April 23, 1968 P. W. CARSTEN 3,379,894

ADJUSTABLE TIMER FOR A PLURALITY OF STATIONS

Filed June 22, 1965 3 Sheets-Sheet 1

Fig. 1

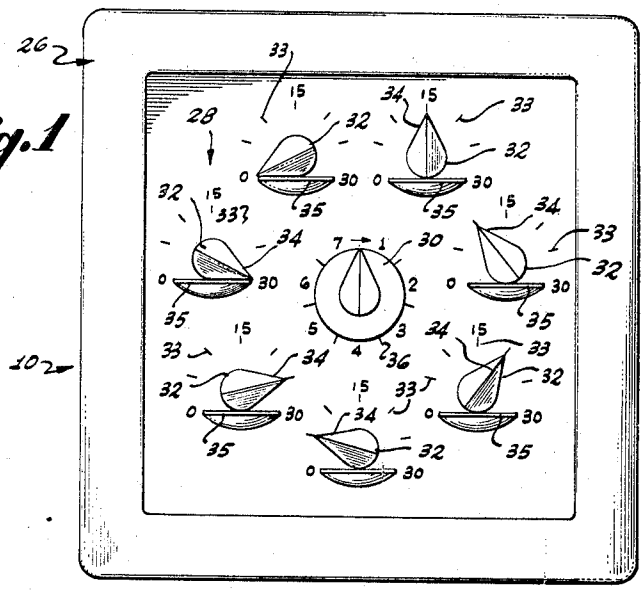

Fig. 2

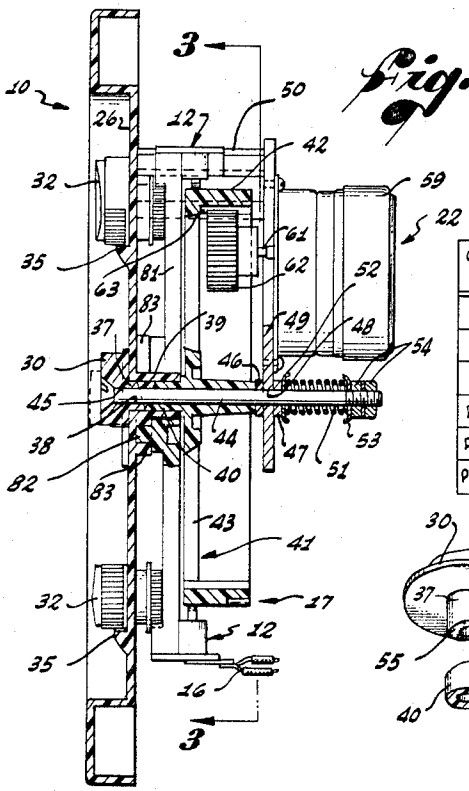

Fig. 3

OPERATION	STATION SWITCH	MASTER SWITCH	LOW SPEED DRIVE	HIGH SPEED DRIVE
OFF	OFF/ON	OFF	OFF	OFF
ON	OFF/ON	ON	ON	ON
TIMING	ON	ON	ON	OFF
POSITION #1	OFF	ON	ON	ON
POSITION #2	OFF	OFF	ON	ON
POSITION #3	ON	OFF	OFF	ON

Fig. 3a

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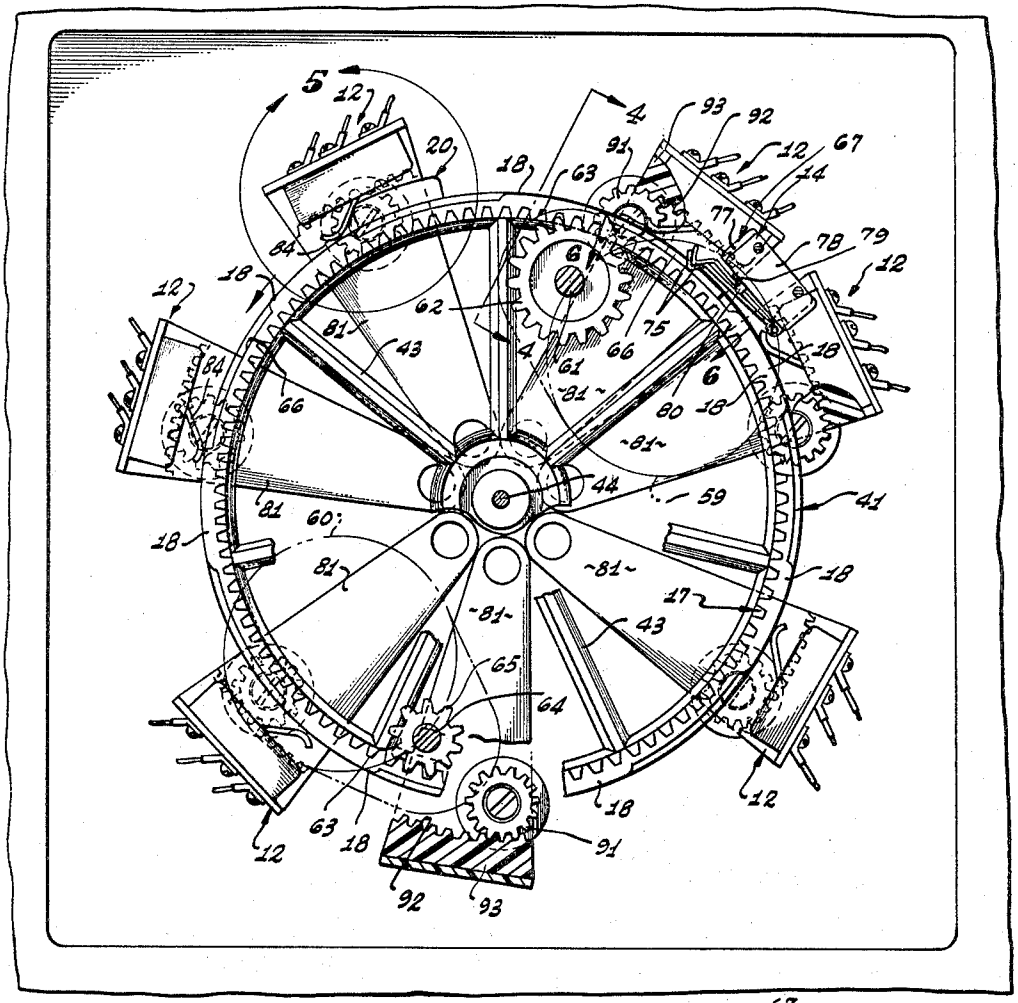

Fig. 3

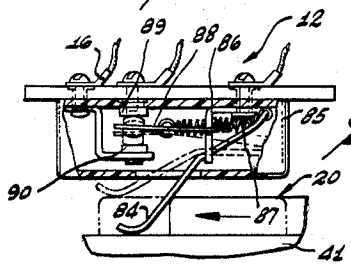

Fig. 5

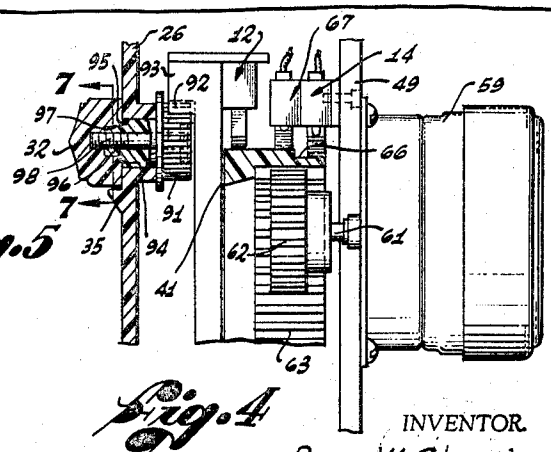

Fig. 4

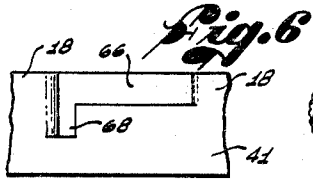

Fig. 6

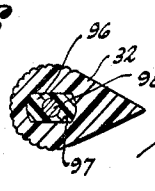

Fig. 7

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ADJUSTABLE TIMER FOR A PLURALITY OF STATIONS

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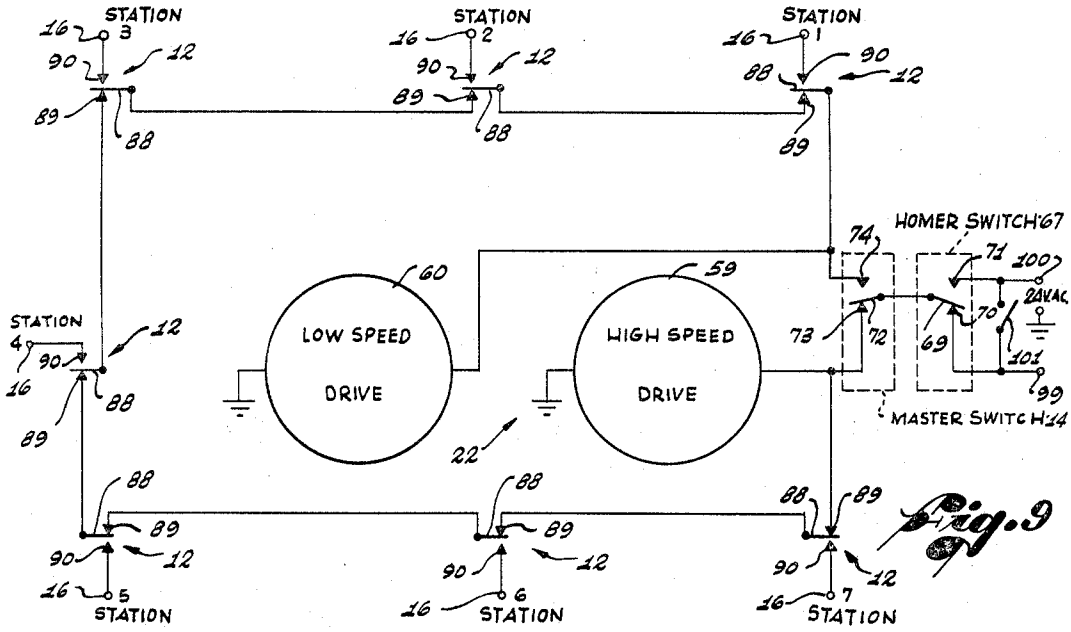

Fig. 9

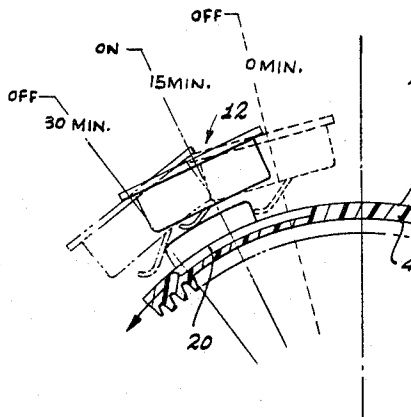

Fig. 10

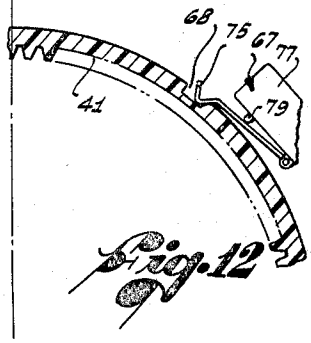

Fig. 12

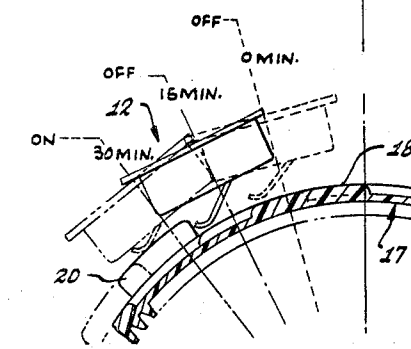

Fig. 11

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3,379,894

ADJUSTABLE TIMER FOR A PLURALITY OF STATIONS

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Filed June 22, 1965, Ser. No. 465,958
20 Claims. (Cl. 307—41)

The present invention relates to timing devices for controlling the sequence of operation and the operating time of a plurality of remote stations and, more particularly, to a novel timer which is adjustable to control the operating time of each station independent of the others.

In various automated systems it is necessary to control the sequence of operation of a plurality of different stations or apparatus. It is also desirable to control the operating time of each station independent of the other stations. An automatic lawn sprinkling system is one such system.

In an automatic lawn sprinkling system, it is desirable to program in advance the sequence of operation of different valves and sprinklers and to individually control their duration of operation. In the past, such control has been provided by timing devices including a combination of an electromechanical timer and a separate electrical power distributor connected to the timer. The conventional timer employed in such combinations includes a plurality of stationary timing units, one for each remote station or valve to be controlled. The units are spaced in an orbital array around a drive shaft and include screw members supported for movement into and out of the orbital path of a timing cam. The cam is connected by a resilient arm to rotate with the drive shaft in a circular path to successively engage the pointed tips of the screws. When the cam contacts a screw tip, the resilient arm is deflected and opens an electrical circuit to a high speed motor which normally turns the drive shaft at a relatively high angular velocity. A low speed motor then takes over to drive the cam over the screw tip for a period of time determined by the degree of projection of the screw tip into the cam path and the rotational velocity of the drive shaft.

The electrical power distributor is connected to and operates with the drive shaft to apply electrical power to different remote stations or valves during the time the cam is engaging the different timing unit screw tips. Therefore, the degree of projection of the timing units into the path of the cam controls the timing operation of the remote stations.

Unfortunately, such conventional timing devices are subject to numerous problems. For example, in order to withstand the friction wear and deformation occurring during normal operation, the timing units, timing cam, and resilient arm are formed of strong, heavy materials. Also, separate gearing is usually employed to connect the drive shaft to the electrical power distributor. These factributor cause the conventional timing devices to be relatively expensive, bulky and complex. Moreover, in practice, such timing devices have been found to require frequent servicing and adjustments.

In view of the foregoing, it is an object of the present invention to provide an improved timer for controlling both the sequence of operation and the operating time of a plurality of remote stations.

Another object of the present invention is to provide an improved timer of the foregoing type which directly and selectively distributes electrical power to remote stations without requiring the use of a separate distributor.

A further object of the present invention is to provide a relatively inexpensive, compact, durable and long lasting timer for controlling the operation of a plurality of remote stations.

The foregoing as well as other objects and advantages of the present invention may be more clearly understood by reference to the following detailed description when taken with the drawings which, by way of example only, illustrate one form of timer embodying the features of the present invention.

In the drawings:

FIGURE 1 is a front view of the timer;

FIGURE 2 is a sectional side view of the timer;

FIGURE 3 is a sectional rear view taken along the line 3—3 in FIGURE 2;

FIGURE 3*a* is a fragmentary perspective view of the central control knob of the timer;

FIGURE 4 is a fragmentary sectional view taken along the line 4—4 in FIGURE 3;

FIGURE 5 is an expanded sectional view of the portion within the circle 5 shown in FIGURE 3;

FIGURE 6 is a fragmentary sectional view taken along the line 6—6 in FIGURE 3;

FIGURE 7 is a sectional view taken along the line 7—7 in FIGURE 4;

FIGURE 8 is a chart depicting the condition of various elements of the timer during different operations thereof;

FIGURE 9 is a wiring diagram of the timer;

FIGURE 10 is a schematic view illustrating the relative positions of a master switch and station switch of the timer with the master switch ready to operate and the station switch in various angular positions relative to the master switch in accordance with the operating time to be provided for apparatus connected to the station switch;

FIGURE 11 is a schematic view similar to FIGURE 10, with the master switch operated and the station switch in the various positions corresponding to those indicated in FIGURE 10; and

FIGURE 12 is a schematic view of a homer switch for the timer shown in an off condition.

In the drawings, the timer is represented generally by the numeral **10** and will be described in an automatic lawn sprinkler setting.

Generally speaking, the timer **10** includes a plurality of station switches **12** spaced from each other and from a master switch **14**. Each station switch **12** is connected to a different output terminal **16** and in a series loop with the master switch **14** such that simultaneous operation of the master switch and a station switch completes an electrical circuit from a power source (not shown) to an electrically controlled valve (not shown) connected to the output terminal **16** of the operated station switch. In this respect, the master switch **14** is repeatedly operated for predetermined periods of time by a removable array **17** of master switch operating means **18** while the station switches **12** are successively operated for predetermined periods of time by a station switch operating means **20** driven with the array **17** by a variable speed drive **22**.

Each station switch **12** is adjustable to vary its spacing from the master switch **14**. Thus, the operating time of each station switch **12** can be advanced or retarded relative to an operating time of the master switch **14** such that there is either a total, partial or no overlap of master switch and station switch operating times during which electrical power is supplied to the output terminal **16** of the station switch to energize its associated valve. Accordingly, by adjusting the position of the station switches **12** relative to the master switch **14**, the sequence of valve operation may be programmed and the operating time of each valve controlled independent of the other valves.

In addition, during the time electrical power is supplied to an output terminal **16** to energize a valve, the

variable speed drive 22 slows from a relatively high speed to provide a relatively slow timing drive for the switch operating means. This allows the valves to be successively operated for controlled amounts of time with a minimum time lapse between scheduled operations.

Referring more particularly to FIGURES 1 and 2, the timer 10 has a front panel 26 adapted for mounting in a wall to support a number of manually adjustable controls 28 of the timer within easy reach of its operator. The front panel 26, controls 28, and many of the moving parts of the timer 10 are preferably formed of a plastic material to reduce the over-all weight and cost of manufacture of the timer, as well as to resist possible rusting when exposed to the atmosphere. Also, the outer rim of the front panel 26 and the indicia carried thereby may be plated with a metal, such as chrome, to improve the outward appearance of the timer and to make the indicia stand out from the panel for clear reading.

The controls 28 allow the operator to program the operating sequence and operating times of the valves connected to the output terminals 16 of the timer 10 and include a central dial 30 and seven station or valve control knobs 32 evenly spaced in a circle around the central dial. Each control knob 32 is connected to a different station switch 12 for turning in either a clockwise or counterclockwise direction to advance or retard the operating time of the station switch relative to the master switch 14, thereby selectively controlling the operating time of the valve connected to the station switch.

To provide a clear indication of the operating time for each valve, the front panel 26 carries a scale 33 around each knob 32, graduated from zero to thirty minutes. Also, each knob 32 has a pointed extension 34 for moving along an associated scale 33 with a turning of the knob to point at the operating time for the associated valve. The degree of rotation of each knob 32 is limited by a lip 35 extending from the front panel to engage the extension 34 of the knob when directed toward the zero and thirty of the associated scale 33.

The front panel 26 also includes a scale 36 around the central dial 30, divided into seven sectors (1 to 7), each corresponding to a different knob 32 and hence a different station switch 12 for the timer 10. The central dial 30 is adapted to rotate upon operation of the timer and to point toward the numeral indicative of the station switch then in operation.

The central dial 30 also may be manually turned in a clockwise direction to modify the programmed operation of the timer 10 or to select a particular station switch 12 for operation. To this end, the dial 30 is connected to the array 17 of master switch operating means 18 and to the station switch operating means 20 to turn the array with a manual turning of the dial in a clockwise direction.

A manual turning of the dial 30 in a counter-clockwise direction, however, has no effect upon the programmed operation of the timer 10. In fact, the dial 30 is free to turn independent of the array 17 and station switch operating means 20 with a manual turning in a counterclockwise direction. This allows the operator to manually reprogram the timer 10 by turning the dial 30 in one direction and insures that the timer will not be damaged by an inadvertent turning of the dial in an opposite direction.

To accomplish this, a sleeve 37 extends from a rear face of the dial 30 through a central opening 38 in the front panel 26 into a slightly larger sleeve 39 extending from the back of the panel. The rearwardly extending sleeve 39 also receives a forward end of a tubular control shaft 40 of the array 17, here preferably taking the form of a cam carrying wheel 41 having an outer rim 42 connected to the central shaft 39 by a plurality of radially extending spokes 43. The sleeve 37 and shaft 40 are free to rotate within the sleeve 39.

The shaft 40 extends forward and rearward of the wheel 41 and is adapted to receive a flatheaded bolt 44. The head of the bolt 44 is seated within the end of a central opening 45 in the dial 30 and the body of the bolt extends through the opening in the dial, the sleeve 37, and the tubular shaft 40. From the shaft 40 the bolt extends rearward through a pair of washers 46 and 47 stationed on opposite sides of an opening 48 in a vertical, motor supporting plate 49 connected to the front panel 26 by a pair of horizontal arms 50. Beyond the washers 46 and 47, the end of the bolt 44 passes through a coil spring 51 and a pair of spring retainers 52 and 53 located on either end of the spring. The spring combination is secured in place by a pair of nuts 54 on the end of the bolt. The nuts 54 press against the rear spring retainer 53 to compress the coil spring aaginst the forward spring retainer 52 and support plate 49. This, in turn, produces an axial force on the bolt 44 urging the rear end of the dial sleeve 37 tightly against the front end of the shaft 40.

As illustrated most clearly in FIGURE 3*a*, the rear end 55 of the sleeve 37 is spiral shaped, spiralling rearwardly in a counterclockwise direction with a diametric shoulder 56 connecting the beginning and end of the spiral. The front end 57 of the shaft 40 is also spiral shaped, spiralling rearwardly in a counterclockwise direction with a diametric shoulder 58 extending between the beginning and end of the spiral. The spiral shaped ends 55 and 57 mate with each other such that the shoulders 56 and 58 lock against each other and a turning of the dial 30 in a clockwise direction produces a similar rotation of the shaft 40 and the wheel 41. This produces a clockwise rotation of the array 17 and station switch operating means 20 to manually program or re-program the operation of the timer 10 and to enable an operator to manually select which station switch 12 is to be operating.

A turning of the dial 30 in an opposite or counterclockwise direction, however, separates the shoulder 56 from the shoulder 58 on the shaft 40 to disengage the dial 30 from the shaft. The spiral shaped end 55 of the sleeve 37 then rides over the spiral shaped end 57 of the shaft 40 and moves axially with the bolt 44 relative to the shaft.' The coil spring 51 accommodates such movement and returns the dial 30 into positive connection with the shaft 40 upon the operator's release of the dial. The coil spring thus provides means for automatically reindexing the dial 30 to indicate the proper operating condition for the timer 10 despite an improper turning of the dial by its operator.

During operation of the timer 10, the wheel 41 is driven by the variable speed drive 22, here comprising a relatively high speed synchronous motor 59 and a relatively low speed synchronous motor 60, both connected to and supported by the motor carrying plate 49. The output shaft 61 of the high speed motor 59 carries a relatively large spur gear 62 mating with an annular ring of inwardly directed teeth 63 extending from the outer rim of the wheel 41. Similarly, the output shaft 64 of the low speed motor 60 carries a relatively small spur gear 65 which also mates with the ring of teeth 63 diametrically opposite the high speed motor 59. The motors are arranged such that operation of the high speed motor 59 overrides the low speed motor 60 to turn the wheel 41 at a relatively high angular velocity while operation of the low speed motor 60 alone turns the wheel at a relatively low angular velocity. As will be described in greater detail, the wheel 41 is driven by the low speed motor 60 alone during the timer operation of the timer 10 and by the high speed motor 59 between timing operations to produce relatively long periods of timing operation, here up to thirty minutes, with a minimum turning of the wheel 41, and a minimum time lapse between successive timing operations.

In addition to the ring of teeth 63, the wheel 41 car-

ries both the plurality of master switch operating means 18 and a station switch operating means 20. Preferably, the master switch operating means 18 takes the form of a plurality of raised, arcuate cams, each having a smooth outer surface. The cams 18 are spaced evenly around the rearmost annular portion of rim of the wheel 41 to define arcuate recessed areas 66 therebetween. There is one cam 18 for each station switch 12.

The station switch operating means 20 preferably takes the form of a generally rectangular raised cam extending from the forwardmost portion of the periphery of the wheel 41. The length of the cam 20 is less than the length of the master switch operating cams 18 to insure that the station switches 12 are operated for a shorter duration of time than the master switch 14.

As most clearly illustrated in FIGURE 5, the master switch 14 and a homer switch 67 are connected side by side and to the motor supporting plate 49. The master switch 14 is stationed directly over the series of master switch operating cams 18. The homer switch is stationed between the master switch and the forward edge of the wheel 41 over the circular path traveled by a notch 68 in the wheel 41 located adjacent the leading edge of one of the master switch operating cams 18, (see FIGURE 6).

The structure of the homer switch 67 is similar to the master switch 14 and as represented diagrammatically in FIGURE 9 includes a switch arm 69 normally contacting a first terminal 70 and movable from the first terimnal to contact a second terminal 71. The master switch 14 is similar, including a switch arm 72 normally contacting a first terminal 73 and movable therefrom to make contact with a second terminal 74. The switch arm 72 of the master switch 14 is electrically connected to the switch arm 69 of the homer switch 67.

The movements of the switch arms 69 and 72 of the homer and master switches are controlled by spring arms 75 and 76 (see FIGURE 3) connected to the housings 77 and 78 of the switches. Actuating pins 79 and 80 extend from the housings 77 and 78 and are connected to the switch arms 69 and 72, respectively, within the associated housings. Normally, the spring arms 75 and 76 are spaced from the actuating pins and the switch arms 69 and 72 are contacting their associated first terminals. Movement of the spring arms to depress the actuating pins 79 and 80, however, causes the switch arms 69 and 72 to move to the second terminals 71 and 74. More particularly, referring to FIGURES 3 and 4, the spring arm 75 of the master switch 14 rides over the annular portion of the wheel rim including the series of master switch operating cams 18. The spring arm 76 of the homer switch 67 rides over the annular portion of the wheel including the notch 68. When the spring arm 75 is between cams 18, the master switch is in its normal condition with the switch arm 72 making contact with the first terminal 73. Similarly, when the spring arm 76 lies in the notch 68, the homer switch is in its normal condition with its switch arm 69 making contact with the first terminal 70. However, when the spring arm 75 engages a cam 18, it moves upwardly to engage the pin 79 and causes the switch arm 72 to break contact with the first terminal 73 and make contact with the second terminal 74. This defines an operating condition for the master switch which continues for a predetermined period of time controlled by the length of the cam 18 and the angular velocity of the wheel 41. Similarly, when the spring arm 76 rides out of the notch 68 with a turning of the wheel 41, the spring arm engages the pin 80 causing the switch arm 69 of the homer switch 69 to move from its first terminal to its second terminal 71 and remains in that position for a complete revolution of the wheel, at which time the spring arm 76 again drops into the notch.

The structure of each station switch 12 is substantially the same and is illustrated most clearly in FIGURE 5. As represented, the station switch 12 includes a switch actuating arm 84 extending from the housing 85 of the switch and pivoted about the end of a support bracket 86 connected to the top of the switch housing. The end of the actuating arm 84 within the housing 85 is connected to one end of a spring 87 having its other end connected to the movable switch arm 88 of the station switch. The movable switch arm 88 is cantilevered from the supporting bracket 86 and normally makes electrical contact with a first terminal 89. When the switch actuating arm 84 contacts the station switch operating cam 20, it is pivoted in a clockwise direction relative to the bracket 86, causing the end of the spring 87 to move downwardly and to move the switch arm 88 from the first contact to a second terminal 90, as illustrated in phantom outline. The second terminal 90 is electrically connected to an output terminal 16 for the timer and hence to a valve controlled by the timer. When the switch actuating arm 84 drops off the station switch operating cam 20, the spring 87 returns the switch arm 88 to its normal position against the first terminal 89. The opertaing time for the station switch 12 is thus determined by the length of the station switch operating cam 20 and the angular velocity of the wheel 41.

The seven station switches 12 of the timer 10 are evenly spaced around the periphery of the wheel 41 and are supported for limited movement along the circular path traveled by the station switch operating cam 20 to selectively adjust and control the angular spacing of the station switches relative to the master switch and, as previously described, thereby control the operating time for valves connected to the station switches. In this regard, each station switch 12 is carried over forwardmost annular portion of the wheel 41 including the cam 20 by a support arm 81 extending along the back of the front panel 26 radially away from the shaft 40 of the wheel 41. The arms 81 are connected to the back of the panel 26 around the shaft and are free to pivot about the connection points to move the station switches 12 along the arcuate path of travel of the station switch operating cam 20. To this end, a pin 82 (see FIGURE 3) extends forward from the innermost radial portion of each support arm 81 and is received in a collar 83 extending from the rear face of the front panel 26. The collars 83 are spaced from each other in a circular array around the rearwardly extending sleeve 39 and tightly receive the pins, yet allow rotation of the pins with the arms 81.

The movement of each station switch 12 along the path of travel of the cam 20 as well as the angular position of each station switch 12 relative to the master switch 14 is under the control of a control knob 32 on the front of the panel 26. In particular, each knob 32 is connected to a different station switch 12. The connection for each knob 32 is most clearly illustrated in FIGURE 4, and includes a spur gear 91 for mating with a sector gear 92 carried by a forwardly extending arcuated flange 93 of the station switch support arm 81 (see FIGURE 3). A tubular stub shaft 94 extends through and forward from the spur gear 91 and is supported within an opening 95 in the front panel 26 immediately behind the knob 32. The forward end of the stub shaft 94 includes a generally rectangular extension 96 seated within a similarly shaped recess 97 in the knob 32 to support the knob on the end of the shaft. A screw 98 extends through the stub shaft 94 and into the knob 32 to tightly hold the knob against the shaft for turning therewith.

Accordingly, a manual turning of the knob 32, either in clockwise or counterclockwise direction, produces a turning of the spur gear 91 to, in turn, pivot the support arm 81 and move its associated station switch 13 along the circular path of travel of the station switch operating cam 20. The degree of rotation of the knob 32 is limited to less than 270° by the lip 35 below the knob. This insures that the spur gear 91 will not run off the sector gear 92 and defines the limits of movement for the station switch 12 along the wheel 41 relative to the master

switch 14. Also, by turning the screw 98, the pressure of the knob 32 against the front panel 26 can be controlled such that sufficient friction forces are developed between the knob and the panel to resist a turning of the knob when the station switch operating cam 20 engages the actuating arm 84 for the switch 12.

In the timer 10, the station switches 12, master switch 14, homer switch 67, and high and low speed motors 59 and 60 are electrically connected as illustrated in FIGURE 9. In particular, the first terminal 70 of the homer switch 67 is connected to an input terminal 99 for receiving a relatively short duration starting pulse such as that developed by the programmer described and claimed in the copending patent application Ser. No. 465,889 filed on even date herewith, now Patent No. 3,324,257. The second terminal 71 of the homer switch 67 is connected to a second input terminal 100 connected to a 24-volt AC source. A manual starting switch 101 is connected between the first and second terminals to provide means for manually initiating the start of the timer 10.

The station switches 12 are connected in a series loop with the master switch 14 and are adapted to operate to complete electrical circuits from the master switch to the various output terminals 16 for the timer. In this regard, the switch arm 88 of the station switch for station 1 is connected to the second terminal 74 of the master switch 14. The switch arms 88 for the remaining station switches 12 are connected to the first terminal 89 of the immediately preceding station switches in the series loop and the first terminal of the last station switch connected to the first terminal 73 of the master switch, while the second terminal 90 of each station switch 12 is connected to a different output terminal 16.

To complete the circuit arrangement, the high speed motor 59 is connected to the first terminal 73 of the master switch and to ground, and the low speed motor 60 to the second terminal 74 of the master switch and to ground.

In operation, and referring particularly to FIGURES 8–21, the timer 10 is initially in an "off" condition. In the "off" condition, the station switch 12 for station 1 is either in an "on" or "off" condition, depending upon the angular position of the station switch relative to the master switch. In particular, in the illustrated form, with the timer off, the station switch 12 for station 1 is in an "on" condition with its switch arm 88 contacting its second terminal 90 for all angular positions except when the station switch is set to energize the output terminal 16 for between approximately twenty and thirty minutes. Within this range, the station switch is in an "off" condition. Also, with the timer off, the master switch 12 is off and, of course, the homer switch 67 is also off.

When a short duration starting pulse is received by the input terminal 99, or when the manual switch 101 is closed, electrical energy is applied to the first terminal 70 of the homer switch 67 and through the switch arms 69 and 72 of the homer and master switches and the high speed motor 59 to ground. If the station switch 12 for station 1 is in an "off" condition, an electrical circuit is also completed through the series loop to the low speed motor 60. In either case, the high speed motor 59 controls, and starts to drive the wheel 41 in a clockwise direction. As this occurs, the homer switch 67 moves along the notch 68. At the trailing edge of the notch, the homer switch 67 is actuated to move the switch arm 69 to contact the second terminal 71 (see FIGURE 12). This breaks the circuit from the input terminal 99 and connects the timer 10 directly to the 24-volt source. The master switch 14 is still in an "off" condition and a circuit is now completed from the 24-volt source to the high and low speed motors 59 and 60 as before.

Continued movement of the wheel 41 brings a master switch operating cam 18 adjacent the spring arm 76 of a master switch 14 (see FIGURE 10). The master switch then switches to an "on" condition with its switch arm 72 moving from the first terminal 73 to the second terminal 74. This is the "on" condition depicted in the chart of FIGURE 8.

In the "on" condition, electrical power is applied directly to the low speed motor 60 through the homer and master switches. Also, if all the station switches 12 are in an "off" condition, an electrical circuit is completed to the high speed motor 59 which continues to override the low speed motor 60. However, if the station switch 12 of station 11 is operating when the timer assumes its "on" condition, the circuit to the high speed motor 59 is not completed and the low speed motor 60 drives the wheel 41 in a clockwise direction for a predetermined period of time.

During the time the station switch 12 of station 1 is operating, electrical power is applied from the 24-volt source through the homer and master switches to the output terminal 16 of the station switch 12 and hence to the valve connected thereto. This condition for the timer is represented in the chart as the "timing" operation and continues while the master switch 14 and station switch 12 are both operating. This, of course, is controlled by the angular position of the station switch 12 relative to the master switch 14 and the angular velocity of the wheel 41 as driven by the low speed motor.

The relative angular positions of the station switch 12 for station 1 relative to the master switch 14 and the operating times for the valve connected to the station switch are diagrammatically represented in FIGURE 10. Thus, when the master switch 14 is ready to operate, the station switch 12 is in the various positions illustrated corresponding to the valve operating times represented. In particular, when the control knob 32 is set for 15 minutes, the station switch 12 is riding on the station switch operating cam 20. When the knob is set for 30 minutes operating time, the station switch 12 is at the leading edge of the cam 20 and in an "off" condition. When the station switch 12 is set for zero operating time, the station switch is already off the trailing edge of the cam 20 and the station switch remains in its normal condition throughout the timer period for which the master switch is operated.

The low speed motor is adapted to drive the wheel 41 at an angular velocity such that 30 minutes is required for the switch actuating arm 84 to completely traverse the cam 20. Therefore, simultaneous operation of the station switch 12 and master switch 14 with the station switch at the leading edge of the cam produces 30 minutes of valve operation while simultaneous operation with the station switch midway along the cam produces 15 minutes of operation and so on.

In FIGURE 11, the relative angular positions of the master switch 14 and station switch 12 for station 1 after 15 minutes of timing operation are diagrammatically illustrated. As represented, when the station switch 12 is set for 15 minutes operation, it has dropped off the trailing edge of the cam while the master switch 14 is still operating. When set for 30 minutes operation, 15 minutes of operating time still remains.

The phantom outline in FIGURE 11 represents the relative angular positions after 30 minutes of timing operation. In this condition, the master switch 14 is still operating and the station switch 12 has dropped off the trailing edge of the cam for each valve operating time.

When the station switch returns to its normal "off" condition, the timer assumes the "position No. 1" operating condition, represented in FIGURE 8. In particular, with the sttion switch 12 off, a series loop is again completed to energize the high speed motor 59 which again overrides the low speed motor to rapidly drive the wheel 41 in a clockwise direction. As this occurs, the master switch 14 then drops off the trailing edge of its operating cam 18 adn the timer assumes the "position No. 2" operating condition.

In the position No. 2 condition, both the master switch 14 and all station switches 12 are off and the low speed

and high speed motors are on, with the high speed motor driving the wheel **41** at a high angular velocity.

Next, the station switch operating cam **20** engages the actuating arm **84** of the station switch of station **2**. The relative angular positions for the station switch **12** of station **2** and the master switch **14** are again as depicted in FIGURES 10 and 11. Accordingly, if the station switch **12** or station **2** is set for any time of operation other than 30 minutes, it will operate prior to the operation of the master switch **14** and the timer **10** will assume the "position No. 3" operating condition (see FIGURE 8). In this condition, the station switch **12** is "on" and the master switch **14** is off. This breaks the series loop to the low speed motor **60**, which shuts off. The high speed motor is still energized directly through the homer and master switches and continues to drive the wheel **41** at a relatively high angular velocity. When the master switch turns on, the timing operation for station **2** begins and the sequence depicted in the chart of FIGURE 8 is repeated.

It should be noted that if the station switch **12** of station **2** is set for zero time, the station switch will have operated and returned to its normal condition prior to the time the master switch **14** is operated (see FIGURE 10). In this case, the timing operation is skipped for station **2** and the wheel **41** continues to turn at a high angular velocity and the timer **10** advances through positions No. 1 and 2 until the station switch **12** for station **3** is contacted by the station switch operating cam **20**.

This operation is repeated for each of the remaining stations of the timer **10**. Upon the completion of one revolution of the wheel **41**, the spring arm of the homer switch **67** drops into the notch **68**. This returns the switch arm **69** to the first terminal **70**. Since the momentary pulse is no longer applied to the first input terminal **99**, the timer **10** shuts off, assuming that the manual start switch **101** has been opened. The timer then waits for another start pulse or manual operation of the start switch **101** to complete another cycle of operation.

From the foregoing, it is appreciated that the present invention provides an improved timer which overcomes the problems associated with conventional timers. In particular, the timer of the present invention is adapted to directly and selectively distribute electrical power to remote stations without requiring the use of a separate distributor. Also, the timer of the present invention is of a relatively inexpensive, compact, durable and long lasting construction, which in practice has proven to be virtually service free.

While in the foregoing specification a particular form of timer has been described in some detail, changes and modifications, of course, may occur to those skilled in the art. It is therefore intended that the present invention be limited in scope only by the terms of the following claims.

I claim:

1. A timer, comprising:
a plurality of output terminals;
a master switch;
a plurality of station switches connected in a series loop with said master switch, each station switch opening said series loop and connecting to a different output terminal upon operation;
means for applying electrical power to said master switch;
first means for successively operating said master switch for predetermined periods of time to apply electrical power to said series loop;
second means for operating each of said plurality of station switches in succession for predetermined periods of time;
and means for advancing and retarding the operating times of said station switches by said second means relative to the operating times of said master switch by said first means.

2. A timer, comprising:
a plurality of output terminals;
a master switch;
a plurality of station switches conected in a series loop with said master switch, said station switches being spaced from each other and from said master switch and each opening said series loop and connecting to a different output terminal upon operation;
means for applying electrical power to said master switch;
first moving means for successively operating said master switch for predetermined periods of time to apply electrical power to said series loop;
second moving means synchronous with said first moving means for operating each of said plurality of station switches in succession for predetermined periods of time;
and means for individually adjusting the spacing between each of said station switches and said master switch to selectively control the time duration for which said master switch and each station switch are simultaneously operating to apply electrical energy to the output terminal associated with said station switch.

3. A timer, comprising:
a plurality of output terminals;
a master switch;
a plurality of station switches connected in a series loop with said master switch, said station switches being spaced from each other and from said master switch and each opening said series loop and connecting to a different output terminal upon operation;
means for applying electrical power to said master switch;
first moving means for successively operating said master switch for predetermined periods of time to apply electrical power to said series loop;
second moving means synchronous with said first moving means for operating each of said plurality of station switches in succession for predetermined periods of time;
means for individually adjusting the spacing between each of said station switches and said master switch to selectively control the time duration for which said master switch and each station switch are simultaneously operating to apply electrical energy to the output terminal associated with said station switch;
variable speed drive means for said first and second moving means;
and circuit means connected to said variable drive means and said series loop for reducing the drive speed to said moving means when said master switch is operating simultaneously with a station switch.

4. A timer, comprising:
a plurality of output terminals;
a master switch including first and second terminals in a movable switch arm;
means applying electrical power to said switch arm;
a plurality of station switches connected in a series loop between said first and second terminals of said master switch, said station switches being spaced from each other and from said master switch and each opening said series loop and connecting to a different output terminal upon operation;
first movable means for successively moving said switch arm between said first and second terminals of said master switch for predetermined periods of time;
second movable means for operating each of said plurality of station switches in succession for predetermined periods of time;
means for individually adjusting the spacing between each of said station switches and said master switch to selectively control the time duration for which said master switch and each station switch are simul-

taneously operating to apply electrical energy to the output terminal associated with said station switch;

and variable speed drive means connected to said master switch for normally driving said first and second movable means at a relatively high speed and at a relatively low speed when said switch arm is contacting said second terminal of said master switch and one of said station switches is operating.

5. The timer of claim 4 wherein said variable speed drive means includes a high speed drive means connected to said first terminal of said master switch and a low speed drive means connected to said second terminal of said master switch.

6. A timer, comprising:

a master switch including first and second terminals and a movable switch arm;

means applying electrical power to said switch arm;

a station switch spaced from said master switch and including a first terminal connected to said first terminal of said master switch, a second terminal connected to an output terminal for said timer, and a movable switch arm normally contacting said first terminal of said station switch and connected to said second terminal of said master switch;

first movable means for repeatedly operating said master switch by successively moving said switch arm from said first terminal to said second terminal for predetermined periods of time;

second movable means for repeatedly operating said station switch by moving said switch arm of said station switch to contact said second terminal of said station switch for predetermined periods of time;

means for selectively adjusting the position of said station switch relative to said master switch to adjust the time of operation of said station switch relative to the time of operation of said master switch;

and variable speed drive means connected to said master switch for normally driving said first and second movable means at a relatively high speed and at a relatively low speed when said switch arms are contacting said second terminals.

7. A timer, comprising:

a master switch including first and second terminals in a movable switch arm;

means applying electrical power to said switch arm;

first and second station switches spaced from each other and said master switch and each including first and second terminals and a movable switch arm normally contacting its associated first terminal, the second terminal of each station switch being connected to a different output terminal for said timer;

circuit means connecting said switch arm of said first station switch to said second terminal of said master switch, said first terminal of said first station switch to said switch arm of said second station switch to said first terminal of said master switch;

first movable means for repeatedly operating said master switch by successively moving said switch arm of said master switch from said first terminal to said second terminal for predetermined periods of time;

second movable means for repeatedly operating said station switches by successively moving said switch arms of said first and second station switches to their associated second terminals for predetermined periods of time;

means for selectively adjusting the positions of said station switches relative to said master switch to selectively adjust the time of operation of said station switches relative to the time of operation of said master switch;

and variable speed drive means connected to said master switch for normally driving said first and second movable means at a relatively high speed and at a relatively low speed when said switch arm of said master switch is contacting its associated second terminal and one of the switch arms of said station switches is contacting its associated second terminal.

8. The time of claim 7 wherein said variable speed drive means includes a high speed drive means connected to said first terminal of said master switch and a low speed drive means connected to said second terminal of said master switch.

9. In a timer:

a master switch including first and second terminals and a movable switch arm;

means applying electrical power to said switch arm of said master switch;

a station switch spaced from said master switch and including a first terminal connected to said first terminal of said master switch, a second terminal connected to an output terminal for said timer, and a movable switch arm normally contacting its associated first terminal and connected to said second terminal of said master switch;

master switch operating means mounted for movement in a circular path about a central axis;

means supporting said master switch adjacent said circular path of said master switch operating means such that said master switch operating means operates said master switch once each revolution by moving said switch arm of said master switch from its first terminal to its second terminal for a predetermined period of time;

station switch operating means mounted for movement with said master switch operating means in a circular path about said central axis;

means pivotally supporting said station switch for limited movement along said circular path of said station switch operating means such that said station switch operating means operates said station switch about the operating time of said master switch once each revolution by moving said switch arm of said station switch from its first terminal to its second terminal for a predetermined period of time, the operating time of said station switch being less than the operating time of said master switch;

means for selectively adjusting the angular position of said station switch relative to said master switch to adjust the time of operation of said station switch relative to the time of operation of said master switch;

and variable speed drive means connected to said master switch for normally driving said switch operating means at a relatively high speed and at a relatively low speed when said master switch and station switch are operating simultaneously.

10. The combination of claim 9 wherein said variable speed drive means includes a high speed drive means connected to said first terminal of said master switch and a low speed drive means connected to said second terminal of said master switch.

11. A timer, comprising:

a master switch including first and second terminals in a movable switch arm;

means applying electrical power to said switch arm of said master switch;

a plurality of station switches connected by circuit means in a series loop with said master switch, each station switch including first and second terminals and a switch arm normally contacting its associated first terminal, the second terminal of each station switch being connected to a different output terminal for said timer;

said circuit means including means connecting the switch arm of a first station switch of said series loop to said second terminal of said master switch and the switch arms of the remaining station switches to the first terminal of the preceding station switch in said series loop and means connecting the first ter-

minal of a last station switch of said series loop to said first terminal of said master switch;

a plurality of master switch operating means, one for each station switch, spaced evenly from each other in a circular array for turning together about a central axis;

means supporting said master switch adjacent said array such that said array repeatedly operates said master switch upon turning about said central axis by moving said switch arm of said master switch from said first terminal to said second terminal for predetermined periods of time;

station switch operating means movable with said array in a circular path about said central axis;

means pivotally supporting said station switches at evenly spaced intervals for limited movement along said circular path of said station switch operating means such that said station switch operating means operates each station switch once each revolution and about the time of operation of said master switch, by moving the switch arm of each station switch to contact its second terminal for a predetermined period of time;

means for selectively adjusting the angular position of each station switch relative to said master switch to adjust the time of operation of said station switches relative to said master switch;

and variable speed drive means connected to said master switch for normally driving said switch operating means at a relatively high angular velocity and at a relatively low angular velocity when said master switch and a station switch are operating simultaneously.

12. The timer of claim **11** wherein said variable speed drive means includes a high speed drive means connected to said first terminal of said master switch and a low speed drive means connected to said second terminal of said master switch.

13. The timer of claim **11** further including:

a front panel;

a shaft extending from said panel along said central axis for turning with said array of master switch operating means;

a pointer carried by said shaft for movement over a portion of said front panel around said shaft;

a scale on said front panel graduated to indicate the different station switches whereby said pointer indicates which station switch is being operated by said station switch operating means;

a plurality of knobs carried by said front panel in a circular array around said shaft each opposite a different station switch;

means connected to each knob for moving the associated station switch along said circular path of said station switch operating means to adjust the angular position of each station switch relative to said master switch;

and graduated scale means on said front panel around each knob for indicating the time duration which each output terminal will be energized during the revolution of said station switch operating means.

14. The timer of claim **13** including means on said front panel for limiting the degree of turning of each of said knobs to limit the travel of said station switches along said circular path of said station switch operating means.

15. The timer of claim **13** wherein said station switch operating means is a cam means for successively engaging the switch arms of said station switches and wherein said turner includes controllable means for urging said knobs against said panel to prevent movement of said station switches upon engaging said cam.

16. The timer of claim **13** including clutch means for positively driving said shaft with said array of master switch operating means in a first rotational direction and for effectively releasing said shaft from said array to permit turning of said shaft in an opposite rotational direction independent of said array.

17. The timer of claim **16** wherein said clutch means comprises:

a first sleeve extending from said pointer around and connected to said shaft and including a spiral-shaped end with a generally vertical connecting wall between the ends of said spiral;

a second sleeve connected to said master switch actuating means and extending around said shaft and including a spiral-shaped end facing and mating with said spiral-shaped end of said first sleeve;

and spring means normally urging said spiral-shaped ends toward each other.

18. A timer, comprising:

a homer switch including first and second terminals and a switch arm normally contacting said first terminal, said first terminal being adapted to receive a relatively short duration electrical power signal to start said timer and said second terminal being adapted to receive a sustained electrical power signal for sustaining operation of said timer for one complete cycle of operation;

a master switch including first and second terminals and a switch arm normally contacting its associated first terminal and connected to said switch arm of said homer switch;

a plurality of station switches connected by circuit means in a series loop with said master switch, each station switch including first and second terminals and a switch arm normally contacting its associated first terminal, the second terminal of each station switch being connected to a different output terminal for said timer;

said circuit means including means connecting the switch arm of a first station switch of said series loop to said second terminal of said master switch and the switch arms of the remaining station switches to the first terminals of the preceding station switches in said series loop, and means connecting the first terminal of a last station switch of said series loop to said first terminal of said master switch;

a plurality of master switch operating means, one for each station switch, spaced evenly from each other in a circular array for turning together about a central axis;

means supporting said master switch adjacent said array such that said array repeatedly operates said master switch upon turning about said central axis by moving said switch arm of said master switch from its first terminal to its second terminal for predetermined periods of time;

homer switch operating means for operating said homer switch at the beginning and during each revolution of said master switch actuating means about said central axis by moving said switch arm of said homer switch to its second terminal, said homer switch returning to its normal condition at the end of each revolution of said array;

station switch operating means for turning in a circular path with said array about said central axis;

means supporting said station switches at evenly spaced intervals for limited movement along said circular path of said station switch operating means to each operate once each revolution of said station switch operating means and about the time of operation of said master switch;

means for selectively adjusting the angular position of each station switch relative to said master switch to adjust the time of operation of said station switches relative to said master switch;

and variable speed drive means connected to said master switch for normally driving said switch operating means at a relatively high angular velocity and at a

relatively low angular velocity when said master switch and a station switch are operating simultaneously.

19. A timer, comprising:

a homer switch including first and second terminals and a switch arm normally contacting said first terminal, said first terminal being adapted to receive a relatively short duration electrical power signal to start said timer and said second terminal being adapted to receive a sustained electriacl power signal for sustaining operation of said timer for one complete cycle of operation;

a master switch including first and second terminals and a switch arm normally contacting its associated first terminal and connected to said switch arm of said homer switch;

a plurality of station switches connected by circuit means in a series loop with said master switch, each station switch including first and second terminals and a switch arm normally contacting its associated first terminal, the second terminal of each station switch being connected to a different output terminal for said timer;

said circuit means including means connecting the switch arm of a first station switch of said series loop to said second terminal of said master switch and the switch arms of the remaining station switches to the first terminals of the preceding station switches in said series loop, and means connecting the first terminal of a last station switch of said series loop to said first terminal of said master switch;

a plurality of master switch operating means, one for each station switch, spaced evenly from each other in a circular array for turning together about a central axis;

means supporting said master switch adjacent said array such that said array repeatedly operates said master switch upon turning about said central axis by moving said switch arm of said master switch from its first terminal to its second terminal for predetermined periods of time;

homer switch operating means adjacent one of said master switch operating means for turning with said array in a circular path about said central axis and for operating said homer switch at the beginning of and during each revolution of said array;

means supporting said homer switch adjacent said circular path of said homer switch operating means to operate at the beginning of and during each revolution of said array by moving said switch arm of said homer switch to contact its second terminal, said homer switch returning to its normal condition at the end of each revolution of said array;

station switch operating means for turning in a circular path with said array about said central axis;

means supporting said station switches at evenly spaced intervals for limited movement along said circular path of said station switch operating means to each operate once each revolution of said station switch operating means and about the time of operation of said master switch;

means for selectively adjusting the angular position of each station switch relative to said master switch to adjust the time of operation of said station switches relative to said master switch;

and variable speed drive means connected to said master switch for normally driving said switch operating means at a relatively high angular velocity and at a relatively low angular velocity when said master switch and a station switch are operating simultaneously.

20. The timer of claim 19 wherein said variable speed drive means includes a high speed drive means connected to said first terminal of said master switch and a low speed drive means connected to said second terminal of said master switch.

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