

[54] **REPEAT CYCLE TIMER OF MODULAR CONSTRUCTION WITH IMPROVED ADJUSTABLE CAM**

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[51] Int. Cl. **H01h 43/10**

[58] Field of Search.....200/38 B, 38 BA, 38 C, 38 CA, 200/153 L, 38, 567, 568 R; 74/567, 568 R

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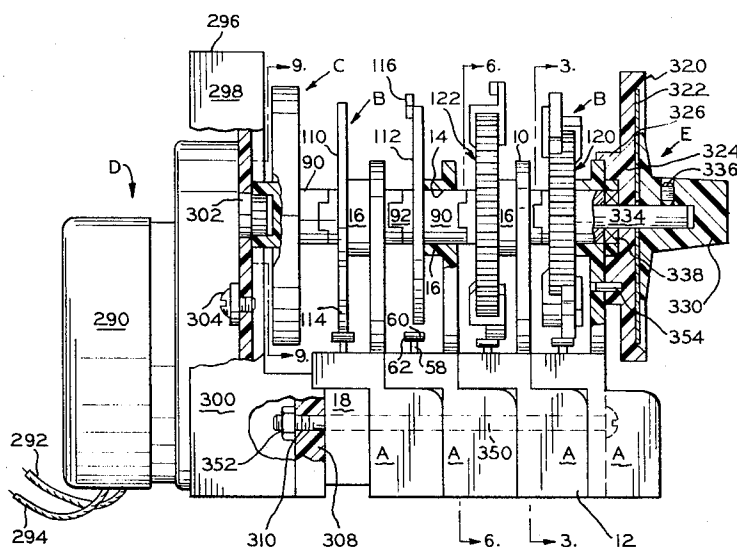
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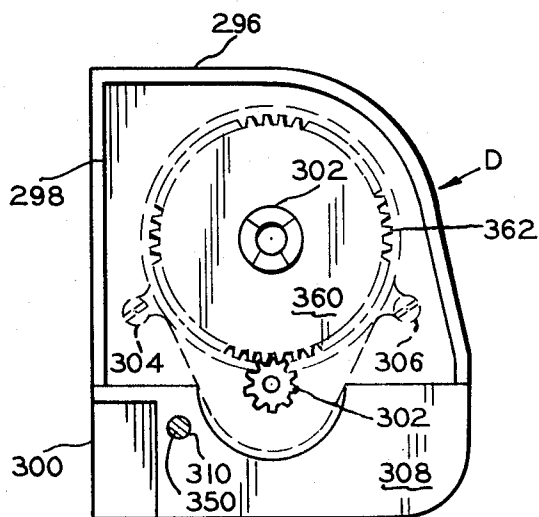
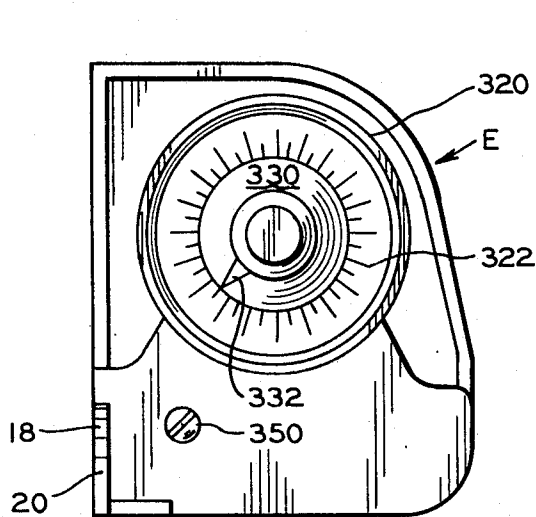
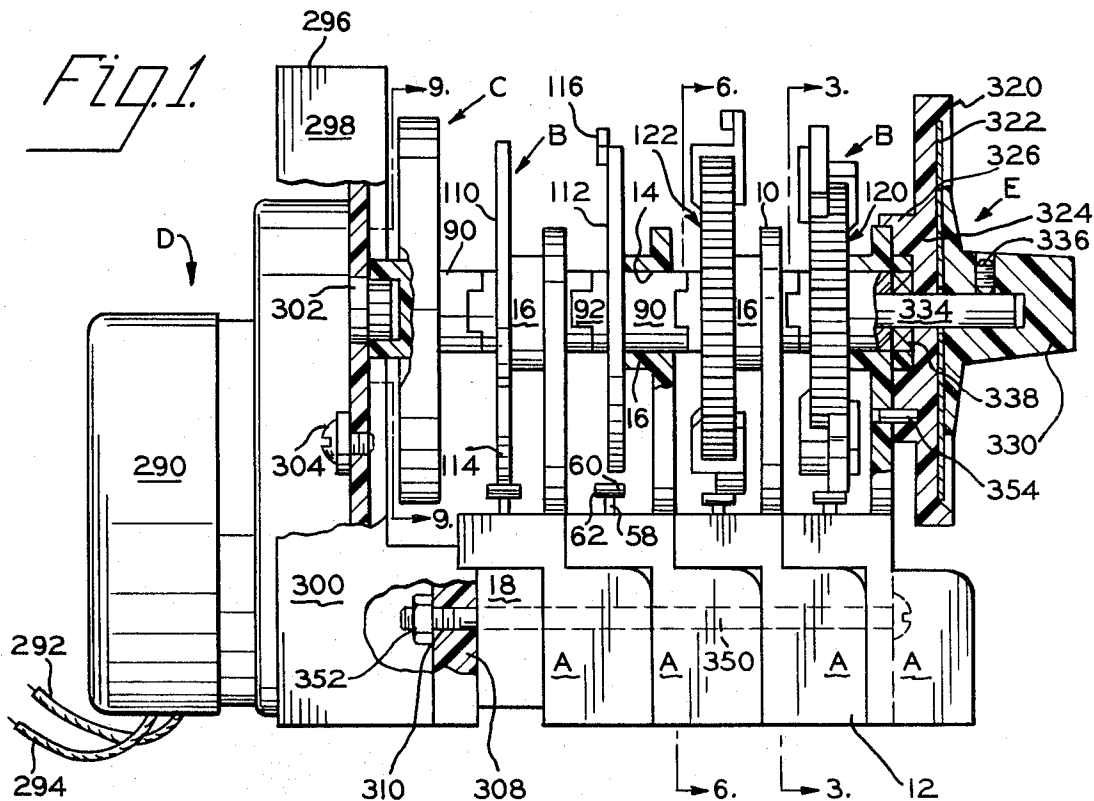
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ABSTRACT

A repeat cycle timer of the type wherein a plurality of cams are coaxially rotated through a timed cycle to effect sequential energization of a plurality of switches adapted to control electrical elements remote therefrom. The timer is comprised of a plurality of identical interchangeable cam modules each including a cam hub and at least one switch associated therewith. The adjacent modules and cam hubs are rotatably driven by drive means. Certain of the cam hubs include adjustable cam surfaces thereon to permit variable switch programs to be presented.

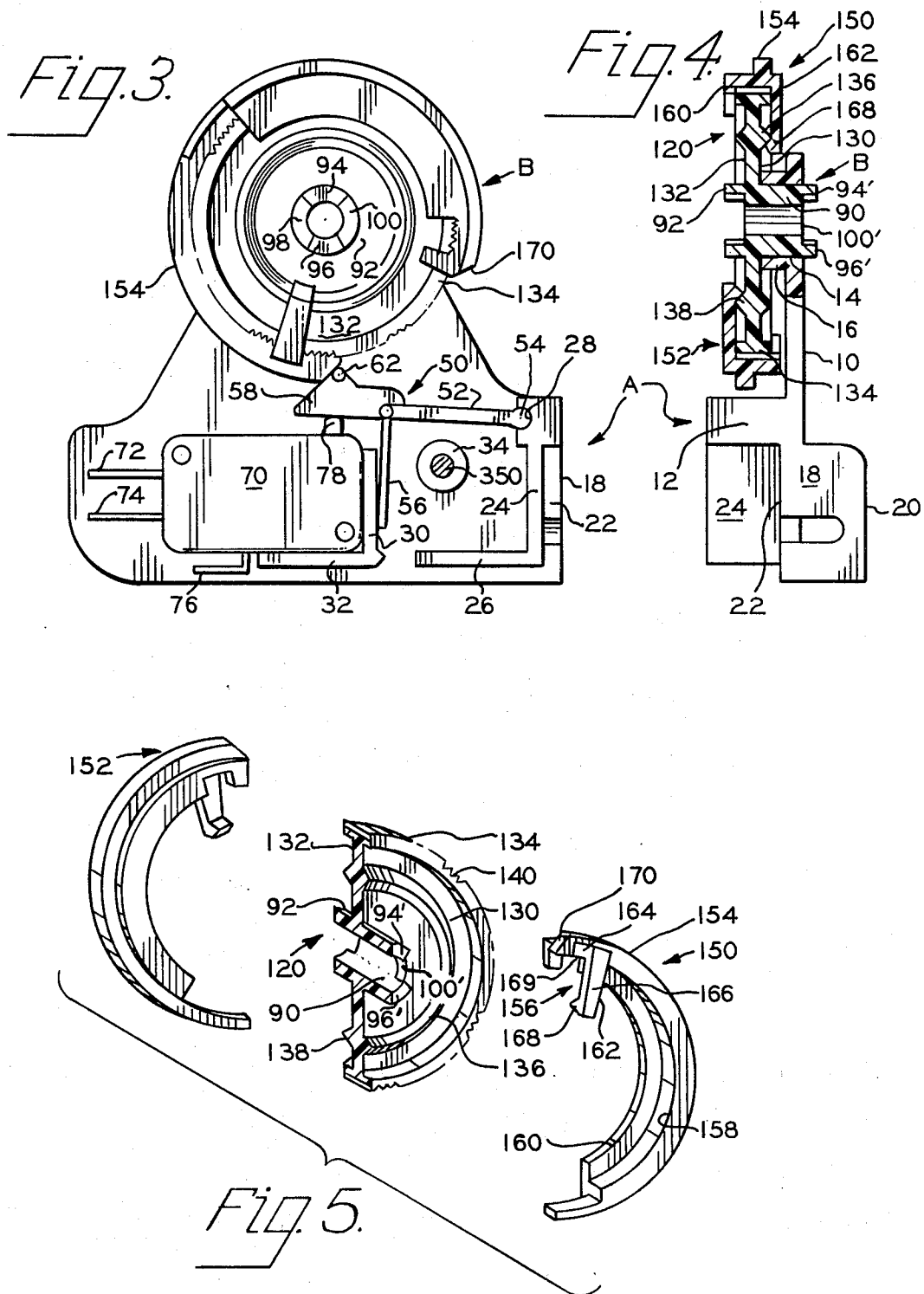
24 Claims, 15 Drawing Figures





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Fig. 6.

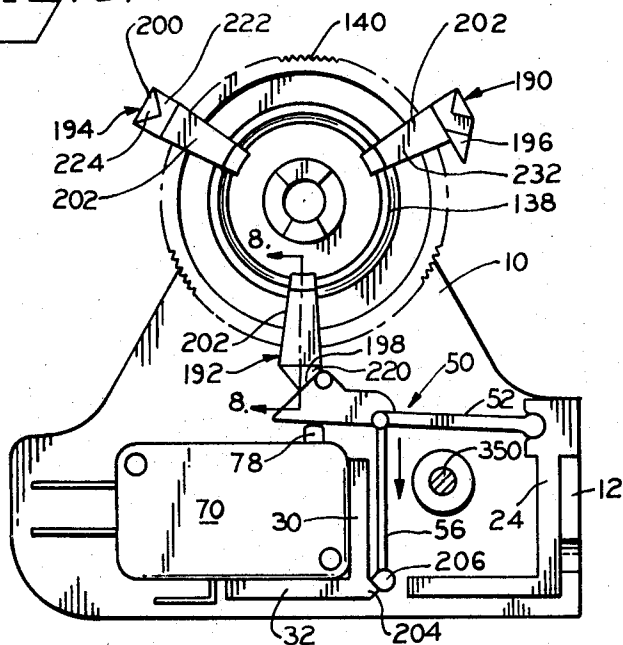


Fig. 7.

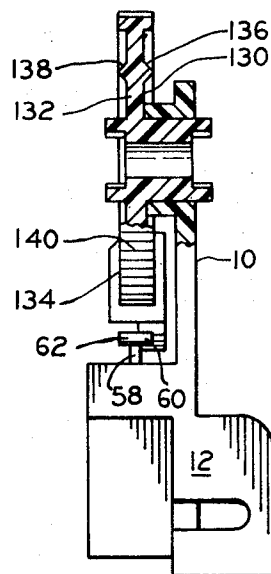


Fig. 7A.

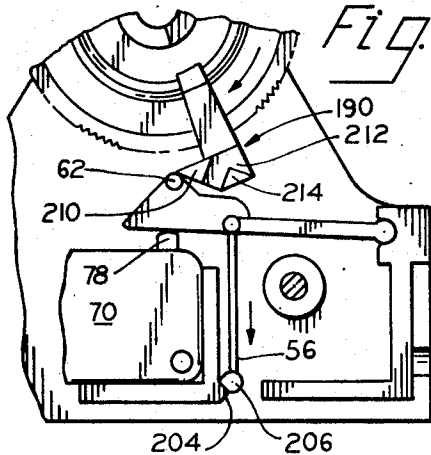


Fig. 7B.

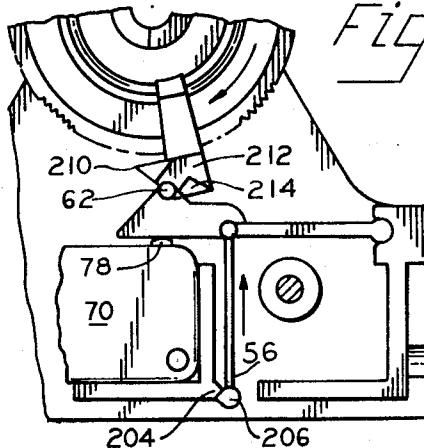
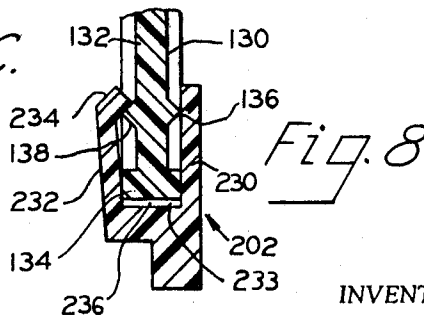
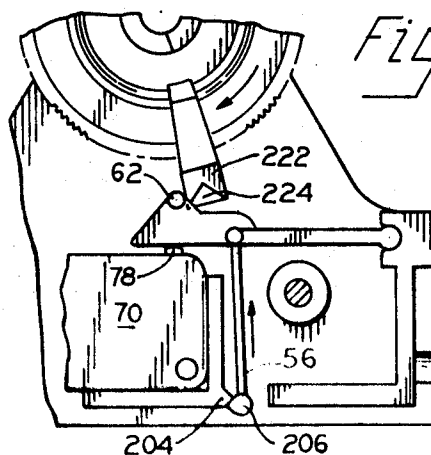


Fig. 7C.



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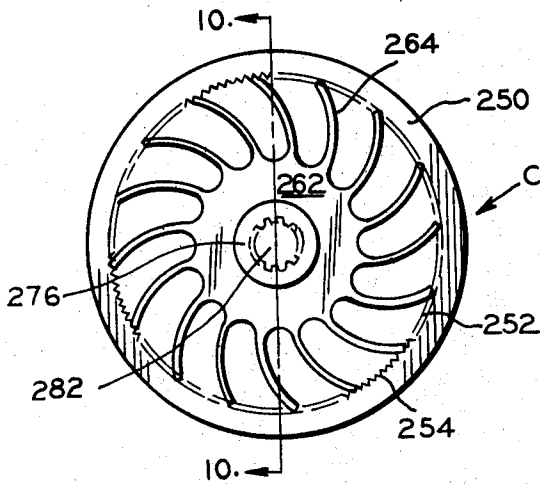


Fig. 9

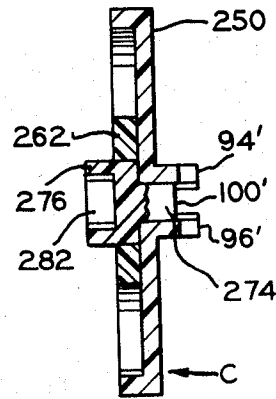


Fig. 10

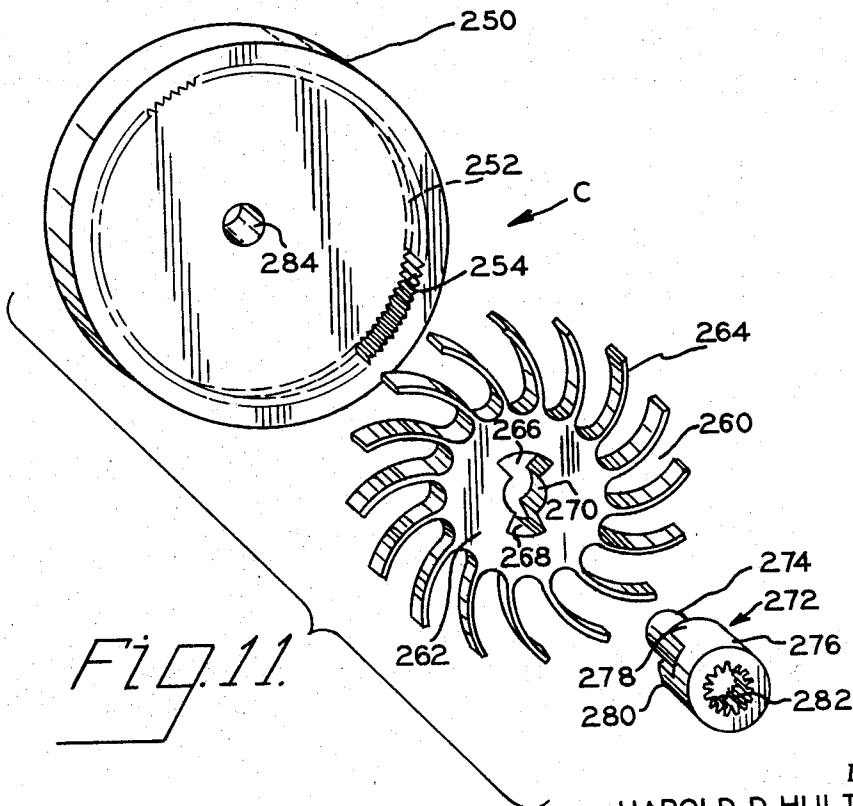


Fig. 11

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REPEAT CYCLE TIMER OF MODULAR CONSTRUCTION WITH IMPROVED ADJUSTABLE CAM

This application pertains to the art of timers and more particularly to a repeat cycle timer of modular construction.

The invention is particularly applicable to a repeat cycle timer of modular construction for use in sequentially controlling a plurality of electrical elements in circuits remote therefrom and will be described with particular reference thereto; however, it will be appreciated that the invention has broader applications and may be used in several environments where it is desired to control any type of element in a particular timed sequence.

Heretofore, repeat cycle timers essentially comprised a plurality of snap action switches actuated by interval circular cams mounted longitudinally along a common drive shaft and rotatably driven through a friction clutch by a synchronous motor. The number of these circular cams which could be mounted on the drive shaft was, of course, limited by its length and the capacity of the timer frame to accommodate further switches. Further, no provisions were made to permit circumferential adjustment of the cam surfaces along the cams or the cams themselves around the drive shaft so as to permit variable sequential control of the elements associated with the timer. Any desired timed sequence changes necessitated dismantling the entire timer or installing a new timer.

Early attempts at overcoming these problems involved the provision of a plurality of cams which were in fact circumferentially adjustable about the common drive shaft to provide sequential control adjustment for the timers. However, this approach often required the timer to be completely dismantled in order to realize the adjustment benefits. Other previous attempts at overcoming this problem resulted in cams which had adjustable cam surfaces thereon but were difficult to utilize. The aforementioned problems and inconveniences presented by the timers only having a certain maximum number of cams were still apparent in these improved timers.

Another problem with the previous timers has also been the number of component parts required therefor. The substantial number of parts made repair and/or adjustment of the timers in the field extremely difficult and virtually impossible such that it was often times required to replace an entire timer instead of merely the component parts therefor.

The present invention contemplates a new and improved repeat cycle timer of modular construction which overcomes all of the above referred problems and others, and provides a new repeat cycle timer which is simple, economical, readily adjustable in the field, and readily adaptable for use for any number of time sequence requirements.

In accordance with the present invention, there is provided a new timer mechanism for energizing a plurality of elements in a predetermined sequence. The new timer is comprised of a plurality of independent interchangeable modules, each including a cam hub having a longitudinal axis and means for mounting the hub for rotation about that axis and at least one control switch adapted to control one of the plurality of elements. Means for rigidly interconnecting successive modules and cam hubs into a unit are provided whereby the longitudinal axes of the hubs form a longitudinal axis for the unit. Drive means are provided for rotating the interconnected cam hubs, each including cam surfaces thereon, about the unit axis to effect the desired sequential energization of the elements.

In accordance with another aspect of the present invention, selected of the cam surfaces are adjustable about their respective cam hubs for effecting varied operating characteristics for the elements associated therewith.

In accordance with yet another aspect of the present invention, there is provided a new cam member for a timer comprising a generally circular hub portion having two opposed generally circular face portions and an outer circumferential surface portion. Further included on the cam hub are means for retaining separate cam surface portions in a predetermined desired position thereon. Each cam hub includes means for interconnecting the hub with other similar cam hubs to form an integral unit and means for mounting the hub about its longitudinal axis.

In accordance with a more limited aspect of the present invention, the retaining means on the new cam hub permits adjustment of the cam surface portions thereon without the necessity of disassembling the timer.

In accordance with still another aspect of the present invention, there is provided a new interchangeable cam module comprising means for mounting a cam member in a predetermined desired position relative to other similar cam members and means for retaining at least one control switch relative to the cam. Means for locating and rigidly interconnecting the module with other similar modules are also included.

The principal object of the present invention is the provision of a new repeat cycle timer of modular construction which readily permits adjustment of the timer cam members in the field without the necessity for disassembling the entire timer.

Another object of the present invention is the provision of a repeat cycle timer of modular construction which readily permits the addition and deletion of cam members and modules as dictated by work requirements for the timer.

Another object of the present invention is the provision of a repeat cycle timer of modular construction which decreases the amount of component parts required therefor.

Yet another object of the present invention is the provision of a repeat cycle timer of modular construction in which the cam members and modules are interchangeable.

Still another object of the present invention is the provision of a new cam member for use in a repeat cycle timer of modular construction which permits adjustment of the cam surfaces thereon without removing the cam from its position in the timer.

Yet a further object of the present invention is the provision of a new interchangeable cam module for a repeat cycle timer of modular construction which module provides support for a cam member and a control switch activated by the cam member.

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment of which will be described in detail in the specification and illustrated in the accompanying drawings which form a part hereof and wherein:

FIG. 1 is a side view of the repeat cycle timer of the subject invention including a partial cross sectional view for clarity in showing the invention;

FIG. 2 is an end view of the reset cycle timer of the subject invention showing in particular the timer adjustment means;

FIG. 3 is a cross sectional view taken along lines 3—3 in FIG. 1;

FIG. 4 is a side view of the cam member shown in FIG. 3 including a partial cross sectional view for clarity in showing the invention;

FIG. 5 is an exploded view of the cam hub and cam surface areas comprising the cam member shown in FIGS. 3 and 4;

FIG. 6 is a cross sectional view taken along lines 6—6 in FIG. 1;

FIG. 7 is a side view of that portion of the timer shown in FIG. 6 including a partial cross sectional view through the cam member;

FIG. 7A shows the cam member of FIG. 6 in a trip position; FIG. 7B shows the cam member of FIG. 6 in the cancel position;

FIG. 7C shows the cam member of FIG. 6 in another trip position;

FIG. 8 is a cross sectional view taken along lines 8—8 in FIG. 6 showing the mounting of the cam surface to the cam hub;

FIG. 9 is a cross sectional view taken along lines 9—9 in FIG. 1 and showing the clutch assembly of the subject invention;

FIG. 10 is a cross sectional view of the clutch assembly in FIG. 9 taken along lines 10—10;

FIG. 11 is an exploded view of the clutch assembly shown in FIG. 9; and,

FIG. 12 is a view showing an alternate position for the drive assembly used with the subject invention.

Referring now to the drawings wherein the showings are for the purposes of illustrating preferred embodiments of the invention only, and not for purposes of limiting same, the FIGURES show the new reset cycle timer of modular construction comprised of a plurality of interconnected cam module assemblies A, a plurality of interconnected cam assemblies B, clutch assembly C, drive assembly D and adjustment assembly E. The cam members of the cam assemblies are driven through clutch assembly C by drive assembly D in order to perform the step of energizing a plurality of control switches in predetermined timed sequence. The specific configuration of drive assembly D does not form a part of the present invention, it being understood that any number of small electrical synchronous motors could be utilized.

Referring to FIGS. 1, 3 and 4, one of the cam module assemblies A will now be described, it being understood that all other of the cam module assemblies are identical thereto unless otherwise specifically noted. It will be seen that cam module assembly A includes a cam assembly mounting area 10 and a base area 12. Included in mounting area 10 is a cam hub receiving hole 14 and a longitudinally extending spacer flange 16 extending longitudinally outward therefrom. Base area 12 includes an end face wall 18 having a front edge surface 20 and a rear edge surface 22. Extending outwardly from rear edge surface 22 is a pair of wall members 24, 26 which form a generally L-shaped configuration. Included in the upper portion of wall member 24 is an actuator receiving slot 28. Slot 28 is generally circular in cross sectional configuration and is opened at one side thereof.

Adjacent wall members 24, 26 on rear edge surface 22 is a second set of outwardly extending wall members 30, 32, also forming a generally L-shaped configuration. Wall members 20, 22 and 32, 34 extend outwardly coextensive with each other. Also extending outwardly coextensive with the wall members is a tube-like member 34 used for joining the modules together as will be hereinafter more fully described. It will be appreciated that cam module assembly A may be formed from any of a plurality of materials, however, in the preferred embodiment, a rigid plastic material is used with all the component parts molded integral therewith.

An actuator arm generally designated 50 is received in the cam module assembly for actuation of a control switch. The actuator arm includes lever arm 52 including thereon a cylindrical actuating arm mounting member 54 receivable in slot 28. The fit between member 54 and slot 28 is such that actuator arm 50 may be pivoted in its mounting. The actuator arm further includes a leg 56 and an actuator head 58. Extending outwardly from actuator head 58 is a pair of actuator protrusions 60, 62 as best shown in FIGS. 1 and 3. Although several materials may be used for making actuator arm 50, in the preferred embodiment, a resilient plastic material is used and all the components of the actuator arm are molded integral therewith.

Disposed in the corner of wall members 30, 32 is a control switch generally designated 70 which does not form a part of the present invention and may comprise any of several types of control switches. Switch 70 includes leads 72, 74 and 76. The control switch also includes a control switch trip member 78 which is adapted to energize or de-energize the switch when pushed inwardly toward the switch body. Cooperating with wall members 30, 32 in maintaining switch 70 in position is a small protrusion (not shown) molded integral in base area 12 for engagement with a detent in the body of switch 70. As can best be seen in FIG. 3 and with actuator arm 50 and control switch 70 in position, actuator head 58 will rest against control switch trip member 78 such that downward or upward movement of the actuator head will cause a corresponding downward or upward movement in control switch trip member 78 to thus cause energization or de-energization of the control switch.

Although cam assemblies B may be comprised of any of a plurality of cam and cam surface configurations which will hereinafter be described in greater detail, the mounting means for adjacent cam assemblies are the same. The following

description will therefore be directed to one of these mounting means, it being understood that the others are identical thereto except where specifically noted. With reference to FIGS. 1, 3, 4 and 5, it may be seen that each cam assembly includes a hollow forwardly extending mounting shaft 90 and a hollow rearwardly extending mounting shaft 92. Shaft 92 includes two V-shaped lands 94, 96 oppositely disposed from one another and two V-shaped grooves 98, 100 also oppositely disposed from one another. Similarly, shaft 90 includes lands 94', 96' and grooves 98', 100'. These lands and grooves are adapted to fit into adjacent lands and grooves in order to rigidly interconnect the adjacent cam assemblies. This interconnection is best shown with reference to FIG. 1.

Aside from this identical means for mounting, each of the four cam assemblies B shown in FIG. 1 is dissimilar from the others. Cam members 110, 112 are non-adjustable cams of two different types. Cam member 110 includes cam surfaces 114 spaced circumferentially therearound for actuation of the associated actuator head 58, and cam member 112 includes actuator head engaging elements 116 which engage protrusions 60 or 62 in a manner hereinafter described. Again, cam surfaces 114 and elements 116 are not adjustable on their respective cam members 110, 112. Although any of several materials could be used in making members 110, 112, in the preferred embodiment, these members are molded from a rigid plastic material to include mounting shafts 90, 92 integral therewith.

In FIG. 1, cam hub 120 shows one embodiment of an adjustable cam member and cam hub 122 shows another embodiment of an adjustable cam member. Cam hub 120 is shown more particularly in FIGS. 3, 4 and 5 and cam hub 122 is shown more particularly in FIGS. 6, 7 and 8.

With particular reference to FIGS. 1, 3, 4 and 5, it will be seen that the cam hub 120 includes oppositely disposed face portions 130, 132 and a circumferentially extending surface portion 134. A generally V-shaped ring-like protrusion 136 is disposed on face portion 130 generally intermediate circumferentially extending surface portion 134 and the center of the cam hub. A second V-shaped ring-like protrusion 138 is similarly disposed relative to face portion 132. Included on circumferentially extending surface portion 134 are a plurality of longitudinally extending serrations 140. Protrusions 136, 138 and serrations 140 are used to retain the adjustable cam surfaces in a desired operative position on cam hub 120 as will be hereinafter described.

Referring now more particularly to FIG. 5, it will be seen that associated with cam hub 120 are two cam surface portions 150, 152. As these cam surface portions are identical to each other except that they are in an oppositely disposed position relative to the cam hub, description will be made with reference to cam surface portion 150, it being understood that cam surface portion 152 is identical thereto unless otherwise specifically noted. The cam surface portion includes a cam surface area 154 extending on the outside periphery thereof and a mounting bracket portion generally designated 156. Associated with the mounting bracket portion is the inner peripheral surface 158 of cam surface area 154 and an inwardly extending side ledge member 160. The mounting bracket includes a protrusion engaging leg 162 having an outwardly extending portion 164 and a downwardly extending portion 166. Leg 162 includes at the distal end thereof an inwardly extending generally V-shaped protrusion engaging lip 168. Surface 158 includes at a position adjacent the mounting bracket portion a plurality of serrations 169 for mating engagement with serrations 140 on surface 134 of the cam hub. As can best be seen in FIGS. 3 and 4, cam surface portions 150, 152 are disposed on opposite sides of cam hub 120 and may present a cam surface for engagement with actuator head 58 for 360° of rotation of the cam hub.

To position the cam surface portions on the hub, it is merely necessary to place surface 158 in engagement with surface 134 and snap mounting bracket portion 156 in position relative to the hub as best shown in FIG. 3. Interfitting serrations 140, 169 restrain the cam surface portion from movement

relative to the cam hub. To adjust cam surface area 154 for desired communication against actuator head 58, it is merely necessary to lift the cam surface portion slightly away from the cam hub at the end including mounting bracket portion 156 to remove the interfitting relationship of serrations 140, 169 and rotate the cam surface portion around the cam hub to the position desired. As shown in FIG. 3, cam surface portions 150, 152 are adjusted to present a cam surface in cooperation with actuator arm 58 for approximately 330° of a cam hub rotation. Also in FIG. 3, it will be seen that each of the cam surface areas includes a cam surface area lead 170 for smooth communication with actuator head 58. In the above described type of adjustable cam assembly B, it will be appreciated that switch 70 is actuated only for that period of time in which cam surfaces 154 maintain actuator head in the depressed position acting against control switch trip member 78. It will also be appreciated that operation of cam 110 relative to its associated control switch 70 is identical with that hereinabove described relative to cam hub 120 excepting that the cam surfaces on cam 110 are non-adjustable. Referring now to FIGS. 6, 7 and 8 and the cam surface portions used in combination with cam hub 122, it will be seen that there are three cam surface portions, namely, 190, 192 and 194 having cam surface areas 196, 198 and 200 respectively thereon. Each cam surface portion also includes an identical mounting bracket portion 202.

In using the adjustable cam surface portions shown in FIGS. 6, 7 and 8, an outwardly extending protrusion 204 at the intersection of wall members 30, 32 is used. Similarly, leg 56 of actuator arm 50 includes an actuator locking element or protrusion 206 at the distal end thereof. As can be seen in FIGS. 6 and 7B, when element 206 is on one side of protrusion 204, actuator head 58 is in a non-actuating relationship relative to control switch trip member 78 and when element 206 is on the lower side of protrusion 204, actuator head 58 is retained in an actuating position relative to the control switch trip member.

Referring specifically to FIGS. 7A and 7B, it will be seen that cam surface portion 190 includes thereon a forwardly extending cam surface 210 having a generally V-shaped groove 212 and an upwardly extending V-shaped cam surface area 214 immediately adjacent thereto. During clockwise rotation of the cam hub in the direction of the FIGURES, cam surface area 210 acts against protrusion 60 to direct actuator head 58 downwardly against trip member 78 to place switch 70 in an energized condition. During this movement, element 206 is biased outwardly over protrusion 204 to retain actuator head 58 in the actuating position. As the cam hub is further rotated, protrusion 60 enters into groove 212 and against cam 214, as shown in FIG. 7B, such that the actuator head is lifted upwardly from its energizing position relative to trip member 78 so that element 206 is pulled outwardly over protrusion 204 to maintain the actuator head in the non-energizing position.

Cam surface portion 192, as seen in FIG. 6, merely includes a downwardly extending V-shaped cam 220 thereon. As cam 220 engages protrusions 60, actuator head 58 is directed downwardly and element 206 is again directed over protrusion 204 to maintain the actuator head in the energizing position. The actuator head will remain in this energizing position until acted upon by an adjacent cam member to cancel the energization.

Cam surface portion 194 is shown in FIGS. 6 and 7C and includes a V-shaped groove area 222 and an upwardly extending V-shaped cam surface area 224. This cam surface portion is used to cancel the energizing position of actuator head 58 by cam surface portion 192. As protrusion 60 enters into groove 222 and against cam 224, the actuator head is lifted from its engaging position as hereinabove described relative to cam surface portion 190. It should be noted that movement between the actuating and non-actuating positions of actuator head 58 causes pivotal movement of leg 52 relative to its mounted position in wall 24. It will be appreciated that any combination of the above described cam surface portions may be used with cam hub 122.

Each of the cam surface portions includes an identical mounting bracket portion 202 for maintaining it in position on cam hub 122. Description is hereinafter made relative to one of these mounting portions, it being understood that the others are identical thereto. With particular reference to FIG. 6 and 8, it will be seen that the mounting bracket portion includes a first protrusion engaging leg 230 for association with one side of the cam hub and a second protrusion engaging leg 232 for association with the other side of the cam hub. These legs are interconnected by a circumferential surface engaging portion 233. Leg 232 includes at the distal end thereof a protrusion engaging lip 234 which is adapted to fit over ring-like protrusion 138. Leg 230 is of sufficient length to be in communication with the edge of surface portion 134 and the outermost edge of ring-like protrusion 136 on the cam hub. Surface portion 233 includes a plurality of serrations 236 to engage serrations 140 on surface 134. To place one of the cam surface portions on cam hub 122, it is merely necessary to direct mounting bracket portion 202 over the edges of the cam hub and into the position shown in FIG. 8. In this position, legs 230, 232 are biased slightly outwardly from each other and lip 234 engages ring-like protrusion 138. Simultaneous therewith, serrations 236 engage serrations 140. In order to adjust any particular cam surface portion, it is merely necessary to pull slightly outwardly on the particular cam surface portion until serrations 236 disengage from serrations 140 to thereby allow the cam surface portion to be moved to any desired position circumferentially about cam hub 122. It will be appreciated that the cam hubs, the cam surface portions and the actuator arms may be made from any suitable materials, however, in the preferred embodiment, the cam hubs are molded from a rigid plastic material and the cam surface portions and actuator arms are molded from a resilient plastic material. Further, it is to be understood that the operation of the cam assembly B utilizing cam member 112 is the same as that hereinabove described relative to cam hub 122 except the cam surface portion thereon are non-adjustable.

Referring to FIGS. 1, 9, 10 and 11, it will be seen that clutch assembly C is comprised of a drive ratchet ring 250 having an inner peripheral surface 252 including a series of longitudinally extending serrations therearound. This drive ratchet ring also includes a forwardly extending hollow mounting shaft 90 having lands 94', 96' and grooves 98', 100'. Associated with the drive ratchet ring is a clutch spider 260 including spider hub 262 and a plurality of outwardly extending arcuate resilient fingers 264. Disposed in the center of spider hub 262 are land receiving recesses 266, 268 on opposite sides of a shaft receiving hole 270.

A clutch drive gear 272 includes a shaft portion 274 and a spider hub engaging portion 276. The spider hub engaging portion includes lands 278, 280 disposed to be received in communication with land receiving recesses 266, 268, respectively. Coaxially disposed in one end face of the clutch drive gear is a drive motor gear receiving hole 282. This receiving hole, in the preferred embodiment, is star-shaped, however, it will be appreciated that any shape for use with a particular selected drive motor may be utilized. Shaft portion 274 extends into a receiving hole 284 in shaft 90 of drive ratchet ring 250. As can be particularly seen in FIG. 9, when clutch spider 260 is in position, each arcuate resilient finger 264 engages serrations 254 of the drive ratchet ring. In that FIGURE, it may also be seen that movement of the spider relative to the drive ratchet ring is permitted in the clockwise direction while being prevented in a counterclockwise direction. The components of clutch assembly C may be manufactured from any suitable material, however, in the preferred embodiment, the drive ratchet ring and clutch drive gear are molded from a rigid plastic material and the spider is molded from a more resilient plastic material.

Drive assembly D is comprised of a drive motor generally designated 90 having leads 292, 294 and a motor mounting module 296. As hereinabove stated, this motor may be selected from any of several types of synchronous motors. The motor mounting module includes a motor mounting portion

298 and base portion 300. Disposed in portion 298 is a drive gear receiving hole 302 positioned to be coaxial with the plurality of mounting shafts 90,92. Drive motor 290 may be mounted to the module by any convenient means, which, in the preferred embodiment, comprise screws 304,306. Base portion 300 includes a front surface area 308 having disposed therein a receiving recess 310 to be coaxial with tube-like members 34. Front surface area 308 is designed to be matingly received relative to a cam module assembly A primarily against wall members 24,26 and 30,32. It will be appreciated that motor mounting module 296 may be manufactured from any suitable material, however, in the preferred embodiment, this module is molded from a rigid plastic material.

Adjustment assembly E is best shown in FIGS. 1 and 2 and includes a dial member 320 having disposed thereon a face member 322. This face member is graduated in accordance with the speed of rotation of drive motor 290 in order to calibrate the length of a timed sequence desired. The dial member includes at the rear portion thereof a cam module engaging surface 324 having a lip surface 326 for mating engagement with the top of the cam assembly mounting area 10 on the adjacent cam module assembly A. An adjustment knob 330, including a pointer 332 thereon, is disposed on one side of face 322 and includes a shaft portion 334 extending coaxially through the face and dial member and into the hollow area of the forward mounting shaft 90 of the adjacent cam assembly B. A set screw 336 maintains shaft 334 in a stationary position relative to knob 330. Included adjacent the end of shaft portion 334 are grooves 338 and lands (not shown) similar to those previously discussed relative to shafts 90,92. These are for engagement with the grooves and lands of the hollow forward mounting shaft of the adjacent cam assembly in order that the adjustment assembly may be rigidly interconnected therewith.

To assemble the repeat cycle timer of the subject invention, it is first necessary to mount the drive motor relative to motor mounting module 296 so that the drive gear extends through hole 302. Once this has been completed, the clutch assembly, which has previously been assembled as shown in FIGS. 9 and 10, may be placed thereon with drive gear receiving hole 282 receiving the drive gear of the drive motor. Next, the first cam module assembly A utilizing the cam assembly A having cam member 110 and with the associated control switch 70 and actuator arm 50 installed thereon, may be placed adjacent motor mounting module 296. In this position, the lands and grooves of shaft 90, integral with drive ratchet ring 250, engage the corresponding lands and grooves of hollow rearwardly extending mounting shaft 92 of cam member 110. Also, base area 12, specifically edge 22 and wall members 24, 26, 30 and 32, engages front surface area 308 of base portion 300.

Similarly, and with the associated control switches 70, actuator arms 50 and cam assemblies B mounted in position on their associated cam module assemblies A the remainder of the switch may be assembled following the steps hereinabove described. Each base area 12 of a cam module assembly mates with base area 12 of the adjacent cam module assembly and each of the front and rear mounting shafts 90,92 mates with the associated adjacent mounting shaft so as to form an integral unit. When the desired number of cam module assemblies A are so mounted, they may be rigidly affixed to drive assembly D by an elongated bolt 350 extending through each of the tube-like members 34 and receiving recess 310 and maintained in this position by a nut 352 threadably received on the bolt.

Finally, adjustment assembly E may be located relative to the last cam module assembly A such that the end of shaft portion 334 is received in front mounting shaft 90 and the lands and grooves associated with the front mounting shaft are mated with the lands and grooves adjacent the shaft portion. Adjustment assembly E is retained in its position relative to the cam module by any convenient means, which, in the preferred embodiment, comprise a screw 354 engaging both dial member 320 and cam assembly mounting area 10 of the adjacent cam module assembly.

With the particular construction of the repeat cycle timer shown in FIG. 1, it is necessary that cam surfaces 114 on non-adjustable cam 110 and control switch actuator elements 116 on non-adjustable cam 112 be placed in their desired oriented position during molding thereof. However, cam surface portions 150,152 associated with cam hub 120 and cam surface portions 190,192 and 194 associated with cam hub 122 may be set at any time following assembly and adjusted thereafter to present any desired operational sequence. The adjustment steps are as has been hereinabove described. To set the timer itself for a preselected timed sequence, it is merely necessary to rotate the interconnected cam assemblies through the clutch assembly by rotating knob 330 generally clockwise in the view of FIG. 2 to a preselected time interval as shown on face 322. Drive motor 290 is then energized to drive the cam assemblies in a counterclockwise direction in the view of FIG. 2 such that during rotation, each of the actuator heads 58 are moved to actuate the associated control switch 70 through control switch trip members 78 in response to communication with the associated cam surface portions as hereinabove previously described.

By using the concepts of the subject invention, it will be seen that a greater or lesser number of cam module assemblies A with cam assemblies B may be used than that shown in FIG. 1. It is merely necessary to lengthen or shorten bolt 350 to accommodate a greater or lesser number of these assemblies. Further, a repeat cycle timer using the concepts of the subject invention could be assembled using any combination of adjustable cam hubs similar to cam hubs 120,122 or non-adjustable cam members such as 110,112. The configuration of the timer need only be dictated by the specific work requirements. Each control switch 70 may be connected to any number of circuits remote from the switch for energization thereby.

A second embodiment of the subject invention is shown in FIG. 12 and comprises the utilization of a large drive gear. With reference to FIG. 12, drive motor 290 is removed from its position as shown in FIG. 1 relative to the first embodiment and inverted such that the motor drive gear is received through a second drive gear receiving hole 302' disposed in motor mounting portion 298 below drive gear receiving hole 302. Clutch assembly C is removed from the timer when using this embodiment and a large drive gear 360 is inserted therefor which is interconnected between motor mounting module 296 and the first cam module assembly A and cam assembly B in a similar fashion to that as hereinabove described. The drive gear of drive motor 290 engages teeth 362 spaced around the outer circumferential surface of gear 360 to effect driving of the cam assemblies. Obviously, this modification has the effect of reducing the speed at which the cams rotate and, in this second preferred embodiment, the reduction ratio is 10:1. Also in this second embodiment, the adjustment assembly is removed from the timer. The actual operation of the timer and the alternatives as to construction remain the same as described with reference to the first embodiment.

The invention has now been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon the reading and understanding of this specification. It is my intention to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

Having thus described my invention, I now claim:

1. A timer mechanism for operating a plurality of elements in a predetermined sequence, said timer comprising:

a plurality of independent interchangeable stationary cam member support modules each including a cam member having a longitudinal axis and means for mounting said cam member for rotation about said axis relative to the associated module and means for locating at least one control switch adapted to control at least one of said elements said plurality of modules forming a frame for said timer;

means for rigidly interconnecting said modules and associated cam members into a unit, the longitudinal axes of said cam members forming a longitudinal axis for said unit;

relative to the cam hub. To adjust cam surface area 154 for desired communication against actuator head 58, it is merely necessary to lift the cam surface portion slightly away from the cam hub at the end including mounting bracket portion 156 to remove the interfitting relationship of serrations 140, 169 and rotate the cam surface portion around the cam hub to the position desired. As shown in FIG. 3, cam surface portions 150, 152 are adjusted to present a cam surface in cooperation with actuator arm 58 for approximately 330° of a cam hub rotation. Also in FIG. 3, it will be seen that each of the cam surface areas includes a cam surface area lead 170 for smooth communication with actuator head 58. In the above described type of adjustable cam assembly B, it will be appreciated that switch 70 is actuated only for that period of time in which cam surfaces 154 maintain actuator head in the depressed position acting against control switch trip member 78. It will also be appreciated that operation of cam 110 relative to its associated control switch 70 is identical with that hereinabove described relative to cam hub 120 excepting that the cam surfaces on cam 110 are non-adjustable. Referring now to FIGS. 6, 7 and 8 and the cam surface portions used in combination with cam hub 122, it will be seen that there are three cam surface portions, namely, 190, 192 and 194 having cam surface areas 196, 198 and 200 respectively thereon. Each cam surface portion also includes an identical mounting bracket portion 202.

In using the adjustable cam surface portions shown in FIGS. 6, 7 and 8, an outwardly extending protrusion 204 at the intersection of wall members 30, 32 is used. Similarly, leg 56 of actuator arm 50 includes an actuator locking element or protrusion 206 at the distal end thereof. As can be seen in FIGS. 6 and 7B, when element 206 is on one side of protrusion 204, actuator head 58 is in a non-actuating relationship relative to control switch trip member 78 and when element 206 is on the lower side of protrusion 204, actuator head 58 is retained in an actuating position relative to the control switch trip member.

Referring specifically to FIGS. 7A and 7B, it will be seen that cam surface portion 190 includes thereon a forwardly extending cam surface 210 having a generally V-shaped groove 212 and an upwardly extending V-shaped cam surface area 214 immediately adjacent thereto. During clockwise rotation of the cam hub in the direction of the FIGURES, cam surface area 210 acts against protrusion 60 to direct actuator head 58 downwardly against trip member 78 to place switch 70 in an energized condition. During this movement, element 206 is biased outwardly over protrusion 204 to retain actuator head 58 in the actuating position. As the cam hub is further rotated, protrusion 60 enters into groove 212 and against cam 214, as shown in FIG. 7B, such that the actuator head is lifted upwardly from its energizing position relative to trip member 78 so that element 206 is pulled outwardly over protrusion 204 to maintain the actuator head in the non-energizing position.

Cam surface portion 192, as seen in FIG. 6, merely includes a downwardly extending V-shaped cam 220 thereon. As cam 220 engages protrusions 60, actuator head 58 is directed downwardly and element 206 is again directed over protrusion 204 to maintain the actuator head in the energizing position. The actuator head will remain in this energizing position until acted upon by an adjacent cam member to cancel the energization.

Cam surface portion 194 is shown in FIGS. 6 and 7C and includes a V-shaped groove area 222 and an upwardly extending V-shaped cam surface area 224. This cam surface portion is used to cancel the energizing position of actuator head 58 by cam surface portion 192. As protrusion 60 enters into groove 222 and against cam 224, the actuator head is lifted from its engaging position as hereinabove described relative to cam surface portion 190. It should be noted that movement between the actuating and non-actuating positions of actuator head 58 causes pivotal movement of leg 52 relative to its mounted position in wall 24. It will be appreciated that any combination of the above described cam surface portions may be used with cam hub 122.

Each of the cam surface portions includes an identical mounting bracket portion 202 for maintaining it in position on cam hub 122. Description is hereinafter made relative to one of these mounting portions, it being understood that the others are identical thereto. With particular reference to FIG. 6 and 8, it will be seen that the mounting bracket portion includes a first protrusion engaging leg 230 for association with one side of the cam hub and a second protrusion engaging leg 232 for association with the other side of the cam hub. These legs are interconnected by a circumferential surface engaging portion 233. Leg 232 includes at the distal end thereof a protrusion engaging lip 234 which is adapted to fit over ring-like protrusion 138. Leg 230 is of sufficient length to be in communication with the edge of surface portion 134 and the outermost edge of ring-like protrusion 136 on the cam hub. Surface portion 233 includes a plurality of serrations 236 to engage serrations 140 on surface 134. To place one of the cam surface portions on cam hub 122, it is merely necessary to direct mounting bracket portion 202 over the edges of the cam hub and into the position shown in FIG. 8. In this position, legs 230, 232 are biased slightly outwardly from each other and lip 234 engages ring-like protrusion 138. Simultaneous therewith, serrations 236 engage serrations 140. In order to adjust any particular cam surface portion, it is merely necessary to pull slightly outwardly on the particular cam surface portion until serrations 236 disengage from serrations 140 to thereby allow the cam surface portion to be moved to any desired position circumferentially about cam hub 122. It will be appreciated that the cam hubs, the cam surface portions and the actuator arms may be made from any suitable materials, however, in the preferred embodiment, the cam hubs are molded from a rigid plastic material and the cam surface portions and actuator arms are molded from a resilient plastic material. Further, it is to be understood that the operation of the cam assembly B utilizing cam member 112 is the same as that hereinabove described relative to cam hub 122 except the cam surface portion thereon are non-adjustable.

Referring to FIGS. 1, 9, 10 and 11, it will be seen that clutch assembly C is comprised of a drive ratchet ring 250 having an inner peripheral surface 252 including a series of longitudinally extending serrations therearound. This drive ratchet ring also includes a forwardly extending hollow mounting shaft 90 having lands 94', 96' and grooves 98', 100'. Associated with the drive ratchet ring is a clutch spider 260 including spider hub 262 and a plurality of outwardly extending arcuate resilient fingers 264. Disposed in the center of spider hub 262 are land receiving recesses 266, 268 on opposite sides of a shaft receiving hole 270.

A clutch drive gear 272 includes a shaft portion 274 and a spider hub engaging portion 276. The spider hub engaging portion includes lands 278, 280 disposed to be received in communication with land receiving recesses 266, 268, respectively. Coaxially disposed in one end face of the clutch drive gear is a drive motor gear receiving hole 282. This receiving hole, in the preferred embodiment, is star-shaped, however, it will be appreciated that any shape for use with a particular selected drive motor may be utilized. Shaft portion 274 extends into a receiving hole 284 in shaft 90 of drive ratchet ring 250. As can be particularly seen in FIG. 9, when clutch spider 260 is in position, each arcuate resilient finger 264 engages serrations 254 of the drive ratchet ring. In that FIGURE, it may also be seen that movement of the spider relative to the drive ratchet ring is permitted in the clockwise direction while being prevented in a counterclockwise direction. The components of clutch assembly C may be manufactured from any suitable material, however, in the preferred embodiment, the drive ratchet ring and clutch drive gear are molded from a rigid plastic material and the spider is molded from a more resilient plastic material.

Drive assembly D is comprised of a drive motor generally designated 90 having leads 292, 294 and a motor mounting module 296. As hereinabove stated, this motor may be selected from any of several types of synchronous motors. The motor mounting module includes a motor mounting portion

298 and base portion 300. Disposed in portion 298 is a drive gear receiving hole 302 positioned to be coaxial with the plurality of mounting shafts 90,92. Drive motor 290 may be mounted to the module by any convenient means, which, in the preferred embodiment, comprise screws 304,306. Base portion 300 includes a front surface area 308 having disposed therein a receiving recess 310 to be coaxial with tube-like members 34. Front surface area 308 is designed to be matingly received relative to a cam module assembly A primarily against wall members 24,26 and 30,32. It will be appreciated that motor mounting module 296 may be manufactured from any suitable material, however, in the preferred embodiment, this module is molded from a rigid plastic material.

Adjustment assembly E is best shown in FIGS. 1 and 2 and includes a dial member 320 having disposed thereon a face member 322. This face member is graduated in accordance with the speed of rotation of drive motor 290 in order to calibrate the length of a timed sequence desired. The dial member includes at the rear portion thereof a cam module engaging surface 324 having a lip surface 326 for mating engagement with the top of the cam assembly mounting area 10 on the adjacent cam module assembly A. An adjustment knob 330, including a pointer 332 thereon, is disposed on one side of face 322 and includes a shaft portion 334 extending coaxially through the face and dial member and into the hollow area of the forward mounting shaft 90 of the adjacent cam assembly B. A set screw 336 maintains shaft 334 in a stationary position relative to knob 330. Included adjacent the end of shaft portion 334 are grooves 338 and lands (not shown) similar to those previously discussed relative to shafts 90,92. These are for engagement with the grooves and lands of the hollow forward mounting shaft of the adjacent cam assembly in order that the adjustment assembly may be rigidly interconnected therewith.

To assemble the repeat cycle timer of the subject invention, it is first necessary to mount the drive motor relative to motor mounting module 296 so that the drive gear extends through hole 302. Once this has been completed, the clutch assembly, which has previously been assembled as shown in FIGS. 9 and 10, may be placed thereon with drive gear receiving hole 282 receiving the drive gear of the drive motor. Next, the first cam module assembly A utilizing the cam assembly A having cam member 110 and with the associated control switch 70 and actuator arm 50 installed thereon, may be placed adjacent motor mounting module 296. In this position, the lands and grooves of shaft 90, integral with drive ratchet ring 250, engage the corresponding lands and grooves of hollow rearwardly extending mounting shaft 92 of cam member 110. Also, base area 12, specifically edge 22 and wall members 24, 26, 30 and 32, engages front surface area 308 of base portion 300.

Similarly, and with the associated control switches 70, actuator arms 50 and cam assemblies B mounted in position on their associated cam module assemblies A the remainder of the switch may be assembled following the steps hereinabove described. Each base area 12 of a cam module assembly mates with base area 12 of the adjacent cam module assembly and each of the front and rear mounting shafts 90,92 mates with the associated adjacent mounting shaft so as to form an integral unit. When the desired number of cam module assemblies A are so mounted, they may be rigidly affixed to drive assembly D by an elongated bolt 350 extending through each of the tube-like members 34 and receiving recess 310 and maintained in this position by a nut 352 threadably received on the bolt.

Finally, adjustment assembly E may be located relative to the last cam module assembly A such that the end of shaft portion 334 is received in front mounting shaft 90 and the lands and grooves associated with the front mounting shaft are mated with the lands and grooves adjacent the shaft portion. Adjustment assembly E is retained in its position relative to the cam module by any convenient means, which, in the preferred embodiment, comprise a screw 354 engaging both dial member 320 and cam assembly mounting area 10 of the adjacent cam module assembly.

With the particular construction of the repeat cycle timer shown in FIG. 1, it is necessary that cam surfaces 114 on non-adjustable cam 110 and control switch actuator elements 116 on non-adjustable cam 112 be placed in their desired oriented position during molding thereof. However, cam surface portions 150,152 associated with cam hub 120 and cam surface portions 190,192 and 194 associated with cam hub 122 may be set at any time following assembly and adjusted thereafter to present any desired operational sequence. The adjustment steps are as has been hereinabove described. To set the timer itself for a preselected timed sequence, it is merely necessary to rotate the interconnected cam assemblies through the clutch assembly by rotating knob 330 generally clockwise in the view of FIG. 2 to a preselected time interval as shown on face 322. Drive motor 290 is then energized to drive the cam assemblies in a counterclockwise direction in the view of FIG. 2 such that during rotation, each of the actuator heads 58 are moved to actuate the associated control switch 70 through control switch trip members 78 in response to communication with the associated cam surface portions as hereinabove previously described.

By using the concepts of the subject invention, it will be seen that a greater or lesser number of cam module assemblies A with cam assemblies B may be used than that shown in FIG. 1. It is merely necessary to lengthen or shorten bolt 350 to accommodate a greater or lesser number of these assemblies. Further, a repeat cycle timer using the concepts of the subject invention could be assembled using any combination of adjustable cam hubs similar to cam hubs 120,122 or non-adjustable cam members such as 110,112. The configuration of the timer need only be dictated by the specific work requirements. Each control switch 70 may be connected to any number of circuits remote from the switch for energization thereby.

A second embodiment of the subject invention is shown in FIG. 12 and comprises the utilization of a large drive gear. With reference to FIG. 12, drive motor 290 is removed from its position as shown in FIG. 1 relative to the first embodiment and inverted such that the motor drive gear is received through a second drive gear receiving hole 302' disposed in motor mounting portion 298 below drive gear receiving hole 302. Clutch assembly C is removed from the timer when using this embodiment and a large drive gear 360 is inserted therefor which is interconnected between motor mounting module 296 and the first cam module assembly A and cam assembly B in a similar fashion to that as hereinabove described. The drive gear of drive motor 290 engages teeth 362 spaced around the outer circumferential surface of gear 360 to effect driving of the cam assemblies. Obviously, this modification has the effect of reducing the speed at which the cams rotate and, in this second preferred embodiment, the reduction ratio is 10:1. Also in this second embodiment, the adjustment assembly is removed from the timer. The actual operation of the timer and the alternatives as to construction remain the same as described with reference to the first embodiment.

The invention has now been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon the reading and understanding of this specification. It is my intention to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

Having thus described my invention, I now claim:

1. A timer mechanism for operating a plurality of elements in a predetermined sequence, said timer comprising:

a plurality of independent interchangeable stationary cam member support modules each including a cam member having a longitudinal axis and means for mounting said cam member for rotation about said axis relative to the associated module and means for locating at least one control switch adapted to control at least one of said elements said plurality of modules forming a frame for said timer;

means for rigidly interconnecting said modules and associated cam members into a unit, the longitudinal axes of said cam members forming a longitudinal axis for said unit;

drive means for selectively rotatably driving said interconnected cam members about said unit axis; and, cam surface areas disposed adjacent the outer peripheral surfaces of said cam members adapted for sequential engagement with actuating means for said switches.

2. The timer as defined in claim 1 wherein selected of said cam surfaces are adjustable about their respective cam hubs for effecting varied operating characteristics for said elements relative to other of said elements.

3. The timer as defined in claim 2 wherein each said cam member includes a coaxial shaft portion extending outwardly on at least one side thereof.

4. The timer as defined in claim 3 wherein each said cam member includes a coaxial shaft portion extending outwardly on both sides thereof and said interconnecting means comprises interfitting groove areas at the end faces of each said shaft portion.

5. The timer as defined in claim 4 wherein said modules include means for supporting at least one of said shaft portions of the associated cam member adjacent its interconnection with an adjacent shaft portion.

6. The timer as defined in claim 5 wherein said modules include areas for mating engagement with adjacent of said modules.

7. The timer as defined in claim 3 wherein each said cam member further includes a hub portion having two opposed face portions and an outer circumferential surface portion, said coaxial shaft portion extending outwardly from one of said face portions generally normal thereto and including an end face; at least one of said cam surface areas disposed adjacent said circumferential surface portion; means for retaining said at least one cam surface area in a predetermined desired position about said cam hub; and, said means for rigidly interconnecting said cam member with other of said cam members being disposed at said end face of said shaft portion.

8. The timer as defined in claim 7 wherein said retaining means for said selected of said cam surfaces are disposed on at least one of said face portions and on said outer circumferential surface portion.

9. The timer as defined in claim 8 wherein said retaining means comprises a plurality of outwardly extending longitudinal serrations on said outer circumferential surface portion and an area on said at least one of said face portions extending outwardly therefrom at least partially from said outer circumferential surface toward said axis.

10. The timer as defined in claim 9 wherein both of said face portions include one of said outwardly extending areas, said outwardly extending areas comprising outwardly extending ring-like areas.

11. The timer as defined in claim 10 wherein said cam surfaces are separate from and cooperate with said cam members, said cam surfaces including at least one mounting bracket portion for resiliently engaging said retaining means.

12. The timer as defined in claim 11 wherein each said mounting bracket portion comprises a generally U-shaped resilient clip member dimensioned such that the legs of said clip member are biased slightly outwardly from each other as said clip member is placed over said hub portion, at least one of said legs contacting one of said face portions at said ring-like area.

13. The timer as defined in claim 12 wherein the bottom portion of said U-shaped clip member includes means for fitting between two adjacent serrations on said outer circumferential surface portion and said at least one of said legs includes an inwardly extending lip portion disposed to be received over the associated ring-like area between said area and said axis.

14. The timer as defined in claim 13 wherein said cam

member includes one of said shaft portions extending coaxially outwardly from each of said face portions, said interconnecting means comprising grooved areas at said end faces for mating engagement with other identical grooved areas.

15. The timer as defined in claim 1 further including means for rotating said cam members in unison to predetermine the length of a timed sequence.

16. The timer as defined in claim 1 further including a clutch member spaced between and interconnecting said drive means and said unit for permitting rotation of said cam members relative to said drive means in one direction of rotation and for drivingly connecting said drive means and said cam members during rotation thereof by said drive means in the other direction.

17. The timer as defined in claim 16 wherein said clutch comprises a sprocket clutch including an outer drive ratchet ring member having a plurality of inwardly extending longitudinal serrations spaced around the inner circumference thereof and a clutch spider member having a plurality of outwardly extending arcuate fingers for receipt in said ratchet member and engagement with said serrations whereby said spider member may be rotated relative to said ring member in said one direction while being prevented from rotation in said other direction.

18. The timer as defined in claim 1 further including means for actuating said control switches, said actuating means being disposed so as to be moved between a normal non-actuating position and an actuating position relative to an associated control switch in response to rotational movement of said cam surfaces areas.

19. The timer as defined in claim 18 wherein selected of said actuating means include means for retaining said actuating means in a normally actuating position relative to the associated control switches.

20. The timer as defined in claim 18 wherein each said retaining means comprises a retaining member disposed for resilient retaining engagement with the associated module when said retaining means is moved to said actuating position.

21. In a timing mechanism of the type used for sequentially controlling a plurality of elements wherein a plurality of interconnected cam members having cam surface areas disposed adjacent their peripheral surfaces are rotated about a longitudinal axis in order to actuate a plurality of control switches adapted to control said elements, an interchangeable cam member support module comprising:

means for mounting at least one of said cam members in a predetermined desired position for cooperation with other of said cam members;

means for locating at least one of said control switches relative to said at least one of said cam members;

means for stationarily positioning said module relative to other of said modules and said timing mechanism to form a timer frame; and,

means for rigidly interconnecting said module with other of said modules to form a unit.

22. The cam module as defined in claim 21 wherein said locating means comprises wall members to engage said at least one switch on at least two sides thereof.

23. The cam module as defined in claim 22 further including means for receiving actuating means for actuating said at least one control switch in response to rotational movement of said at least one cam member.

24. The cam module as defined in claim 23 wherein said positioning means comprises a base area on said module positionable against other similar base areas and said mounting means comprises a mounting hole in the body of said module adapted to receive a mounting shaft for said at least one of said cam members.

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