

[54] **TIMER SWITCH ASSEMBLY
CONTROLLING CONTINUOUS AND
INTERMITTENT OPERATIONS OF AN
OVEN**

[75] Inventor: **William Charles Fox**, Plainville,
Conn.

[73] Assignee: **Veeder Industries, Inc.**, Hartford,
Conn.

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E, 144 B, 132 R, 132 A, 144 R, 144 M

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Primary Examiner—James R. Scott

Attorney, Agent, or Firm—Prutzman, Hayes, Kalb &
Chilton

[57] **ABSTRACT**

A timer for controlling the operation of a microwave oven including a defrosting operation comprises a manually settable predetermining counter, a primary switch operable in response to movement of the counter for controlling the ON/OFF function of the oven, a synchronous electric motor having a splined drive output, a combined cam and gear mounted for rotation with the output and axially shiftable relative thereto for movement into and out of driving engagement with the counter and biased into driving engagement therewith, a time input for manually driving the counter and for axially shifting the combined cam and gear out of driving engagement therewith to effect movement of the counter to a selected time reading and a second switch for interrupting the operation of the oven, the cam being adapted to control the intermittent and repeated operation of the second switch to impart a defrost operating sequence during count movement toward the predetermined count readout.

21 Claims, 5 Drawing Figures

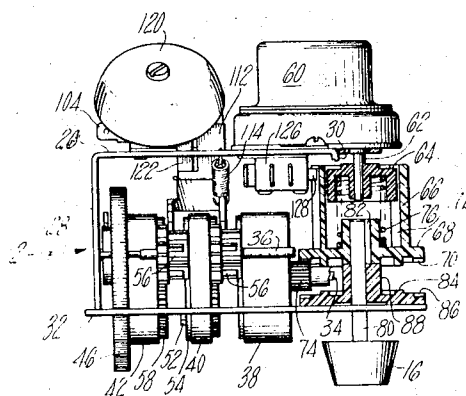
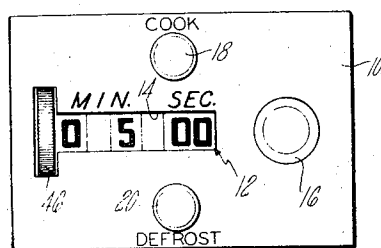


FIG. 1

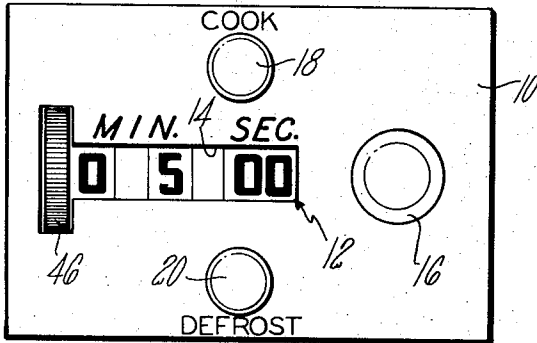


FIG. 5

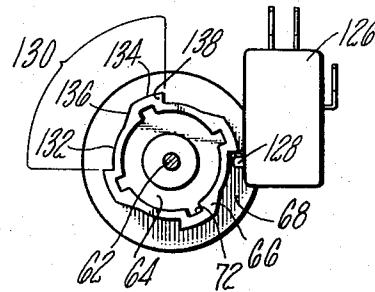


FIG. 2

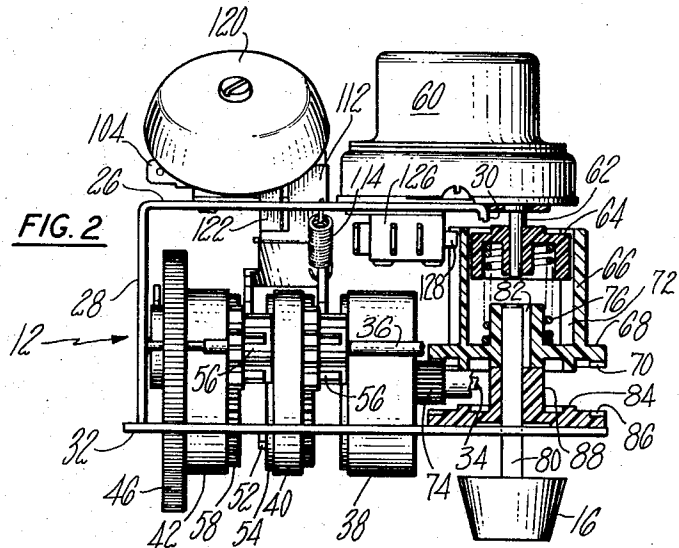


FIG. 4

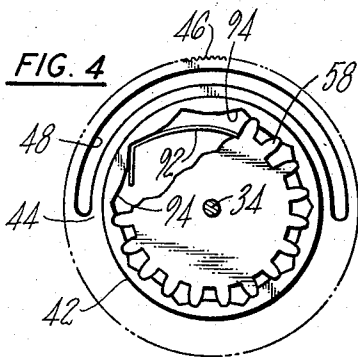
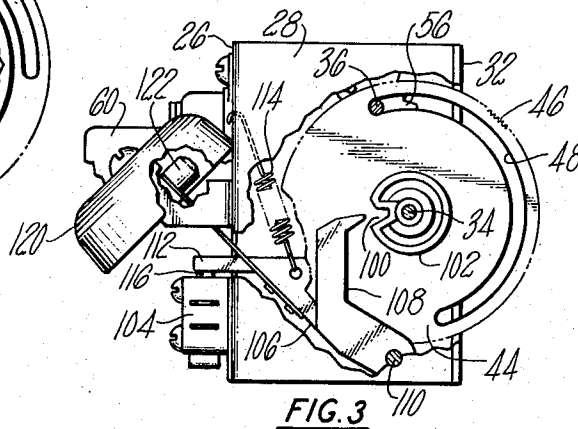


FIG. 3



TIMER SWITCH ASSEMBLY CONTROLLING CONTINUOUS AND INTERMITTENT OPERATIONS OF AN OVEN

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates generally to timer devices for electrical appliances and is particularly concerned with a new and improved manually settable predetermining timer device for controlling the operation of electrical appliances such as microwave ovens and the like.

In recent years there have been numerous innovative developments in the field of electrical appliances and many of these new appliances require precise control over their time of operation. This is particularly true in the case of microwave cooking units which substantially accelerate the cooking operation and thereby reduce the time required for a specific cooking function. For example, items which previously required cooking times of one or more hours now are fully cooked in only a matter of minutes and those items previously requiring cooking periods within the minute range are ready within only a few seconds. With the advent of this increased operating speed there has been a corresponding requirement for more precise control over the operating time of electrical appliances such as microwave ovens. Due to the rather imprecise timers associated with conventional electric or gas ovens such timing devices have proved inadequate to fulfill this requirement of precise control over the operation of microwave cooking units and timers of greater accuracy have been required.

Microwave ovens have the additional advantage of permitting the rapid defrosting or thawing of frozen foods so as to condition them for the cooking operation. However, in order to achieve a defrosting operation it is necessary to sequentially control the ON/OFF function of the oven and in many instances this defrosting operation had to be performed manually thereby requiring constant vigilance by the operator. As can be appreciated, such manual control was extremely imprecise resulting in undesired partial cooking during the defrosting operation.

Accordingly, it is an object of the present invention to provide a new and improved timer device for electrical appliances that can be accurately set so as to control functions of those appliances in a highly accurate and relatively precise manner. Included in this object is the provision for a timer device having particular application to microwave ovens and the like.

Another object of the present invention is to provide a new and improved timer device for microwave ovens and the like capable of controlling not only the ON/OFF cooking function of the oven but also providing for sequentially, intermittently and repeated control over the operation of the oven to effect an appropriate defrosting or thawing operation. Included in this object is the provision for a single timer device capable of controlling both the conventional cooking operation and the intermittent defrosting operation.

Still another object is to provide a timer of the type described that requires only a single drive for its multiple operations and can be rapidly set to a selected time setting by the operator. Included in this object is the provision for a digital timer that permits separate manual time setting means for the highest order digit and

the lower order digits coupled with a simple limit on travel of the timer beyond certain upper and lower values.

Other objects will be in part obvious and in part pointed out in more detail hereinafter.

These and related objects are accomplished in accordance with the present invention by providing a single timer device for controlling both continuous and intermittent operation of an electrical appliance including a manually settable predetermining digital counter having a plurality of number wheels rotatable between a predetermined count readout and a selected count readout, rotary drive means for rotatably driving the number wheels from the selected count readout toward the predetermined count readout, first electrical appliance control means responsive to counter movement into and out of said predetermined count readout to perform a first control function when the counter is driven out of its predetermined count readout and a second control function upon completion of counter movement toward the predetermined count readout, second electrical appliance control means separate from the first control means for causing said appliance to perform its second and first control functions during movement of this counter between the manually selected count readout and the predetermined count readout and cam means operatively associated with the drive means for repeatedly operating said second control means and causing the appliance to intermittently perform its first and second control functions.

A better understanding of the objects, advantages, features, properties and relationships of the invention will be obtained from the following detailed description and accompanying drawing which set forth an illustrative embodiment and are indicative of the way in which the principles of the invention are employed.

A BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is a plan view of a portion of a control panel for a microwave oven, the panel including a timer device incorporating the features of the present invention;

FIG. 2 is an enlarged top view, partially broken away and partially in section, of the timer device prior to installation in the panel of FIG. 1;

FIG. 3 is a left side view, partially broken away, of the timer of FIG. 2;

FIG. 4 is a right side view, partially broken away, of the highest order number wheel of the timer of FIG. 2;

FIG. 5 is a rear view of the defrost cam subassembly of the timer device of FIG. 2.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawing in greater detail wherein like reference numerals indicate like parts throughout the several figures, FIG. 1 shows a control panel portion 10 particularly well suited for use in a microwave oven or the like. The control panel 10 typically includes a manually settable timer device 12 mounted behind a generally rectangular window 14 for exposing the count readout on the timer, a time selector knob 16 beside the window and a pair of cycle selector buttons 18 and 20 above and below the window 14 for controlling separate operating cycles of the microwave oven. For example, when it is desired that the microwave oven perform a cooking function, the timer

device 12 is simply manually set to a specific time setting by means of the knob 16 and the control button 18 actuated to initiate operation of both the oven and the timer. In the specific embodiment used for illustrative purposes, the timer 12 will count backwards from the selected time setting until it reaches a zero readout condition whereupon it automatically trips a switch to turn the oven to its OFF condition. Similarly, when the oven is to be used to perform a defrosting operation, the timer 12 is set so as to indicate at the readout window 14 the total lapsed time for the defrosting operation. The defrosting button is then actuated to initiate the operation of the microwave oven and simultaneously initiate the defrosting operation which will continue until the timer reaches its zero readout condition and automatically turns the oven off. As will be appreciated, the cycle control buttons 18 and 20 used to initiate the cooking and defrosting operations are suitably connected to both the timer and the oven by suitable control circuits which do not form a part of the present invention.

The single timer 12 used for both the cooking and defrosting operation includes a predetermining digital counter, that is, a counter which is set to an appropriate count readout and moves either forward or backward to a predetermined count readout to provide a control function at the predetermined count readout. By way of example and for purposes of illustration, the invention will be hereinafter described in connection with a predetermining counter that is manually moved in one rotatable direction to a selected time reading and is automatically driven in the opposite rotatable direction to a zero count readout for performing its control function at the zero readout condition.

Referring to FIG. 2, the timer device 12 comprises a generally U-shaped frame member consisting of a back plate 26, a pair of integral end walls 28, 30 and a front plate 32 secured across the opening of the U-shaped member so as to provide a box-like generally rectangular frame unit with the front plate 32 extending beyond wall 30. A counter wheel shaft 34 and a pinion shaft 36 extend between and are fixedly mounted on the two end walls 28, 30. The shaft 34 rotatably supports a plurality of number wheels including a lowest order number wheel 38 which in the specific embodiment illustrated, is provided on its outer peripheral face with a plurality of paired characters beginning with "00" and progressing in units of five to the characters "55". The spaces between the characters are also divided so that the entire outer surface of the lowest order number wheel 38 is provided with 60 gradations of equal distance. As will be appreciated, and as shown in FIG. 1, the lowest order number wheel 38 is used to designate the "seconds" of the time readout. The two higher order number wheels 40 and 42 are used to designate "minutes" of the time readout and are provided with single numeral characters based on ten characters per revolution with the highest order number wheel 42 being limited to the 0 through 5.

The front plate 32 of the frame unit is provided with an enlarged aperture (not shown) and all of the number wheels project outwardly therethrough. The highest order number wheel 42 is provided with an outwardly extending flange 44 that is knurled on its outer surface 46 to facilitate rapid manual setting eliminating the necessity for manually setting the timer beyond a ten minute designation by the timer selector knob 16. In accordance

with the present invention, the flange 44 on the highest order number wheel is provided with an annular slot 48 of about 180° which permits passage therethrough of the transfer pinion shaft 36. The cooperative action between the ends of the slot 48 and the transfer pinion shaft 36 provide a simple yet effective means for limiting the rotary movement of the highest order number wheel beyond its 0 and 5 readout positions.

As will be appreciated the number wheels 38 and 40 are provided with conventional count transfer means, such as the transfer tooth segment 52 and locking ring 54 on wheel 40, that cooperate with the transfer pinions 56 rotatably mounted on shaft 36 for transferring the count to the adjacent higher order number wheel upon each revolution of the adjacent lower order number wheel. The count transfer is completed through the driving engagement of the transfer pinion 56 with the driven gear of the higher order number wheel, such as the driven gear 58 of wheel 42.

A suitable clock motor such as the synchronous electric motor 60 is mounted on the rear plate 26 of the frame and includes a rotary drive shaft 62 having an externally splined drive gear 64 fixedly mounted thereon. A hollow drum-like cam 66 having a radially extending flange 68 on one end thereof carrying a planar gear face 70 is provided with internal grooves 72 for slidably receiving the splined drive gear 64. The planar gear face 70 drivably engages a driven gear 74 on the hub of the lowest order number wheel 38 and a clutch spring 76 is mounted within the drum-like cam 66 between the flange 68 and the drive gear 64 for constantly biasing the gear face 70 into driving engagement with the gear 74 to effect a driving connection between the synchronous motor 60 and the number wheels of the counter. In the preferred embodiment, the motor 60 drives the wheels of the counter in one rotatable direction only for driving the count readout from the selected value to its zero readout condition.

As shown in FIG. 2, the time selector knob 16 is fixedly connected to a time setting drive shaft 80 that extends through the front plate 32 of the frame unit and is received within an axially extending aperture 82 in the hub of the cam 66. The manually operated shaft 80 is freely rotatable within the aperture 82 and fixedly mounts a time setting gear 84 having a planar gear face 86 substantially identical to and spaced confronting relationship with the gear face 70 on the cam 66. The gear 84 mounted on the manually operated shaft 80 includes an elongated hub 88 extending toward and into engagement with the cam for axially driving the cam rearwardly against the bias of the clutch spring 76. The hub 88 of the gear 84 is of sufficient length to hold gear face 86 out of engagement with gear 74 during driving contact between the gear face 70 of the cam 66 and the driven gear 74 of the lowest order number wheel 38.

Thus by depressing the manually operated knob 16 and drive shaft 80, the gear 84 fixedly mounted thereon will drive the cam 66 rearwardly in sliding fashion along the splined gear 64 against the bias of the clutch spring 76 thereby driving the gear face 70 out of engagement with the driven gear 74 of the lowest order number wheel 38 and moving the gear face 86 into driving engagement therewith. The knob is then rotated while depressed to drive the lowest order number wheel to a selected count readout. In the preferred embodiment, the gear ratio between the gear face 86 and

the driven gear 74 is such that one complete revolution of the manually actuated drive shaft 80 will cause the lowest order number wheel 38 to rotate through four complete revolutions. As will be appreciated, it requires up to only two and one half revolutions of the time selector knob 16 to advance the counter to any time readout up to ten minutes. As previously mentioned, the highest order number wheel 42 can readily be set to still higher time readouts by simply manually advancing that number wheel 42 by means of the knurled flange 44 projecting outwardly therefrom. Advancement of the highest order number wheel 42 will not disturb the setting on the lower order number wheels 38, 40 since, as shown in FIG. 4, the highest order number wheel 42 is connected to its driven gear 58 by means of a leaf spring 92 mounted on the gear 58 for releasable engagement with the scalloped interior surface 94 of the number wheel 42. Thus the operator may, if desired, fully set the timer by means of the manually operated drive shaft 80 or may partially set the timer by means of that shaft and complete the setting by means of the knurled flange 44 thereby substantially reducing the time required to set the timer to a desired count readout in excess of ten minutes.

As mentioned hereinbefore, the predetermining counter utilized in the timer device of the present invention can be set to a selected time readout and upon actuation will be driven by the synchronous electric clock motor 60 in descending number fashion toward a zero readout condition to perform a control function at that condition. In the embodiment illustrated, this is achieved by providing each number wheel of the counter with a hub detent such as the detent 100 in the hub 102 on wheel 42 (FIG. 3). Additionally, a control switch 104 is mounted on the rear plate 26 of the frame and a zero count sensing comb 106 having a plurality of sensing fingers 108 is pivotably mounted on a shaft 110 secured to the side walls 28, 30 of the frame. The comb 106 includes an integral, rearwardly extending switch arm 112 and is biased in a clockwise direction, as viewed in FIG. 3, by a spring 114 thereby urging the fingers 108 into engagement with the hubs of the number wheels. The detents on the respective hubs are positioned so that they are in registry with the fingers 108 of the comb when the count readout is zero on each number wheel.

The control switch 104 is provided with a contact button 116 for moving the switch between its closed circuit condition and its open circuit conditions, the switch being normally biased toward its open circuit condition. Thus when all three number wheels 38, 40 and 42 exhibit a zero count readout, the fingers 108 of the comb 106 are received within the detents on the respective number wheels, such as detent 100 on wheel 42, and are held therein by the bias of the comb drive spring 114. Since the comb 106 is rotatably displaced in a clockwise direction as viewed in FIG. 3 from the position shown in FIG. 3, the arm 112 has released button 116 and the switch 104 is in its open circuit condition.

When the manually actuated drive shaft 80 is axially depressed and rotated so as to move the counter to a selected count readout, the fingers 108 of the comb are driven out of the detents against the bias of the comb drive spring 114. The resultant counter clockwise movement of the comb, as viewed in FIG. 3, results in corresponding movement of the integral switch arm

112 into engagement with the contact button 116 of the micro switch 104 to move the switch to its closed circuit condition where it is held until the counter returns to its predetermined zero count readout.

After the timer is set to a selected time in the foregoing manner, it will remain in this condition until the appropriate cycle control button, such as button 18, is actuated to initiate simultaneous operation of the oven and the electric clock motor 60. When the particular cycle control button utilized is the cooking button 18, the preconditioned timer will be driven by the gear face 70 until it reaches the predetermined zero count readout. As will be appreciated, during the last 10 minutes of the timer's operation the comb finger 108 associated with the highest order number wheel 42 will be in registry with its corresponding detent 100 but will not move into engagement therewith since the remaining fingers of the comb will be held outwardly by the hubs of the lower order number wheels and the comb will not be able to move until all three number wheels simultaneously reach the predetermined zero count readout.

If desired, a bell dome 120 also may be mounted on the rear plate 26 of the frame and a suitable clapper 122 may be connected to the comb 106 so that as the comb moves clockwise as viewed in FIG. 3 under the driving action of spring 114, the clapper 122 will simultaneously contact the bell dome 120 to provide an audible signal indicating that the predetermined count has been reached.

It is an advantageous feature of the present invention that the timer device 12 used to control the cooking operation of the microwave oven is also used to control the defrosting operation thereof. In this connection a second micro switch 126, identical to switch 104, is mounted on the frame adjacent the drum-like cam 66 so that a switch button 128 controlling the switch's operation between its closed circuit and open circuit conditions in turn is controlled by the cam 66. In the particular embodiment illustrated, the cam 66 is provided with four substantially equal and identical circumferential cam segments 130 extending longitudinally along the drum-like cam member so as to confront button 128 irrespective of the cam's slidable position. Each segment 130 includes a radially recessed portion 132 and a radially extended portion 134 connected by an inclined portion 136, the radially extended portion 134 being provided with an abrupt shoulder 138 abutting the adjacent cam segment. Thus, counter clockwise driving rotation, as viewed in FIG. 5, of the drive gear 64 by the electric clock motor 60 will drive the cam 66 in a corresponding counter clockwise direction so that the recessed portion 132, inclined portion 136, extended portion 134 and abrupt shoulder 138 are sequentially brought into registry with button 128.

The micro switch 126 is positioned so that the contact button 128 thereof is in a released open circuit condition when the radially recessed portion 132 of the cam 66 is in registry therewith and is in a closed circuit position when the radially extended portion 134 of the cam is in contact therewith. Thus, counter clockwise rotation as viewed in FIG. 5, of the cam 66 through an arc segment of 90° will bring the inclined portion 136 of one cam segment 130 into engagement with the contact button 128 of the switch causing the button to depress thereby creating a closed circuit condition activating the microwave oven. As the cam 66 rotatably advances so as to bring the shoulder 138 into registry

with the contact button 126, the contact button will abruptly fall off the shoulder thereby creating an open circuit condition and deactivating the microwave oven. Since the rotary output of the motor 60 is preferably one quarter revolution per minute, time lapse for cam travel through a complete cam segment is also one minute and the microwave oven is in an ON condition for only a selected portion of that minute, namely that portion corresponding to the portion of the cam segment occupied by the radially extended portion 134. In the preferred embodiment, the oven is in an ON condition for approximately 30 seconds out of each minute. As will be appreciated, this intermittent ON/OFF action will continue in a sequential fashion throughout the entire time period originally selected and until the counter reaches its predetermined zero count position. At that time the counter will release control switch 104 in the manner mentioned hereinbefore so as to terminate the defrosting operation.

As will be appreciated by persons skilled in the art, various modifications, adaptations and variations of the foregoing specific disclosure can be made without departing from the teachings of the present invention.

I claim:

1. In a timer device adapted for controlling both continuous and intermittent operation of an electrical appliance, the combination including a manually settable predetermining counter comprising a plurality of number wheels rotatable between a predetermined count readout and a selected count readout, rotary drive means for continuously driving the number wheels from said selected count readout to said predetermined count readout, first electrical appliance control means responsive to counter movement into and out of said predetermined count readout to perform a first control function when the counter is driven out of its predetermined count readout and a second control function upon completion of counter movement toward the predetermined count readout, second electrical appliance control means separate from said first control means for effecting said second and first control functions during movement of the counter between the manually selected count readout and the predetermined count readout and cam means operatively associated with the drive means for repeatedly and intermittently operating said second control means.

2. The timer device of claim 1 wherein said rotary drive means includes a motor having a rotary output and said cam means includes a cam rotatably driven by said rotary output and having plural cam segments controlling the operation of the second control means.

3. The timer of claim 1 wherein said rotary drive means includes a rotary drive shaft, a drive connector mounted for rotary movement with said shaft and for axial movement relative to the shaft for shifting into and out of driving engagement with the number wheels of the counter and biasing means constantly urging said drive connector into driving engagement with said number wheels.

4. The timer of claim 3 including manual time selector drive means movable into and out of driving engagement with said counter and adapted to shift said drive connector to disengage the rotary drive means from the number wheels of the counter upon movement of said manual time selector drive means into driving engagement with said number wheels against the bias of said biasing means.

5. The timer device of claim 1 wherein said second electrical appliance control means includes a switch operative between open and closed circuit conditions and normally biased into said open circuit condition, said rotary drive means includes first and second rotary drive members alternatively shiftable into and out of driving engagement with said number wheels, biasing means for biasing one of said first and second drive members into driving engagement, said cam means including a rotatable cam surface associated with at least one of said first and second drive members and engageable with said switch for intermittently and repeatedly driving said second switch toward its closed circuit condition against its normal bias in response to the rotary driving action of one of said first and second drive members.

6. The timer of claim 5 wherein said rotary drive means includes a motor having a splined rotary drive connector, said first drive member being connected to said connector through said spline to facilitate axial shifting of said first drive member relative to said connector, said first drive member mounting said cam surface for rotation with said connector, said cam surface having radially extended and radially recessed portions operative irrespective of the axial shifting of said first drive member, said radially extended portion engaging said switch to effect a closed circuit condition and said radially recessed portion releasing said switch to effect an open circuit condition.

7. The timer of claim 1 wherein the counter includes a transfer pinion shaft and the number wheels include a lowest order number wheel and at least one higher order number wheel having a limit stop cooperating with said transfer pinion shaft to limit rotary motion of said higher order number wheel beyond said predetermined count readout.

8. The timer of claim 7 wherein the higher order number wheel is provided with a character bearing surface and a manually operated position control flange extending radially outwardly from the character bearing surface, said limit stop including an annular slot in said flange for receiving the transfer pinion shaft and cooperating therewith to limit rotary motion of said higher order number wheel.

9. The timer device of claim 1 wherein each number wheel is provided with a detent positioned relative to said predetermined count readout, actuating means for said first electrical appliance control means comprising a lever mounted for movement between an actuating position and a retracted position and having a plurality of fingers engageable with the detents to prevent the continued rotation of said number wheels, spring means for biasing said lever toward said retracted position and said fingers into engagement with said detents, manually operated drive means for driving the number wheels out of their predetermined count readout and driving said fingers out of said detents against the bias of said spring means while moving said lever to said actuating position.

10. The timer device of claim 1 wherein said predetermining counter includes limit stop means preventing count movement of the number wheels beyond said predetermined count readout.

11. In a microwave oven timer for controlling both continuous and defrosting operations of a microwave oven, a settable predetermining digital counter including manually operated time input means for setting the

counter to a selected time readout, drive means for driving the counter from the selected readout toward a predetermined readout, first oven operation control means responsive to counter movement into and out of said predetermined readout for controlling continuous operation of the microwave oven and terminating operation of said oven when the counter reaches the predetermined readout, second oven operation control means for interrupting said continuous operation during movement of the counter toward said predetermined readout and a control cam operatively associated with said drive means for repeatedly and intermittently operating said second oven operation control means for limited time intervals to effect a defrosting operation.

12. The timer of claim 11 wherein said drive means includes a motor having a rotary output and said cam means includes a cam rotatably driven by said rotary output and having plural cam segments controlling the operation of the second control means.

13. The timer of claim 11 wherein said drive means includes a rotary drive shaft, a drive connector mounted for rotary movement with said shaft and for axial movement relative to the shaft for shifting into and out of driving engagement with said counter and biasing means constantly urging said drive connector into driving engagement with the counter.

14. The timer of claim 13 wherein said manual time input means is shiftable into and out of driving engagement with said counter and adapted to shift said drive connector to disengage the drive means from the counter upon movement of said manual time input means into driving engagement with said counter against the bias of said biasing means.

15. The timer of claim 11 wherein said second oven control means includes a switch operative between open and closed circuit conditions and normally biased into said open circuit condition, said cam means including a rotatable cam surface engageable with said switch for intermittently and repeatedly driving said second switch toward its closed circuit condition against its normal bias in response to the driving action of said drive means.

16. The timer of claim 15 wherein said drive means includes a motor having a splined rotary drive connector and a drive member connected to said connector through said spline to facilitate axial shifting thereof relative to said connector, said drive member mounting said cam surface for rotation with said connector, said cam surface having radially extended and radially recessed portions operative irrespective of the axial shifting of said drive member, said radially extended portion engaging said switch to effect a closed circuit condition and said radially recessed portion releasing said switch to effect an open circuit condition.

17. The timer of claim 11 wherein the counter includes a plurality of rotatable number wheels provided with detents positioned relative to said predetermined readout, actuating means for said first oven control means comprising a lever mounted for movement between an actuating position and a retracted position and having a plurality of fingers engageable with the detents to prevent the continued rotation of said number wheels, spring means for biasing said lever toward said retracted position and said fingers into engagement with said detents, said manually operated time input means being effective to drive said fingers out of

said detents against the bias of said spring means and move said lever to said actuating position while setting the counter to a selected time readout.

18. In a timer device for an electrical appliance, the combination comprising a manually settable predetermining counter comprising a shaft, a lowest order number wheel and at least one higher order number wheel coaxially mounted for rotation on said shaft, a transfer pinion shaft and a transfer pinion rotatably mounted on the pinion shaft for transferring the count between the number wheels, the higher order number wheel having a character bearing surface and a flange extending radially outwardly from the character bearing surface, said flange including a manually operated position control rim, and limit stop means on said higher order number wheel cooperating with said transfer pinion shaft to limit rotary motion of said higher order number wheel beyond predetermined count readout limits.

19. The timer device of claim 18 wherein said limit stop means includes an annular slot in the flange between the character bearing surface and the outer rim and the transfer pinion shaft extends through said annular slot to limit rotary motion of said higher order number wheel and rotation of the counter beyond predetermined upper and lower count limits.

20. In a timer device for an electrical appliance the combination comprising a frame, first and second control switches mounted on said frame for operation between open and closed circuit conditions, a manually settable predetermining counter movable into and out of a predetermined count readout comprising a shaft mounted on the frame, a lowest order number wheel and a plurality of higher order number wheels coaxially mounted for rotation on said shaft, actuating means for the first control switch comprising a lever pivotably mounted on said frame for movement between a switch actuating position for effecting a closed circuit condition and a retracted position and having sensing means for sensing movement of the counter into and out of said predetermined count readout to effect movement of said lever between its actuating and retracting positions, manually operated first rotary drive means mounted on the frame for driving the lowest order number wheel out of its predetermined count readout, second rotary drive means including a drive shaft, a drive member mounted for rotation with said shaft and axially shiftable relative thereto for movement into and out of driving engagement with the lowest order number wheel and biased into driving engagement therewith, and a rotatable cam associated with at least one of said first and second drive means and engageable with said second control switch for intermittently and repeatedly driving said second switch between its open and closed circuit positions in response to the rotary driving action of one of said first and second drive means, said predetermining counter including a higher order number wheel having a limit stop and a transfer pinion shaft mounted on the frame and cooperating with said limit stop to limit rotary motion of said higher order number wheel.

21. In a timer device for controlling the operation of a microwave oven including a defrosting operation, the combination comprising a frame, first and second switches mounted on said frame for operation between open and closed circuit conditions and normally biased into said open circuit condition, a manually settable predetermining counter comprising a shaft mounted on

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the frame, a lowest order number wheel and a plurality of higher order number wheels coaxially mounted for rotation on said shaft, each number wheel having a detent positioned relative to a predetermined count readout, actuating means for the first switch comprising a lever pivotably mounted on said frame for movement between a switch actuating position and a retracted position and having a plurality of fingers adapted to engage the detents on the number wheels and prevent the continued rotation thereof, a spring biasing said fingers toward said retracted position and said fingers into engagement with said detents, manually operated first rotary drive means mounted on the frame for driving the lowest order number wheel out of its predetermined count readout and driving said fingers out of said detents against the bias of said spring to move said lever to the switch actuating position, second rotary drive means including a drive shaft, a drive member mounted for rotation with said shaft and axially shiftable relative thereto for movement into and out of driving engagement with the lowest order number wheel and biased

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into driving engagement therewith, said first rotary drive means being coaxially mounted with said shiftable drive member and axially shiftable therewith for movement into driving engagement with the lowest order number wheel against the bias of said drive member and a rotatable cam associated with said second drive means and engageable with said second switch for intermittently and repeatedly driving said second switch between its open and closed circuit positions in response to the rotary driving action of said second drive means, said predetermining counter including a higher order number wheel having a number bearing surface and a manually operated position control rim extending radially outwardly from the number bearing surface, said rim being provided with an annular slot between the number bearing surface and the outer periphery of the rim and a transfer pinion shaft mounted on the frame and extending through said annular slot to limit rotary motion of said higher order number wheel.

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