Sept. 11, 1962 J. BOWMAN ETAL 3,053,947

SEQUENTIAL TIMER

Filed June 15, 1959 2 Sheets-Sheet 1

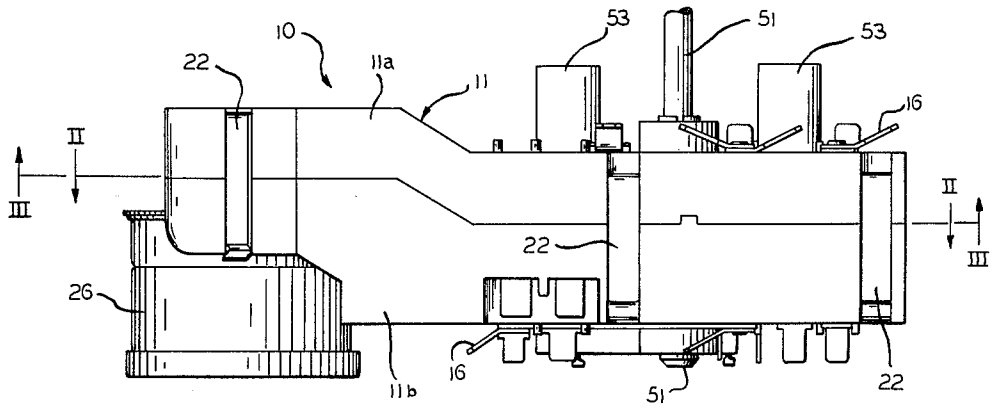


FIG. 1

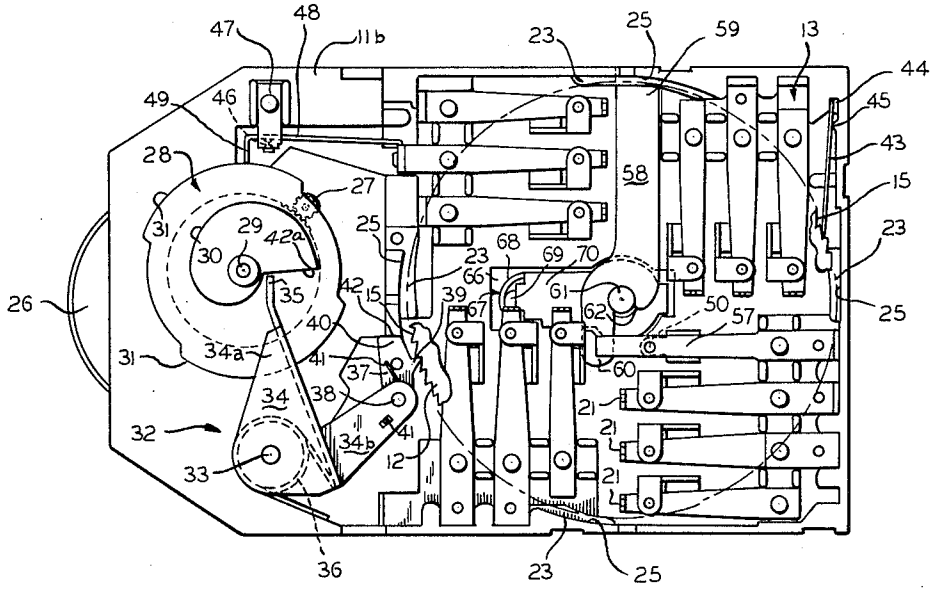


FIG. 2

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SEQUENTIAL TIMER

Filed June 15, 1959 2 Sheets-Sheet 2

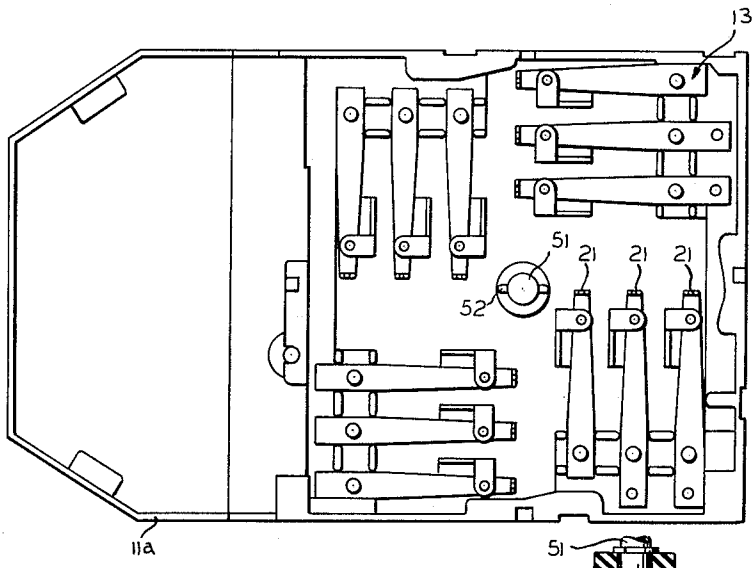


FIG.3

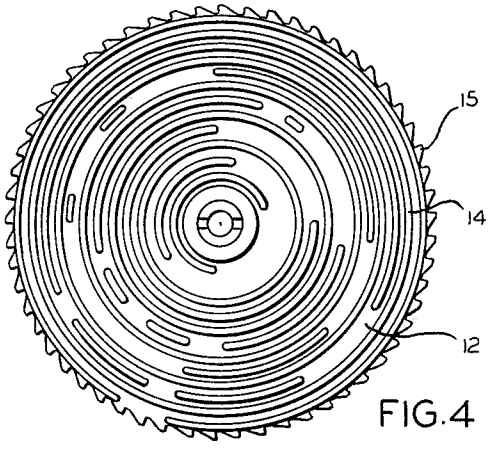


FIG.4

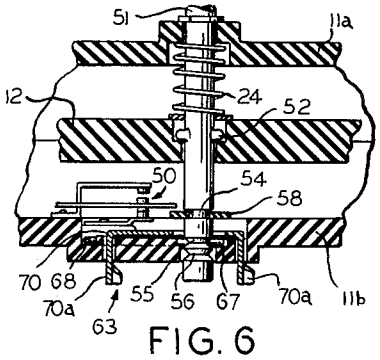


FIG. 6

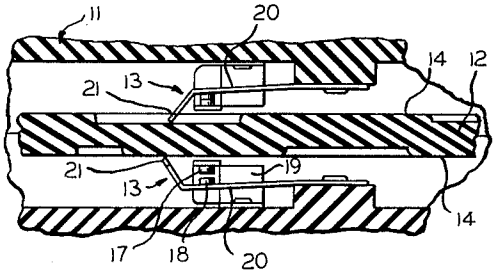


FIG.5

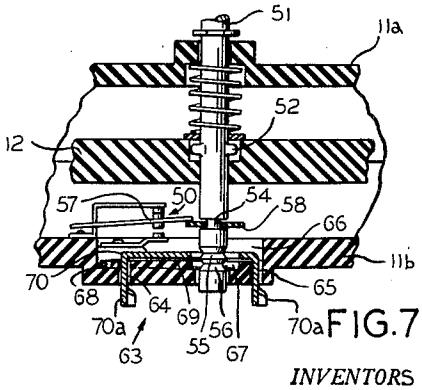


FIG.7

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3,053,947

# SEQUENTIAL TIMER

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Filed June 15, 1959, Ser. No. 820,342
9 Claims. (Cl. 200—38)

This invention relates generally to sequential timers, and more specifically to a timer structure which is adapted to handle a relatively large number of electrical circuits.

Although the principles of the present invention may be included in various timers, a particularly useful application is made in timers to be employed in washing machines of the domestic type. In particular, as the complexity of domestic washing machines increases, the complexity of the electric circuitry thereof also increases. This brings about a need for a timer structure capable of handling a relatively large number of circuits. Standing alone, this would appear not to pose a serious problem. However, it is ordinarily required that the space occupied by such a timer be no larger than that occupied by timers constructed to handle a somewhat lesser number of circuits.

There are manufacturing and flexibility advantages to employing only single-pole switches in such a device. A solution which has previously been considered for the present problem is the use of double-pole switches. However, frequently the circuitry will not admit of such usage, and the resulting dimensions which must be carefully controlled are vastly increased, thereby rendering the device unduly expensive to manufacture, coupled with a tendency to have more critical adjustments.

Once the need for an increase in number of switches has been recognized, the structure to be employed to accommodate the same in a single package presents numerous problems. For example, for reliability, a certain amount of torque is needed to rotate the sequence cam within the device. It is apparent that as the number of switches to be operated thereby is increased, the torque-load on the source of power is likewise increased. Thus in the carrying out of the principal objective, other structural and functional problems arise.

The present invention contemplates the utilization of a disc-like cam having radially spaced cam tracks on both sides thereof which actuate housing-mounted switches. The switches are proportioned and disposed with respect to each other so that twenty-four independent circuits can be handled by the device and governed by the rotation of the sequence cam. The cam is actuated in a step-by-step manner by a drive mechanism which is able to handle this number of switches reliably even when a motor of conventional power rating is employed for the purpose. Since the number of switches to be aligned precisely with the sequence cam is relatively large, the device is constructed in such a manner that the sequence cam is axially stationary. However, in response to consumer requirements, a manual operating shaft is provided which is axially reciprocable with respect to the sequence cam so that the forces emanating from the various switches do not provide an axial thrust on the shaft.

Accordingly, it is an object of the present invention to provide a sequential timer of an improved construction.

Another object of the present invention is to provide a sequential timer capable of handling a relatively large number of electrical circuits.

Yet another object of the present invention is to provide a novel switch arrangement and disposition within a timer in order that a relatively large number of switches may be accommodated in a relatively small space or envelope.

A further object of the present invention is to provide



a novel drive mechanism for a timer of the type described.

A still further object of the present invention is to provide an improved line-switch actuating mechanism.

Another object of the present invention is to provide improved means for holding a rotatable shaft which is axially slidable in a predetermined axial position.

A still further object of the present invention is to provide a simplified structure in a step-by-step timer for obtaining closing of a circuit for a few seconds periodically at an operational rate faster than that which the sequence cam is indexed in incremental steps.

Many other advantages, features and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which a preferred structural embodiment incorporating the principles of the present invention is shown by way of illustrative example.

On the drawings:

FIGURE 1 is an elevational view taken edgewise of a sequence timer provided in accordance with the principles of the present invention;

FIGURE 2 is an elevational view, partly broken away, taken along line II—II of FIG. 1 when the timer is partially disassembled;

FIGURE 3 is an elevational view taken along line III—III of FIG. 1 when the timer is partially disassembled;

FIGURE 4 is an elevational view of a typical sequence cam employed in the structure of FIG. 1;

FIGURE 5 is an enlarged fragmentary sectional view of a portion of FIG. 1; and

FIGURES 6 and 7 are enlarged fragmentary views, partly diagrammatic, and partly in elevation, taken adjacent to the shaft of FIG. 1.

As shown on the drawings:

The principles of this invention are particularly useful when embodied in a sequential timer or switch mechanism such as is illustrated in FIG. 1, generally indicated by the numeral **10**. The switch mechanism includes a housing **11** within which is disposed an intermittently driven sequence cam **12** which operates a series of switches generally indicated in each of FIGS. 2 and 3 by the numeral **13**. As best seen in FIGS. 4–7, the sequence cam is generally flat or disc-like and is provided on each axially directed face thereof with a series of radially spaced tracks **14**. On its periphery, the cam **12** typically is provided with sixty ratchet teeth identified by the numeral **15** so that when the cam is rotated by one tooth, a 6° movement will take place. The sequence cam **12** is rotatably mounted in the housing **11** in a manner set forth more fully later herein. Interconnections may be provided between the various switches **13** as desired to adapt this timer device to a particular washing machine. Likewise, the angular extent of each of the tracks **14** is selected to effect the desired control program.

Each of the switches **13** is adapted to be connected into an appropriate circuit, as by terminals **16** shown in FIG. 1. As best seen in FIG. 5, each of the switches **13** includes a pair of contacts **17**, **18**, the contact **17** being carried on a relatively stiff support bracket **19**, and the contact **18** being secured to a support means in the form of a flexible blade having a movable portion **20**. The contact bracket **19** and the movable blade are secured as by riveting to one of the halves of the housing **11**. Each of the switches **13** is provided with a movable cam follower **21**, in this embodiment comprising an angularly or axially directed ear secured to the movable blade portion **20**. Each of the cam followers **21** engages one of the tracks **14** so that each of the

switches 13 is opened and closed in response to rotation of the cam 12.

The housing 11 comprises two halves 11*a* and 11*b*, each of which has a configuration complemental to the other so as to define a unified housing when one is superposed on the other. The housing halves 11*a* and 11*b* are held together by a series of resilient spring clips 22 shown in FIG. 1. When the clips 22 have been removed, and other holding means yet to be described and associated with the shaft have been released, the housing halves may be separated, and the interior of the switch mechanism 10 viewed as shown in FIGS. 2 and 3. It will be noted that the various cam followers 21 supported by the housing half 11*b* are each spaced from the rotational axis of the cam 12 by a different distance from that which other cam followers on the same side of the cam 12 are spaced from the rotational axis. It is also to be noted that each of the cam followers is thus directed generally axially of the sequence cam 12.

In like manner, the various cam followers 21 which are supported by the housing half 11*a*, are also spaced from the rotational axis of the cam 12 by a distance which differs from the spacing of the other cam followers on the same side of the cam 12. In this embodiment, there are twelve such cam followers carried by each of the housing halves 11*a*, 11*b*, and the cam 12 therefore has a like number of tracks 14 on each side thereof for cooperation with each of the cam followers individually.

In each of the housing halves 11*a*, 11*b*, the switches 13 are arranged in the form of four quadrants. It will be noted that the cam followers 21 of each of the quadrants defines a generally radial line of engagement with the tracks 14. Thus, on each side of the cam 12, there are four radial lines of engagement, each spaced from adjacent lines by about 90°. As best seen in FIG. 5, the radial lines of engagement on one side of the cam 12 are substantially aligned with the radial lines of engagement on the opposite side of the cam 12.

The housing half 11*b*, as best seen in FIG. 2, is provided with four abutment means 23, each of which is disposed adjacent to the outer end of the lines of engagement defined by the cam followers 21. The abutment means 23 jointly define a plane which is adjacent to the peripheral portions of one side of the cam, and which plane is normal to the rotational axis of the sequence cam 12. A spring 24 is disposed between the housing half 11*a* and the cam 12, which spring urges the cam 12 axially against the abutment means 23. The strength of the spring is such that for any combination of switches, for example if all of the switches adjacent to one of the abutment means 23 were so positioned as to apply a maximum opposing force to the spring 24, the spring 24 will nevertheless hold the cam 12 against each of the abutments 23. Thus the spring 24 insures that the cam 12 is always in an axially fixed position regardless of the combination of switches 13 which may be opposing the spring 24.

Adjacent to each of the abutment means 23, the case has a portion or shoulder which extends toward the viewer in FIG. 2 and indicated at 25. The distance between two opposite shoulders 25 is slightly greater than the diametral distance across the teeth of the cam 12. The shoulders 25 and the abutments 23 in combination with the spring 24 thus jointly define structure for rotatably supporting the cam 12, irrespective of any other supporting structure which may be included.

In order to effect incremental periodic rotation of the cam 12, the switch mechanism 10 includes a conventional motor 26, which drives a pinion 27 through a gear train. The pinion 27 meshes with and drives a motor-driven gear-cam 28 which is rotatably supported on a pin 29 secured to the housing part 11*b*. The pin 29 is radially offset from the rotational axis of the sequence cam 12. The motor-driven cam 28 has two axially spaced peripheral cam tracks indicated at 30 and 31. An intermittent drive mechanism generally indicated at 32 is pivotally supported on a pin 33 secured to the housing part 11*b*. More specifically, the drive mechanism 32 includes a lever 34 having two arms. One arm 34*a* has an outer or free end 35 which is engageable with the cam track 30 of the motor-driven cam 28, which track is operative to pivot the lever 34 by engaging the end 35, so as to rock the lever 34 about an axis which is parallel to and offset from the axes of both of the cams 12 and 28. The torsion spring 36 acts between the lever 34 and the case 11*b* to resiliently bias or urge the lever 34 in a counterclockwise direction as viewed in FIG. 2, whereby when the cam track 30 engages the end 35 of the lever 34 the lever will returnably yield in response to such engagement.

The other arm 34*b* of the lever 34 extends toward the sequence cam 12, terminating adjacent to the periphery thereof. A dog 37 is pivotally supported on a pin 38 disposed at the distal end of the arm 34*b*. The dog has a tooth engaging portion 39 and an abutment portion 40. A spring 41 acts between the dog 37 and the arm 34*b* to provide a clockwise torsional bias about the axis of the pin 38 to urge the tooth engaging portion 39 into driving engagement with one of the ratchet teeth 15. When the lever 34 is rotated by the cam track 30 in a clockwise direction, the adjacent tooth cams the dog 37 in a counterclockwise direction until the tooth engaging portion 39 slips off the tooth, and moves clockwise under the influence of the spring 41 to engage the next tooth. When the end 35 of the lever 34 reaches a precipitous drop 42*a*, the lever 34 moves in a counterclockwise direction under the influence of energy stored in the spring 36, thereby positively driving the dog 37 into engagement with one of the teeth 15, and also effecting a clockwise rotation of the sequence cam by an angular amount equalling that defined by the tooth just driven. Thus the sequence cam 12 is caused to rotate in discrete increments in one direction, or in a step-by-step manner. The rotation of the sequence cam 12 in each increment is terminated when the abutment portion 40 of the dog 37 strikes a stop 42 comprising a part of the case or housing half 11*b*.

It is apparent that since the intermittent drive mechanism 32 is stopped in its counterclockwise movement by the stop 42, only the dimension between the stop or abutment portion 40 and the tooth engaging portion 39 of the dog 37 needs to be accurately controlled to get the proper amount of movement. This is so because the cam track 30 could cause raising of the end 35 by an amount almost sufficient to engage two teeth and yet still only one would be driven. Similarly the cam track 30 may have a drop greater than needed, and as shown, because the intermittent drive mechanism is arrested in its movement by the housing half 11*b* at the stop 42, whereas the end 35 of the lever arm 34*a* does not drop to the bottom or lowest point on the cam track. This structure eliminates a substantial amount of wear as well as impact deformation, thereby providing a structure which is durable and susceptible to long service. Further, the contour of the cam is not critical, and should wear take place on the track 30, this will have no effect on the magnitude of the incremental advance of the sequence cam 12.

To insure that the spring 41 during clockwise movement of the lever 34 does not effect a counterclockwise movement of the sequence cam 12, rotation direction limiting means 43 are provided. In this embodiment, the means 43 comprises a resilient blade one end of which is carried in a recess or pocket 44 of the housing half 11*b*, and the other end of which is endwise engageable with successive ratchet teeth 15. A fulcrum point 45 insures that the free end of the blade 43 is biased toward the sequence cam 12. Any tendency of the sequence cam 12 to rotate in a counterclockwise direction is therefore opposed by the means 43 which is thereby placed in compression to preclude such movement. In this manner, the limiting means 43 insures one-way driv-

ing engagement by the drive mechanism 32. In step-by-step operation, the counterclockwise movement of the lever arm 34 is arrested by the means 40, 42 just after the free end of the blade 43 has slipped off a tooth 15. It is to be understood that the terms "clockwise" and "counterclockwise" have been used herein as terms of reference and not of limitation.

The housing 11 supports two additional sets of contacts, such sets being identified by the reference numerals 46 and 50. The contacts 46 are supported by the housing, one on a relatively stationary bracket 47 and the other on a movable blade 48 which is connected in series with one of the switches 13. A cam follower portion 49 is secured to the blade 48 and is engageable with the other came track 31 of the motor-driven cam 28. The track 31 includes two switch-opening and two-switch-closing portions so that the circuit governed by the contacts 46 will be twice opened and closed during one revolution of the cam 28 which, as seen above, corresponds to the time which the sequence cam 12 remains stationary in one position. The circuit including the contacts 46 may be used to advantage to regulate periodic sprays or relatively rapid rinses in a washing machine.

As best seen in FIG. 2, it can be seen that if the sequence cam 12 were rotated manually in a clockwise direction, the dog 37 would yield under the influence of ratchet teeth 15, as would also the blade 43. Likewise, the blade 43 would preclude manual rotation of the cam 12 in a counterclockwise direction. To effect such rotation, a shaft 51 may be provided, the shaft 51 having means generally indicated at 52 in FIG. 6 for insuring co-rotation between the shaft 51 and the cam 12. The shaft 51 is a unitary part which extends through the housing 11, either end of which may be elongated to provide a place to secure a knob (not shown). Adjacent to the shaft 51, suitable mounting means generally indicated at 53 in FIG. 1 may also be provided if desired. As best seen in FIG. 6, the shaft 51 is rotatably supported by the housing in apertures provided in opposite walls thereof. The shaft 51 is axially slidable within the housing and is also axially slidable with respect to the sequence cam 12. The exact nature of the axially slidable rotational driving engagement which the shaft has with the cam 12 is a matter of choice.

The shaft 51 is provided with three circumferential grooves, in this embodiment all disposed on one side of the sequence cam 12. The first of these grooves is identified by the numeral 54, and the second and third of these grooves are identified by the numerals 55 and 56. The grooves 55 and 56 are each defined in part by a cam shoulder as shown in FIGS. 6 and 7, each of such cam shoulders being axially directed away from the cam shoulder of the other of the grooves 55 and 56. The contacts 50 comprise part of an additional switch supported by the housing part 11*b*, which switch has a movable blade 57 which may be actuated in either direction to close one portion of the switch. It is apparent that the actuating portion of this switch is movable in a direction generally parallel to the axis of the shaft 51. To simplify FIG. 2, the details of the switch structure having the contacts 50 has been simplified. However, it is apparent from FIGS. 6 and 7 that the contacts 50 may be either opened or closed by a pushing or pulling force applied to the shaft 51. Thus, as suggested by FIG. 2, either half of the double-pole structure shown in FIG. 6 and FIG. 7 may be omitted. By the proper omission, the contacts 50 may be made to close in response to pushing or may be made to open in response to an axial pushing force applied to the shaft 51.

To transfer the axial force from the shaft 51 to the blade 57 there is provided a switch actuating lever 58 best seen in FIG. 2. The housing 11*b* has an aperture corresponding in size to the cross-sectional configuration of the lever 58 so that one end 59 projects into such aperture to be pivotally and slidably retained by the housing. The other end 60 thereof is the free end which is drivingly engageable with the actuating portion of the blade 57. Intermediate the ends 59 and 60, the lever 58 is provided with a generally C-shaped slot 61, spaced from the pivoted end 59. The opening 62 in the slot is slightly narrower than the diameter of the shaft in the groove 54, so that when the parts have been forced or snapped together as shown in FIGS. 6 and 7, they will resist becoming disconnected. Thus as the shaft 51 is moved axially, it applies a force to an intermediate portion of the actuating lever 58 which, in turn, operates or moves the switch blade 57. A switch which is responsive to axial shaft movement is typically employed in a washing machine to be a line switch or a master switch, and therefore is appropriately connected in the circuit, and is not necessarily under the control of one of the tracks on the sequential cam 14.

Certain structure is provided to hold the shaft 51 in an axial position which has been selected, such structure being generally indicated by the numeral 63 in FIGS. 6 and 7, and cooperating with the grooves 55, 56 of the shaft 51. A wall in the housing portion 11*b* is provided with a pair of slotted apertures 64, 65 respectively disposed on opposite sides of the shaft 51. The same wall is also provided with a nest or recess 66, at least one of the apertures 64, 65 and the shaft 51 extending transversely therethrough. In the bottom of the nest, there is provided a U-shaped spring 67 having a closed end 68 which loops about the aperture 64, and having resilient fingers extending to the right of the shaft as shown, the resilient fingers being tangentially receivable in the grooves 55, 56. In FIG. 6, one of the fingers is shown received in the shaft groove 55 to hold the shaft in a lowered position as shown, while in FIG. 7 the same finger is received in the shaft groove 56 to hold the shaft 51 in a raised position. The force of the spring finger is sufficient to insure that the blade 57 will be positively held into or out of closed position, as desired. The fingers of the U-shaped spring 67 are yieldable radially of the shaft, toward and away from the viewer, in response to engaging the cam shoulder of either of the grooves 55, 56 during axial shaft movement. A web 69 extends between the fingers of the spring, and is integral with the wall of the housing 11.

To hold the spring 67 in substantially fixed position, a spring retainer member 70 is disposed within the housing and within the nest 66. The spring retainer member 70 comprises a flat apertured portion through which the shaft 51 extends, which portion is engageable flatwise with the U-shaped spring 67 to hold it in the nest 66. From each end of the flat apertured portion, there is an ear 70*a* which respectively extends through one of the slotted apertures 64, 65. A portion of each of the ears 70*a* thus extends through the wall outwardly of the housing 11, such outwardly extending portion being twisted to prevent withdrawal of the spring retaining member 70. To disassemble the device as previously described, in addition to release of spring clips 22, it is necessary that the ears 70*a* be straightened or untwisted to permit their withdrawal into the housing.

From the foregoing, the operation of the sequential timer is now apparent. When the motor 26 is energized it causes the cam 28 to be driven at a continuous rate, thereby cycling the spray switch contacts 46. Rotation of the cam 28 also effects a gradual storage of energy in the spring 36 when the cam track 30 drives the lever 34 in a clockwise direction, such energy being released periodically by a cam drop to effect an incremental angular advance of the sequence cam 12 driven by the drive mechanism to a predetermined point determined by the structure of the case. The various rises and falls of the different cam tracks 14 are so disposed as to be located approximately midway during such travel, although staggering of the ends which effect cam rises may also be

done under penalty of working to closer dimensions. Thus each of the switches 13 is rapidly opened or closed in response to the high-speed incremental advances of the sequence cam 12. The cam 12 may not be rotated either by the drive mechanism or by manual means in an opposite direction because of the effect of the blade 43. However, both the drive mechanism and the blade 43 permit manual positioning of the sequence cam to a selected point of rotation.

The sequence cam is rotatably guided by the case or housing and is biased by the spring 24 to a fixed axial position regardless of what combination of switches 13 may be actuated. The sequence cam shaft 51 is also utilized as an axially movable shaft to actuate the line switch blade 57 through the novel switch actuating lever 56, the shaft 51 being provided with novel structure for holding it in a predetermined axial position within which the sequence cam may be rotated, there being but a single shaft.

Upon disconnection of the spring clips 22, and straightening of the ears 70*a*, the device comes apart as shown in FIGS. 2 and 3, the lever 53 thereby also with a slight force becoming disconnected from the shaft to permit removal of the cam from the shaft 51. This type of structure facilitates the substitution of different program cams. Further, when the structure is disassembled to the condition shown in FIG. 2, the cam 28 may also be manually removed, the lever 34 being manually held out of the way. This further permits the substitution of a different stepping or spray cam 28.

Although various minor modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such embodiments as reasonably and properly come within the scope of our contribution to the art.

We claim as our invention:

1. A switch mechanism for opening and closing a plurality of circuits in predetermined sequence, comprising in combination: a housing; a disc-like sequence cam rotatably supported in said housing and having a series of radially spaced axially directed tracks on an axially directed face thereof; a series of switches within said housing and each constructed to be connected into one of said circuits, each of said switches including a movable cam follower biased in a direction parallel to the axis of said sequence cam against one of said tracks, each of said switches being secured to said housing so that the cam followers jointly define four substantially radial lines of engagement with said tracks, said lines of engagement each being defined by a plurality of said cam followers and being angularly spaced from adjacent lines of engagement by about 90°; said cam followers each being operative to open and close its switch in response to rotation of said sequence cam; said housing having abutment means adjacent to the periphery of said disc-like sequence cam at the outer end of each of said lines of engagement, said means defining a plane adjacent to peripheral portions of one side of said cam and normal to the rotational axis thereof; and a spring acting between said housing and said disc-like cam and continually urging said cam axially directly against said abutment means, no matter what combination of said switches are being actuated.

2. A switch mechanism for opening and closing a plurality of circuits in predetermined sequence, comprising in combination: a housing; a sequence cam rotatably supported in said housing and having a series of tracks thereon; means holding said cam in an axially fixed position; a series of switches within said housing and each constructed to be connected into one of said circuits, each of said switches including a movable cam follower, each of said switches being secured to said housing so that the cam followers jointly engage with said tracks to effect switch operation in response to rotation of said sequence cam; a single rotatably supported axially slidable shaft carried by said housing and having rotational driving engagement directly with said sequence cam, said shaft having a circumferential groove on one side of said sequence cam; an additional switch carried by said housing, said switch having an actuating portion movable in a direction generally parallel to the axis of said shaft; and a switch actuating lever, one end of said lever being pivotally retained by said housing and its other end being free and drivingly engageable with said actuating portion of said additional switch, said lever having an intermediate portion received in said shaft groove, whereby said additional switch is actuable in response to axial movement of said shaft.

3. A switch mechanism for opening and closing a plurality of circuits in predetermined sequence, comprising in combination: a housing; a sequence cam rotatably supported in said housing and having a series of tracks thereon; means holding said cam in an axially fixed position; a series of switches within said housing and each constructed to be connected into one of said circuits, each of said switches including a movable cam follower, each of said switches being secured to said housing so that the cam followers jointly engage with said tracks to effect switch operation in response to rotation of said sequence cam; a single rotatably supported axially slidable shaft carried by said housing and having rotational driving engagement directly with said sequence cam, said shaft having a circumferential groove on one side of said sequence cam; an additional switch carried by said housing, said switch having an actuating portion movable in a direction generally parallel to the axis of said shaft; and a switch actuating lever, one end of said lever being pivotally and slidably retained by said housing and its other end being free and drivingly engageable with said actuating portion of said additional switch, said lever having a C-shaped slot spaced from said one end and snapped onto said shaft at said circumferential groove, whereby said additional switch is actuable in response to axial movement of said shaft.

4. In a switch mechanism having a single shaft rotatably supported in a housing for opening and closing a plurality of circuits in predetermined sequence, said shaft being also axially slidably supported in the housing for opening and closing a circuit at any angular position thereof, the improvement comprising in combination therewith: means in said housing defining a pair of slotted apertures extending through a wall of the housing on opposite sides of the shaft; means in said housing defining a nest on the inner side of said wall, said shaft and at least one of said slotted apertures extending through said wall at said nest; said shaft having at least one axially directed cam shoulder defining a circumferential recess; a spring disposed in said nest and having at least one resilient finger tangentially receivable in said shaft recess, said finger being yieldable radially of said shaft in response to engagement with said cam shoulder during axial movement of said shaft; and a spring retaining member disposed within said housing, said member having a flat apertured portion slidably receiving said shaft and engageable with said spring to retain it in said nest, and an ear extending from each end of said flat portion respectively through one of said slotted apertures, the outer end of each of said ears being adapted to prevent withdrawal thereof.

5. In a switch mechanism having a single shaft rotatably supported in a housing for opening and closing a plurality of circuits in predetermined sequence, said shaft being also axially slidably supported in the housing for opening and closing a circuit at any angular position thereof, the improvement comprising in combination therewith: means in said housing defining a pair of slotted apertures extending through a wall of the housing on opposite sides of the shaft; means in said hous-

ing defining a nest on the inner side of said wall, said shaft and at least one of said slotted apertures extending through said wall at said nest; said shaft having a pair of circumferentially directed grooves each defined by an axially oppositely directed cam shoulder and another shoulder; a generally U-shaped spring disposed in said nest having its closed end extending about said one slotted aperture, and including a pair of resilient fingers tangentially receivable in said grooves, said fingers being yieldably radially of said shaft in response to engagement with said cam shoulder of either of said grooves during axial movement of said shaft; and a spring retaining member disposed within said housing, said member having a flat apertured portion slidably receiving said shaft and engageable with said spring to retain it in said nest, and an ear extending from each end of said flat portion respectively through one of said slotted apertures, the outer end of each of said ears being adapted to prevent withdrawal thereof.

6. A switch mechanism for periodically opening and closing a plurality of circuits in predetermined sequence, comprising in combination: a housing; a sequence cam rotatably supported in said housing and having a series of radially spaced axially directed tracks on each axially directed face thereof, said cam having ratchet teeth on the periphery thereof; a series of switches within said housing and each constructed to be connected into one of said circuits, each of said switches including a movable cam follower biased in a direction parallel to the axis of said sequence cam against one of said tracks, each of said switches being secured to said housing so that the cam followers jointly define four substantially radial lines of engagement with said tracks on each side of said sequence cam, said lines of engagement being spaced from adjacent lines on the same side of said sequence cam by about 90°, and each being substantially aligned with one of the engagement lines on the other side of said sequence cam; said cam followers each being operative to open and close its switch in response to rotation of said sequence cam; said housing having abutment means adjacent to the outer end of each of said lines of engagement defining a plane adjacent to peripheral portions of one side of said cam and normal to the rotational axis thereof; a spring acting between said housing and said disc-like cam and continually urging said cam axially directly against said abutment means, no matter what combination of said switches are being actuated; a motor-driven cam rotatably supported on said housing in radially offset relation to said sequence cam, and having a peripheral cam track; an intermittent drive mechanism pivotally supported by said housing and reciprocably driven by said peripheral cam track, said mechanism including a dog having one-way driving engagement through a tooth engaging portion thereof with the peripheral teeth of said sequence cam to effect incremental advance thereof, said dog also having an abutment portion; a stop on said housing for engaging said abutment portion of said dog to define the limit of driving movement of said dog and hence also the limit of each incremental advance of said sequence cam; a single rotatably supported axially slidable shaft carried by said housing and having rotational driving engagement directly with said sequence cam, said shaft having a first circumferential groove on one side of said sequence cam, and a second and a third circumferential groove axially spaced therefrom, said second and third grooves each being defined in part by a cam shoulder axially directed away from the cam shoulder of the other of said second and third groove; an additional switch carried by said housing, said switch having an actuating portion movable in a direction generally parallel to the axis of said shaft; a switch actuating lever, one end of said lever being pivotally and slidably retained by said housing and its other end being free and drivingly engageable with said actuating portion of said additional switch, said lever having an intermediately disposed C-shaped slot spaced from said one end and snapped into said shaft in said first groove for effecting actuation of said additional switch in response to axial movement of said shaft; means in said housing defining a pair of slotted apertures extending through a wall of the housing on opposite sides of the shaft; means in said housing defining a nest on the inner side of said wall, said shaft and at least one of said slotted apertures extending through said wall at said nest; a generally U-shaped spring disposed in said nest having its closed end extending about said one slotted aperture, and including a pair of resilient fingers tangentially receivable in said second and third grooves, said fingers being yieldable radially of said shaft in response to engagement with said cam shoulder of either of said second and third grooves during axial movement of said shaft; and a spring retaining member disposed within said housing, said member having a flat apertured portion slidably receiving said shaft and engageable with said U-shaped spring to retain it in said nest, and an ear extending from each end of said flat portion respectively through one of said slotted apertures, the outer end of each of said ears being adapted to prevent withdrawal thereof.

7. A switch mechanism for opening and closing a plurality of circuits in predetermined sequence, comprising in combination: a housing; a disc-like sequence cam rotatably supported in said housing and having a series of radially spaced axially-directed axially-operative tracks on each axially directed face thereof; a series of paired contacts; and support means, secured to said housing, for each of said contacts, and constructed to be connected into one of said circuits, the support means of one of each pair of contacts having a flat elongated movable portion carrying the contact and including a cam follower; said support means being arranged on said housing in eight quadrants divided into four quadrants on each side of said sequence cam with the cam followers thereof directed and biased generally axially of and toward the opposite faces of said sequence cam, all of said support means on each side lying in a substantially common plane; each cam follower in each quadrant being spaced from the rotational axis of said sequence cam by a distance differing from that of the corresponding cam followers in the other three quadrants disposed on the same side of said sequence cam, said cam followers jointly defining four substantially radially extending coplanar lines of engagement with said tracks on each side of said sequence cam, the lines of engagement for each of said eight quadrants each being defined by a plurality of cam followers and being spaced from adjacent lines on the same side of said sequence cam by about 90°, and the four lines of engagement on one side being substantially aligned with the four engagement lines on the other side of said sequence cam so that the cam followers jointly apply a substantially balanced non-rocking force to said sequence cam; said cam followers each being operative to open and close a pair of said contacts in response to rotation of said sequence cam.

8. A switch mechanism for periodically opening and closing a plurality of circuits in predetermined sequence, comprising in combination: a housing; a plurality of switches supported by a portion of said housing and adapted to be connected in said circuits, each of said switches having a cam follower; a disc-like sequence cam rotatably supported in said housing, said cam having ratchet teeth on the periphery thereof and having a plurality of radially spaced tracks on an axially directed face thereof for engagement with the cam followers of said switches and operative to open and to close said switches in response to rotation of said sequence cam; a motor-driven cam rotatably supported on said housing in radially offset relation to said sequence cam

and having a peripheral cam track; an intermittent drive mechanism pivotally supported by said housing and reciprocably driven by said peripheral cam track, said mechanism including a dog having one-way driving engagement through a tooth engaging portion thereof with the peripheral teeth of said sequence cam to effect incremental advance thereof, said dog also having an abutment portion; and a fixed stop integral with said switch supporting housing portion, said stop being abuttable by said abutment portion of said dog to limit the driving movement of said dog and hence also to limit the magnitude of each incremental advance of the said sequence cam to a predetermined angular amount which is independent of any wear of said motor-driven cam of said pivotally supported drive mechanism.

9. A switch mechanism for periodically opening and closing a plurality of circuits in predetermined sequence, comprising in combination: a housing; a plurality of switches supported by a portion of said housing and adapted to be connected in said circuits, each of said switches having a cam follower; a disc-like sequence cam rotatably supported in said housing, said cam having ratchet teeth on the periphery thereof and having a plurality of radially spaced tracks on an axially directed face thereof for engagement with the cam followers of said switches and operative to open and to close said switches in response to rotation of said sequence cam; a motor-driven cam rotatably supported on said housing in radially offset relation to said sequence cam and having a peripheral cam track; an intermittent drive mechanism pivotally supported by said housing and reciprocably driven by said peripheral cam track, said mechanism having one-way driving engagement with the peripheral teeth of said sequence cam to effect incremental advance thereof, said mechanism also having an abutment portion; and a fixed stop integral with said switch-supporting housing portion, said stop being abuttable by said abutment portion of said pivotal mechanism to limit the driving movement of said pivotal mechanism and hence also to limit the magnitude of each incremental advance of said sequence cam to a predetermined angular amount which is independent of any wear of said motor-driven cam or of said pivotally supported drive mechanism.

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