, the simplified illustrative wiring diagram of the control circuit for operating the machine shown in Figure 1, it can be seen that each of the switches 101 to 105, inclusively, controls one or more components of that machine. To simplify the explanation and the understanding of this wiring diagram, switch 101 is shown in Figure 6 as controlling the single fill solenoid 111 which supplies washing fluid to casing 10 during the fill and rinse periods of the operational cycle. While more complex arrangements are known in the art to produce varying water temperatures, this selectivity is not critical to the explanation of this illustrative machine so that only one solenoid is shown. Power supplied between lines N and L₂ to fill solenoid 111 is also controlled by a series conventional float or fluid pressure operated switch 112 (not shown in Figure 1) which interrupts fluid flow to casing 10 through the mixing valve 16 after a desired fluid level has been obtained within casing 10.

The timer operated switch 102, controlled by the wash cam 38, regulates the sequential energization of the drain solenoid 115 (not shown in Figure 1) which controls fluid flow from casing 10 through pump 20.

The spin solenoid 116 controls the sequential shifting of the conventional two-speed transmission 22 between

its low drum tumbling speed of 50 r.p.m. and its 200 r.p.m. extractign spin speed. As illustrated, solenoid 116 must be energized in order to shift into the 200 r.p.m. speed.

The timer drive motor 32 and the double-ended drive motor 18 are both controlled through the single switch 104 actuated and controlled by the timer cam 41 and its adjacent auxiliary cam 55 while the electric heating element 24 connected across the 220 volt line existing between lines L_1 and L_2 is controlled by switch 105 which is regulated by the drier cam 42 and its adjacent secondary cam 54. While main cam 41 controls the operation of drive motor 18 and timer motor 32 during both the wash and dry cycles, its cooperation with secondary cam 55 to produce a drying period of variable duration justifies its being termed a dry cam like cam 42.

The positioning of line switch 95, the master power switch controlled by axial movement of timer control knob 86, determines the energization of the entire control circuit of Figure 6 and while a single line switch has been illustrated in this figure, additional switches similar to switch 95 could also be employed to break lines L_1 and N .

To understand Figure 6, it should be assumed that the cams shown at the right of that figure rotate in a clockwise direction to produce their equivalent cam developments shown in the center of that same figure. These cam developments may be assumed, for illustrative purposes, to move to the left in Figure 6 to actuate the switches 101 to 105, inclusive, in a programmed sequence as determined by the profiles of their respective cams. It should be noted that the starting points for the various cam developments actuating these respective switches are illustrated as coinciding with the leading edge of the first cam lobe on cam 37 as this cam is rotated clockwise in the right side of that figure. From this, it will be seen that any clockwise rotation of shaft 36 and its affixed cams from this position will, for example, rotate cams 37 and 41 into a position such as to immediately close switches 101 and 104.

Referring to Figure 2, it can be seen that the timer control knob 86 is marked with a reference arrow 121 which points to the word "OFF" appearing in the indicia 122 printed on the back panel 15 around the periphery of the timer control knob 86. This positioning of arrow 121 in this figure indicates that the knob 86 must be rotated approximately 10° in a clockwise direction before timer cams 37 to 39, 41 and 42 are positioned relative to their respective switches as illustrated diagrammatically by cam developments in Figure 6.

Indicia 122 is divided into two main parts, the first of which is indicated as the "Wash Time" which includes a fifteen minute agitation period (a 90° rotation of timer cams) and a rinse period which terminates after the cams have been rotated approximately 160° past the starting point designated in Figure 6. This rinse period is between eleven and twelve minutes long with this particular timer construction.

The end of the rinse period, which is also the end of the "Wash Time," marks the beginning of the "Dry Time" which is thirty minutes in duration and represents 180° clockwise rotation of the timer cams past the end of the rinsing operation. While both the washing and drying times illustrated herein are adequate for purposes of illustration, the timer which, in this descriptive embodiment rotates 6° every minute, can be modified to operate over a more lengthy cycle of operation with more complex programming than is shown in this description.

In Figure 7 which shows the angular positioning of cam 37 and the planetary carrier member 67 with reference to arrow 121 in the "OFF" position, it should be noted that the leading cam lobe (left dotted line lobe in Figure 7) of cam 37 is displaced approximately 100° in a counterclockwise direction from the vertical due to

the fact that switch 101, like the remaining switches 102 and 105, is positioned in a vertical position on the left side of the timer assembly 31 and due to the additional fact that the reference arrow 121 on the timer knob 86 must move approximately 10° past the vertical in a clockwise direction in Figure 7 in order to start the wash period indicated in that figure. This relative positioning between cam 37 together with the remaining cams and with the reference arrow 121 and indicia 122 coordinates the function performed by the various switches with the nomenclature indicated by the arrow 121.

For an understanding of the operation of this invention, it can be seen that rotation of the timer control knob 86 10° in a clockwise direction from the position shown in Figure 7 will move the cams affixed to timer shaft 36 into the position diagrammatically shown by the cam developments of Figure 6. This point represents the start of the fifteen minute agitation period during which the casing 10 is filled to the desired level with washing fluid by the energization of the fill solenoid 111. The float or pressure operated switch 112 shown in Figure 6 automatically opens when the fluid discharged into casing 10 reaches a predetermined liquid level within that casing. Switch 101 is opened after a 20° rotation of cam 37 past the position shown in Figure 6 to temporarily prevent any further energization of solenoid 111.

Also energized during this fifteen minute agitation period are the drive motor 18 and the timer motor 32 which are energized as long as switch 104 is closed and the entire machine remains in operation.

At the end of the 15 minute agitation period, switch 102 closes to energize the drain solenoid 115 prior to the energization 10° later of the spin solenoid 116 which shifts the transmission 22 from the low speed operation into a 200 r.p.m. centrifuging speed to centrifugally extract the washing fluid from the clothes retained within drum 17. At the end of the first spin-dry period which coincides with the end of the first drain period and the beginning of the rinse-fill period (120° rotation from starting point), fill solenoid 111 is again energized through the switches 101 and 112 to rinse the clothing before switches 102 and 103 are again closed to centrifugally extract and drain the rinsing fluid from the clothes thereby placing them in a damp-dry condition preparatory to the beginning of the drying operation which is initiated after the timer cams have been rotated 160° past the start position shown diagrammatically in Figure 6.

From a comparative inspection of Figures 3, 7 and 8, it can be seen that as timer motor 32 rotates pinion gear 34 to rotate timer drive shaft 36 and its affixed timer cams in the prescribed clockwise direction the differential gear mechanism also rotates in the same direction. However, the rotation of timer drive shaft 36 causes carrier 67 and cross pins 68 to rotate at only half the speed at which timer drive shaft 36 itself rotates. This difference between the rate of rotation of timer drive shaft 36 and members 67 and 68 does not, however, affect the relative angular positioning between cams 41 and 42 and their respective secondary cams 55 and 54.

To appreciate this explanation, it will be seen that the rotation of the timer drive shaft 36, which is affixed to the rear internal crown gear 64 by means of the flat 63, imparts a similar rotation to that crown gear 64. Rotation of the rear internal crown gear 64 causes the internal planetary pinions 71 to roll around on the stationary front internal crown gear 75 which is fixed to the sleeve member 76 connected in turn to the stationary front timer plate 46 by means of the guide pin 82 piercing flange 81. Since the crown gear 75 is stationary, the cross-pins 68 and their attached planetary carrier hub 67 rotate about the axis of the timer drive shaft 36 at half the speed imparted to the latter shaft. This is due to the fact that the rotational axes of these pins lie midway between the identical crown gears 64 and 65 thereby lying in a plane any point of which

moves at only half the instantaneous speed of the points lying in the pitch circle of the internal crown gear 64. This difference in the rate of rotation can be seen from a comparison of Figures 7 and 8 showing the angular change of arrow 121 and cam 37 with respect to that of cross-pins 68 and their supported pinions 71 and 72.

While the differential control lever 78 can be manually oscillated on the front sleeve member 76, the construction and cooperation between these parts permits a sufficient frictional drag to exist between these members during the rotation of timer shaft 36 by the timer drive motor 32 so that the front external crown gear 79 can be deemed to be stationary during this period. Since gear 79 is stationary due to this frictional drag, the rotation of cross-pins 68 about the axis of timer drive shaft 36 at half the speed of the latter shaft causes the external planetary pinions 72 to rotate the rear external crown gear 62 at twice the rotational speed of planetary carrier member 67. The speed imparted to gear 62 is therefore the same as that imparted to shaft 36 so that no relative change occurs between these primary and secondary cams 41, 42, 55 and 54 during the rotation of timer drive shaft 36.

It can be seen from Figure 6 that if the secondary cams 55 and 54 are not rotated with respect to their cams 41 and 42 to thereby change the respective peripheries of these primary cams 41 and 42 by the effective extension of the timer lobes or recesses of those cams, the drying period during which the heater 24 and fan 25 are energized will last approximately thirty minutes corresponding to a 180° rotation of these cams with the entire operation terminating after a 340° timer shaft rotation.

However, if sleeve 45 carrying the secondary cams 54 and 55 is rotated with respect to the timer drive shaft 36, the cam profiles of cams 41 and 42 will be changed with a corresponding change in the duration of operation of the drying period. Figure 6 shows that the switch 104 which controls the energization of timer motor 32 and drive motor 18 is closed only so long as the cam lobe on cam 41 maintains it in a closed position. It will be noted from an inspection of that figure that for a full drying operational period of thirty minutes the secondary cam 55 must extend the drop off point of this cam lobe to the beginning of the "OFF" period and any movement of the secondary cam 55 to shorten the effective length of this cam lobe will accordingly shorten the period of operation for these motors.

With respect to switch 105 which maintains the heater 24 in operation during the drying period it will be seen in Figure 6 that this switch remains closed so long as a recess is provided for cam 42. The termination point for this recess can be moved ahead by a relative movement of secondary cam 54 to thereby effectively shorten the recess of cam 42 and consequently shorten the duration of operation of heater 24. It should be noted here that in this illustrative embodiment the end or drop off point of the cam lobe of cam 41 as modified by its auxiliary cam 55 is always angularly coincident with the termination point of the recess in cam 42 as modified by its auxiliary cam 54. In other words, for a full 30 minute dry period, the drop off point of the cam lobe of cam 41 and the end of the recess of cam 42 are both positioned at 340° total cam rotation. If adjusted for 15 minute dry duration, the drop off point and the end of the recess come at the 250° mark as shown by the dotted lines on the cams and cam developments in Figure 6.

It can be seen from this brief description then that any relative movement of secondary cams 54 and 55 by sleeve member 45 throughout the 180° arc permitted by slot 59 in cam 42 will vary the drying period anywhere from thirty minutes down to the point where the drying period can be eliminated entirely so that the

operation of the combination washer-drier incorporating this timer invention would operate through the washing period and stop once that operation has been completed.

In order to vary the respective positioning between the main cams 41 and 42 and their respective secondary cams 55 and 54, the differential gear mechanism located between the panel 15 and the front timer plate 46 is provided. To understand the operation of the differential drier time setting mechanism, an inspection should be made of Figure 9 in which all cams, the planetary carrier member 67, its planetary pinions 71 and 72, the reference arrow 121 and the differential control lever 78 are positioned in the same position as that shown in Figure 8 with the primary difference between these figures being that in Figure 9, cam 42, rather than cam 37, is shown by the portion broken away.

In this position, the drying time is set for 25 minutes. In other words, the drying time would be terminated after timer shaft 36 had been rotated 310° from the start position to thereby open switch 104 and terminate the operation of drive motor 18 and the timer motor 32 and completely terminate the operation of the washer-drier mechanism. Switch 105 would also be opened after 310° total timer shaft rotation to effect a deenergization of heater 24.

Shortening of the drying period from the 25 minute position shown in Figure 9 to the 15 minute interval shown in Figure 10 is achieved as follows. By pulling the differential control lever 78 downwardly in a counterclockwise direction, rotation of the same magnitude and direction is imparted to the front external crown gear 79 which is normally held stationary by reason of its frictional drag on flange 81. Inasmuch as the front internal crown gear 75 is prevented from rotation by reason of its connection to the sleeve 76 held against rotation by guide pin 81 and due to the fact that timer drive shaft 36 requires a relatively large torque before it can be turned and thereby restrain front internal gear 64 from rotation, internal pinions 71 are effectively locked against rotation relative to either of the internal gears 75 or 64. This locking of the planetary pinions 71 with respect to gears 75 and 64 also prevents pinions 71 from any rotation about the axis of shaft 36 thereby preventing rotation of the planetary carrier member 67 and its cross-pins 68 about that timer shaft axis.

This stationary positioning of cross-pins 68 causes the planetary pinions 72 to act as reversing gears for the drive imparted to the front external crown gear 79 so that the counterclockwise rotation imparted to that gear by the differential control lever 78 causes the rear external crown gear 62, together with sleeve 45 and the secondary cams 55 and 54, to move ahead in a clockwise direction by the same amount to thereby effectively advance the termination point of the drying cycle to the point indicated by the positioning of the differential control lever on indicia 122. This 15 minute termination point of the drying cycle as adjusted in Figure 10 is governed by the positioning of the secondary cams 54 and 55 as shown by the dotted lines in the cam developments and cams illustrated in the center and right sections of Figure 6. As indicated by Figure 6, presetting lever 78 to the 15 minute drying mark reduces the end or drop off point of the lobe of cam 41 from 340° to 250° while moving the end of the effective recess in cam 42 from 340° to 250°. This means that both of switches 104 and 105 will be actuated after a total timer shaft rotation of 250° rather than 340°.

If lever 78 were moved counterclockwise to the beginning of the dry period, the point dividing the rinse and dry operations, the drop off point of cam 41 would be reduced to the minimum 160° point provided in cam 41 itself. At the same time this adjustment would eliminate the recess in cam 42 so that the drying period would be completely eliminated and the machine would be de-

energized after a 160° rotation of shaft 36 marking the end of the washing operation.

It should be noted that while the illustrative selection of the cam profiles has been made to provide an even 30 minute dry period, the secondary cam 55 overlaps the lobe of cam 41 by 20° in the "OFF" position thereby maintaining switch 104 closed and necessitating the use of line switch 95 to completely deenergize the entire machine whenever this illustrative timer is positioned in the "OFF" position.

This, of course, does not affect the termination point of the machine which would automatically shut down after 160° of timer shaft rotation even with switch 95 in its open position. This overlap resulting from the use of the cam profiles selected for illustrative purposes may be eliminated if the washing operation is at least as long as the drying operation or if the degree of cam rotation assigned to these functions is of the same magnitude. This problem may also be eliminated by the use of three-level cams in place of the two-level cams illustrated so as to actuate switches on opposite sides of the cam followers forming the movable parts of the switches. From the drawings, it will be apparent that the adjustment of the drying period by movement of lever 78 may be readily made during the operation of the timer assembly itself to lengthen or shorten the operational termination point without deenergizing the machine during this adjustment.

Since the reference arrow 121 carried on the dial of the timer control knob 86 is positioned to indicate the precise function being performed by the machine utilizing this timer, the cooperation between arrow 121, indicia 122 and lever 78 can indicate the time remaining in any given portion of either of the washing or drying operations. For simplicity, the indicia 122 has been calibrated in the accompanying drawings to indicate the time remaining in the fifteen minute agitation period and in the thirty minute drying period. This allows the amount of the tumble agitation and the drying time to be selected by the operator of the washer-drier embodying this particular type marking. If the control knob 86 is positioned with its arrow 121 pointed opposite the numeral 10 appearing in the indicia 122, this indicates that there will be ten minutes of tumbling to wash the fabrics placed within drum 17. If desired, the entire washing operation may be calibrated in a similar manner.

Since the positioning of the arrow 121 indicates the stage of operation being performed, the operation of that machine will continue until arrow 121 advances to that point of the cycle selected as the termination point of the entire fabric treatment operation. That is, the machine will operate until arrow 121 rotates clockwise to an angular position coinciding with that of the differential gear control lever 78. With the embodiment shown, this position will be achieved when arrow 121 points to and bisects the end of the control lever 78.

Since it may be desirable to preset the wash period to some position intermediate the full fifteen minute agitation period prior to the energization of the machine, this invention includes provisions for opening the line switch 95 to preset the timer cams without energizing any of the components controlled by these various cams. In the position shown in Figure 3, the timer control knob 86, timer shaft 36 and its affixed cams are pulled axially to the left causing line switch 95 to close under its own resiliency once the rear cam 37 no longer forcibly separates its contacts. When timer control knob 86 is pushed inwardly, it forces timer shaft 36 and cam 37 axially to the right to separate the contacts of switch 95. Since the various crown gears and planetary pinions are axially restrained between flange 82 and the sleeve 45, these parts remain in their same relative positions with respect to each other while flange 82 shifts axially on the guide pin 81 to prevent any rotation of the differential gear mechanism during this shifting movement.

It will be appreciated that the differential control lever

78 moves in a similar manner during this axial movement of control knob 86. This axial shifting of the lever 78 is made possible by the fact that the 180° arcuate slot (not shown) located in the panel 15 and penetrated by the differential control lever 78 to allow for the arcuate adjustment of the drying time is also of such lateral dimensions as to allow this axial movement without interference between the parts 15 and 78.

It can be seen from this description that a flexible, simply operated sequential controller capable of regulating the programming of one or more groups of circuits with respect to that of one or more other groups of circuits is provided by this invention. Additional secondary cams for other main cams may be used without departing from the spirit of this invention. In addition, while the preferred selection of the stationary or relatively stationary reaction members for the differential gear mechanism is shown in the accompanying drawings, it is well within the scope of this invention to select other reaction members to perform the same function of adjusting the relative angularity between the primary and secondary cams controlling separate groups of control circuits.

I claim:

1. In a sequential controller the combination of a first cam for controlling the programmed actuation of a first switch, a second cam for controlling the programmed actuation of a second switch, an auxiliary cam contiguously mounted with respect to said second cam and angularly adjustable relative to said second cam to modify the effective cam profile of said second cam, and means including a differential gearing control mechanism having gear elements differentially interconnecting said second and auxiliary cams for rotating said cams in unison in the same direction and for regulating the angular adjustment of said auxiliary cam relative to said second cam to alter the programmed actuation of said second switch relative to the programmed actuation of said first switch.

2. In a sequential controller the combination of a first cam for controlling the programmed actuation of a first switch, a second cam for controlling the programmed actuation of a second switch, a first gear, means connecting said first gear to said first and second cams, an auxiliary cam contiguously mounted with respect to said second cam and angularly adjustable relative to said second cam to vary the effective cam profile of said second cam in its actuation of said second switch, a second gear connected to said auxiliary cam, and means including first and second pinions respectively engaging said first and second gears for moving said auxiliary cam relative to said second cam to alter the programmed actuation of said second switch relative to the programmed actuation of said first switch.

3. In a sequential controller the combination of a first cam to control the programmed actuation of a first switch, a second cam to control the programmed actuation of a second switch, a first gear, means connecting said first gear to said first and second cams, an auxiliary cam contiguously mounted with respect to said second cam and angularly adjustable relative to said second cam to vary the effective cam profile of said second cam in the actuation of said second switch, a second gear connected to said auxiliary cam, means restraining one of said first and second gears from rotation, and means including a control lever attached to the other of said first and second gears for angularly adjusting said auxiliary cam relative to said second cam to alter the programmed actuation of said second switch relative to the programmed actuation of said first switch.

4. In a control mechanism the combination of a first revoluble drive shaft, a main cam affixed to said drive shaft for controlling the programmed actuation of a switch during rotation of said drive shaft, a sleeve revolvably mounted on said drive shaft, an auxiliary cam connected to said sleeve and mounted in a contiguous relationship to said main cam, said auxiliary cam being angu-

larly adjustable relative to said main cam to vary the effective profile of said main cam in its actuation of said switch, a first gear attached to said drive shaft, a second gear attached to said sleeve, first and second pinions respectively engaging said first and second gears, a nonrevolvable third gear engaging one of said pinions, and an oscillatable fourth gear engaging the other of said pinions to provide a means for manually adjusting the relative angularity between the main and auxiliary cams to vary the programmed actuation of said switch.

5. In a control mechanism the combination of a main cam for controlling the programmed actuation of a switch, a revoluble drive shaft fixed to said main cam for rotating said main cam, a sleeve member revolubly mounted in a concentric relationship to said drive shaft, an auxiliary cam mounted adjacent said main cam and fixed to said sleeve, a first gear affixed to said drive shaft, a second gear affixed to said sleeve, a carrier member revolubly mounted on said drive shaft and provided with first and second pinions respectively engaging said first and second gears, a nonrevolvable third gear engaging said first pinion, and an oscillatable fourth gear engaging said second pinion and movable throughout an arcuate range to vary the angular positioning of said auxiliary cam with respect to said main cam to change the effective cam profile of said main cam in the actuation of said switch.

6. In a control mechanism the combination of a panel member, a timer knob, a plurality of cams angularly adjustable relative to each other, differential gear means for adjusting the relative angularity between said cams, said knob and said cams being rotatable to control the actuation of switches, indicia on said panel, a control member controlling said differential gear means and cooperating with said indicia to indicate the termination point of said mechanism, and means on said knob cooperating with said indicia for indicating the position of said cams during operation of said mechanism and cooperating further with said control member to automatically indicate the position of said control mechanism relative to said termination point.

7. In a control mechanism the combination of a panel member, a timer knob, a plurality of primary cams for controlling the operation of switch members, at least one secondary cam, differential gearing means for adjusting the effective relative angularity between said primary and said secondary cams, said primary and secondary cams being revoluble about the common axis, indicia on said panel, a control member controlling said differential gear means and cooperating with said indicia to indicate the operational terminal point of said mechanism, and means on said knob cooperating with said indicia for visually indicating the operational position of said mechanism and further cooperating with said control member to automatically indicate the position of said mechanism with respect to the terminal point.

8. In a control mechanism the combination of a panel member, a timer knob, a plurality of primary cams for controlling the actuation of switch members, at least one secondary cam for controlling secondary switch members, differential gearing mechanism interconnecting said primary and secondary cams for adjusting the effective relative angularity therebetween, said primary and secondary cams being coaxially and rotatably mounted, indicia on said panel for indicating the programmed operational stages of said mechanism, a lever controlling said differential gearing means and extending through said panel and cooperating with said indicia to indicate the operational termination point of said mechanism, and means on said knob cooperating with said indicia for visually indicating the stage of operation being performed by said mechanism and cooperating further with said lever to automatically indicate the stages remaining to be performed prior to the termination point of said mechanism.

9. In a sequential controller the combination of a

first cam revolubly mounted to actuate a first switch member through a programmed sequence, a second cam revolubly mounted to actuate a second switch member through a programmed sequence, a first auxiliary cam contiguously mounted to said first cam and relatively revoluble thereto to effectively vary the cam profile of said first cam, a second auxiliary cam mounted contiguously to said second cam and relatively revoluble thereto to effectively vary the cam profile of said second cam, an arcuate slot in said first cam, means projecting through said slot and interconnecting said first auxiliary cam with said second auxiliary cam, a revoluble drive shaft interconnecting said first and second cams, a sleeve revolubly mounted on said shaft, means connecting said sleeve to at least one of said auxiliary cams, and manually adjustable differential gearing means interconnecting said shaft and said sleeve for varying the angular relationship between said cams and said auxiliary cams.

10. In a sequential controller the combination of a first cam revolubly mounted to control the actuation of a first switch member through a programmed sequence, a second cam revolubly mounted to control the actuation of a second switch member through a programmed sequence, a first auxiliary cam mounted contiguously to said first cam and relatively revoluble thereto to effectively vary the cam profile of said first cam, a second auxiliary cam mounted contiguously to said second cam and relatively revoluble thereto to effectively vary the cam profile of said second cam, an arcuate slot in said first cam, means projecting through said slot and interconnecting said first auxiliary cam with said second auxiliary cam, a revoluble drive shaft interconnecting said first and second cams, a sleeve revolubly mounted on said shaft, means interconnecting said sleeve to at least one of said auxiliary cams, means interconnecting said shaft and said sleeve to transmit angular movement of said shaft to said sleeve, said last named means including manually operable differential gearing means for varying the angular relationship between said cams and said auxiliary cams.

11. In a sequential controller the combination of a first cam revolubly mounted for controlling the actuation of a first switch member through a programmed sequence, a second cam revolubly mounted for controlling the actuation of a second switch member through a programmed sequence, a first auxiliary cam mounted contiguously to said first cam and relatively revoluble thereto to effectively vary the cam profile of said first cam, a second auxiliary cam mounted contiguously to said second cam and relatively revoluble thereto to effectively vary the cam profile of said second cam, an arcuate slot in said first cam, means projecting through said slot and interconnecting said first auxiliary cam with said second auxiliary cam, a revoluble drive shaft interconnecting said first and second cams, a sleeve revolubly mounted on said shaft, means connecting said sleeve to at least one of said auxiliary cams, differential gearing interconnecting said sleeve and said shaft to transmit angular movement of said shaft to said sleeve, and a manually movable member connected to said differential gearing for adjusting the angular relationship between said cams and said auxiliary cams to vary the programmed actuation of said first switch member relative to said second switch member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,209,108	Briggs	July 23, 1940
2,241,772	Emerson	May 13, 1941
2,536,256	Berg	Jan. 2, 1951
2,540,723	Geldhof et al.	Feb. 6, 1951
2,541,299	Shannon	Feb. 13, 1951
2,561,348	Dunham	July 24, 1951
2,585,607	Whitmore et al.	Feb. 12, 1952
2,605,833	Bliss	Aug. 5, 1952
2,776,009	Tamburn	Jan. 1, 1957