United States Patent

Murata et al.

[15] **3,697,770**

[45] **Oct. 10, 1972**

[54] **RECORDING CLOCK AND ELECTRICAL SYSTEM**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**.....**307/141.4,** 200/33 R, 200/38 D

[51] **Int. Cl.**.....**H01h 7/08,** H01h 43/10, H01h 33/59

[58] **Field of Search** .....178/50, 53, 53.1; 179/15; 200/5 E, 33 R, 35 R, 36, 37 R, 38 R, 38 D, 38 DA, 153 J; 307/141, 141.4, 141.8

[56] **References Cited**

UNITED STATES PATENTS

3,342,956	9/1967	Sutherland	307/141.4 X
3,015,003	12/1961	Simmons	200/5 E
2,790,862	4/1957	Montgomery	307/141.8 X
2,938,969	5/1960	Gladden et al.	200/37 R X
3,566,705	3/1971	Frydman	200/153 J UX

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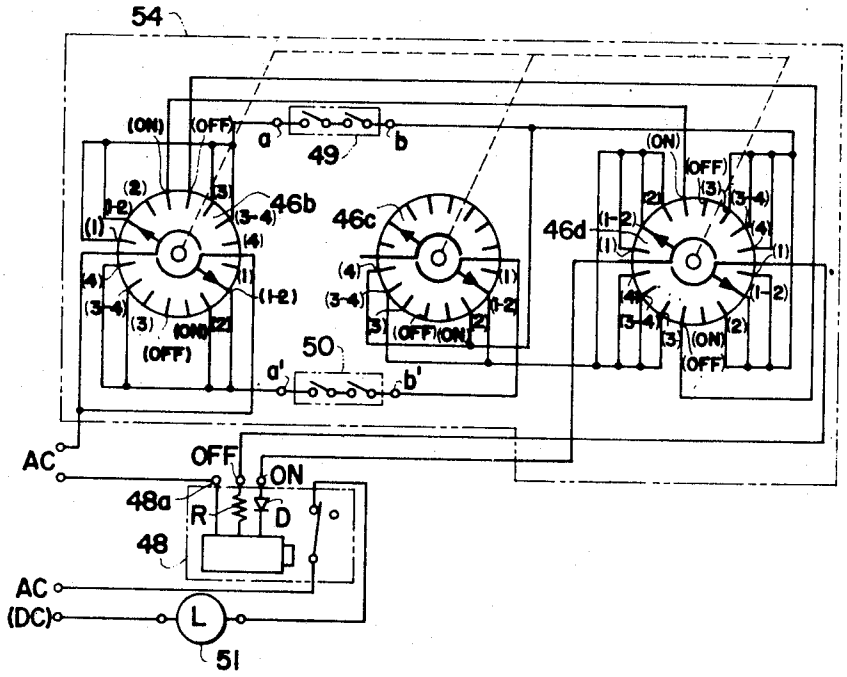
[57] **ABSTRACT**

A multiplex action timer device interlocked with a clock mechanism comprising two pairs of time-setting mechanism arranged so that two pairs of micro-switches are closed at the pre-set time, relay means for controlling make and break of a power switch of a load circuit in accordance with an ON-signal and an OFF-signal, and a control circuit whose connection is switched so as to apply the ON-signal and the OFF-signal to said relay means upon closure of the respective pairs of micro-switches, said timer device being operative so that the power switch of the load circuit is actuated in such a way that its connection is changed — in accordance with the pre-set time — to assume one of the following modes of switching action, namely, from ON to OFF; from OFF to ON; from OFF to ON and then to OFF again and thereafter repeating this cycle; and from ON to OFF and then to ON again and thereafter repeating this cycle.

4 Claims, 10 Drawing Figures



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SHEET 1 OF 3

FIG. 1

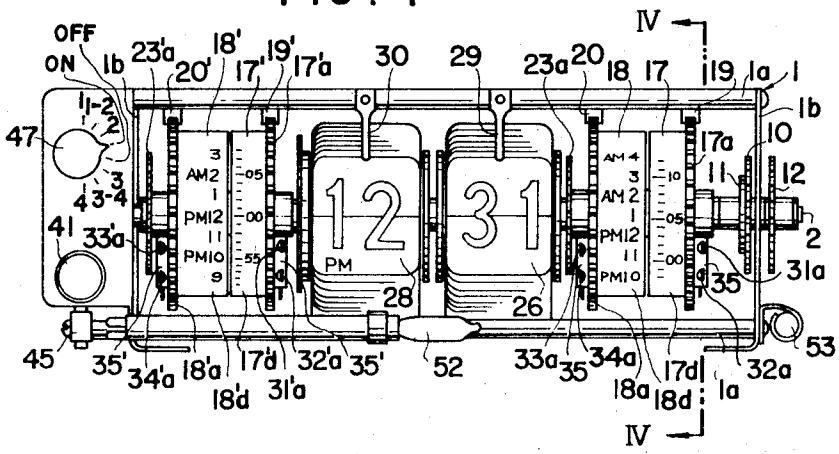

FIG. 2

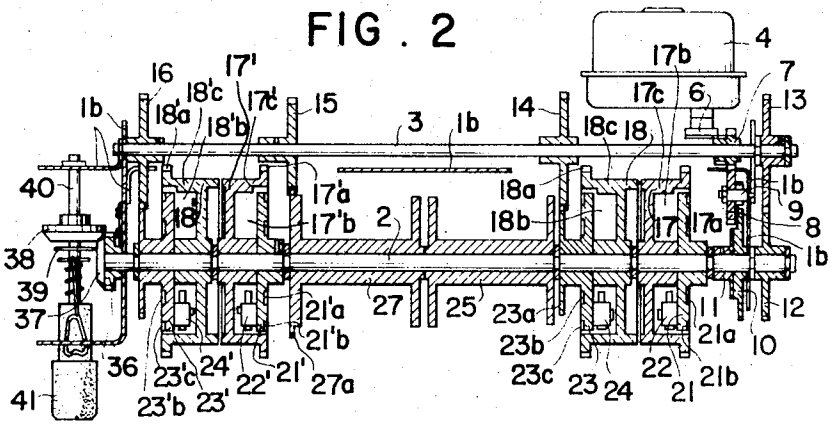

FIG. 3

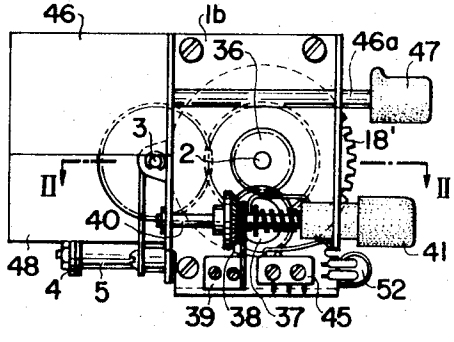

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FIG. 4

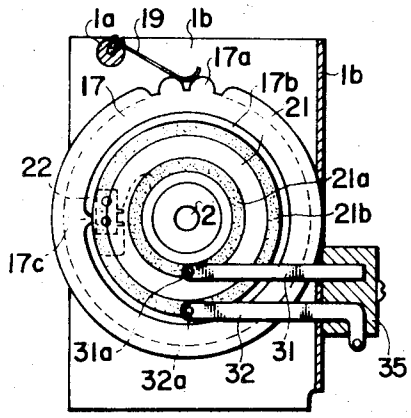

FIG. 5

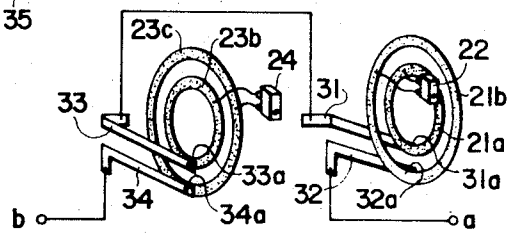

FIG. 6

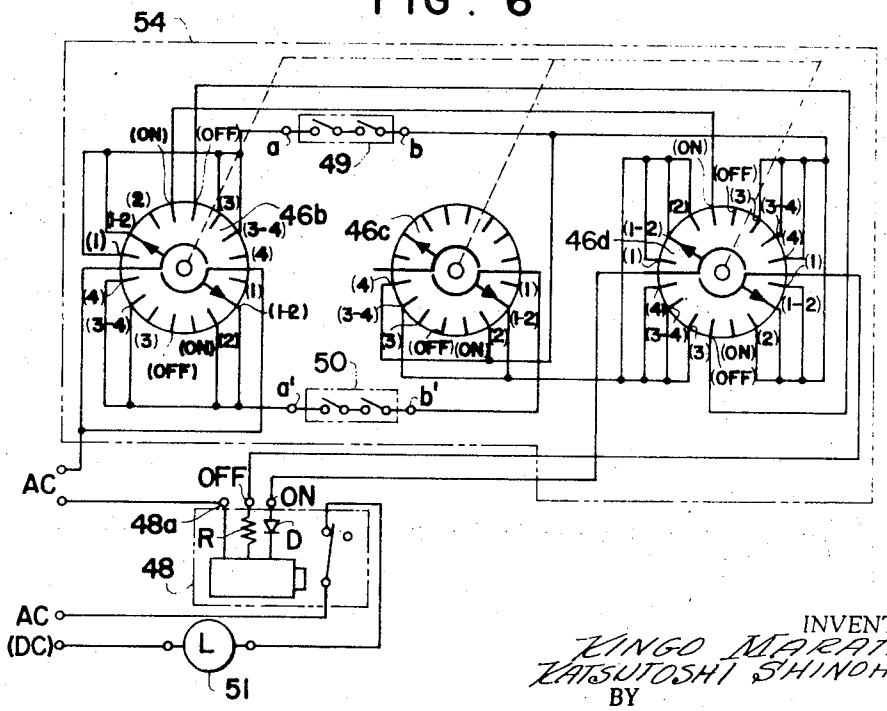

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FIG. 7a

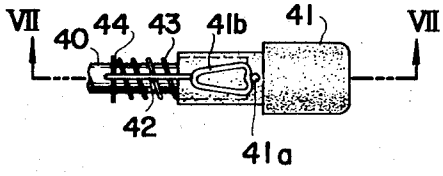


FIG. 7b

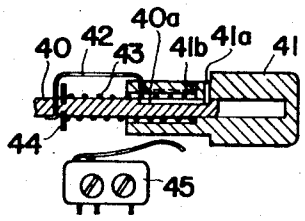


FIG. 7c

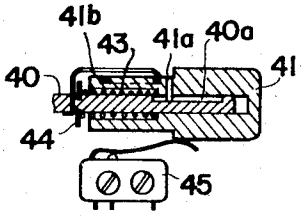
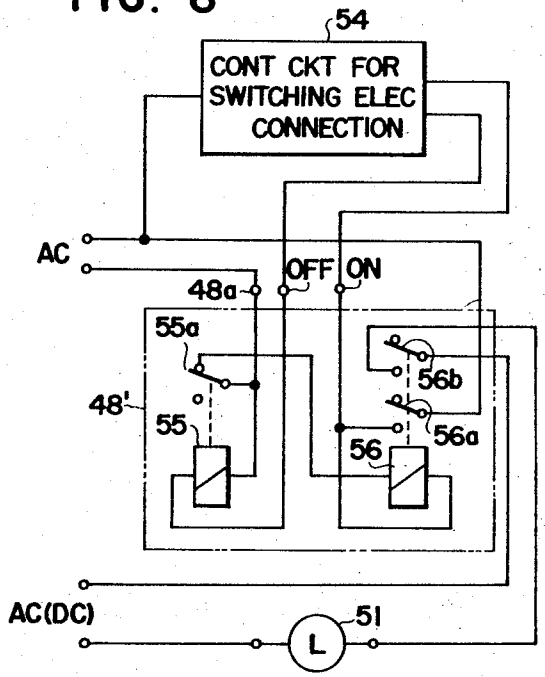


FIG. 8



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RECORDING CLOCK AND ELECTRICAL SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is concerned with a timer device interlocked with a clock mechanism and arranged so as to control a load circuit, and more particularly, it relates to a timer device arranged so that making and breaking of the power switch of the load circuit are controlled in multiplex actions in accordance with a set position of the changeover mechanism at a pre-set time of the time-setting mechanisms which can be set for the unit time of "minute."

2. Description of the Prior Art

Conventional timer devices interlocked with a clock mechanism and arranged to control the power switch of a load circuit at a pre-set time were designed to be operative in either of the following two modes of action, that is to say, the connection of the power switch which was in the OFF state could be changed over to the ON state at the arrival of the pre-set time, or conversely from the ON state to the OFF state.

However, the performance capability which is limited to only the aforesaid two modes of action were insufficient from the viewpoint of effecting a desired full control of the load circuit. The present invention contemplates an improvement of the aforesaid drawback of the timer devices of the prior art.

SUMMARY OF THE INVENTION

It is, therefore, a primary object of the present invention to provide an improved timer device interlocked with a clock mechanism and capable of acting at a pre-set time in accordance with the pre-determined program, for any selected switch position of the changeover mechanism.

Another object of the present invention is to provide an improved multiplex action timer device arranged so that the connection of the power switch of the load circuit is adapted to be changed — by two pairs of time-setting mechanisms — from a certain initial state to the other reverse state and then switched back to said initial state in accordance with the set position of connection of the changeover mechanism at the arrival of a pre-set time.

Still another object of the present invention is to provide an improved multiplex action timer device which will not become any burden for the rotation force of the motor assigned to drive the clock mechanism.

A further object of the present invention is to provide an improved multiplex action timer device which permits both of the two pairs of time-setting mechanism to be set for the time unit of "minute."

A still further object of the present invention is to provide an improved multiplex action timer device which is operative so that, even when the two pairs of time-setting mechanism are concurrently set simultaneously to the same time, the power switch of the load circuit is unfailingly rendered to the OFF state.

Other objects and a fuller understanding of the present invention can be had by referring to the following description and claims when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevational view, showing the internal mechanism of a clock incorporating therein a timer device embodying the present invention;

FIG. **2** is a sectional view, with parts broken away, taken along the line II—II in FIG. **3**;

FIG. **3** is a left side view of the internal mechanism shown in FIG. **1**;

FIG. **4** is a sectional view, on an enlarged scale and with parts broken away, taken along the line IV—IV in FIG. **1**;

FIG. **5** is a perspective view, with parts exploded, to show the electric connection of the internal mechanism of FIG. **1**;

FIG. **6** is a circuit diagram, showing an example of the control circuit which is connected to the timer device of the present invention;

FIG. **7***a* is a fragmentary plan view, on an enlarged scale, showing the mechanism of the knob means intended for setting the timer device;

FIG. **7***b* is a sectional view, on an enlarged scale, taken along the line VII—VII in FIG. **7***a*;

FIG. **7***c* is a sectional view, on an enlarged scale, taken along the line VII—VII and showing the state of the knob means of FIG. **7***a* when it is pushed inwardly; and

FIG. **8** is a circuit diagram showing another modified example of the relay means shown in FIG. **6**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. **1** and **2**, there are shown the positional relations between the action mechanism of a digital type clock and a timer device of the present invention. Frame **1** comprises beams **1**a and side plates **1***b* for supporting said beams **1***a*. A main shaft **2** and a driven shaft **3** are rotatably supported on said side plates **1***b*, respectively. A "minute" indicating mechanism of the clock mechanism is rotatably mounted on this shaft **2**.

A driving motor **4** is secured to supports **5** (see FIG. **3**) which, in turn, extended from the side plate **1***b*. A crown gear **6** is secured to the shaft of this motor **4**. This gear **6** is in mesh with a pinion **7** which, in turn, is rotatably mounted on said driven shaft **3**. This pinion **7** is of an independent tooth formed in a region different from the region where this pinion **7** meshes with said gear **6**.

An intermittent motion gear **8** is rotatably mounted on a shaft **9** which extends from the side plate **1***b*. This gear **8** is brought into mesh with said independent tooth at the rate of once per revolution of the pinion **7**.

Another gear **10** is provided, on one side thereof, with a toothed section intended for ratchet drive, and this gear **10** is rotatably mounted on said main shaft **2** and is in mesh with the gear **8**. A pawl member **11** is provided with a pawl adapted to engage the toothed section formed on said one side of the gear **10** for ratchet drive, and it is secured to the main shaft **2**. The motion of the gear **10** which is rotated by the rotating motor **4** works in such a way as to bring the said toothed section formed on said one side of the gear **10** into engagement with the said pawl of the pawl member **11**. A gear **12** is secured to the main shaft **2**. Gears **13**,

14, 15 and 16 are secured to the driven shaft 3, respectively, and said gear 13 is in mesh with the gear 12.

A first "minute" drum 17 and a first "hour" drum 18 are rotatably mounted on the main shaft 2, respectively. These two drums 17 and 18 are provided, on the peripheral edges of their circumferences, with rows of teeth 17*a* and 18*a*, respectively. A part of each of these two rows of teeth 17*a* and 18*a* projects to the external side of the clock casing not shown on the front side of this clock casing at such positions as enabling these two drums 17 and 18 to be operated manually from the external side of the casing. Also, these two drums 17 and 18 are provided with cylindrical hollow portions 17*b* and 18*a* which are concentric with the drums 17 and 18, respectively, and further with convex portions 17*c* and 18*c*, respectively, one for each drum.

"Minute"-indicating graduations 17*d* are provided on the circumference of said first "minute" drum 17 at positions determined by dividing the circumference into 60 equal sections. On the other hand, "hour"-indicating graduations 18*d* are formed on the circumference of the first "hour" drum 18 at positions determined by dividing this circumference into 24 equal sections.

When any selected ones of these two kinds of graduations 17*d* and 18*d* which are formed on the circumferences of these two drums 17 and 18, respectively, are brought into register with the indices fixed to the clock casing not shown as these drums 17 and 18 are rotated, these two drums are semi-fixedly locked at their present respective positions by virtue of the click action resulting from the engagement of the rows of teeth 17*a* and 18*a* of these two drums 17 and 18 with resilient members 19 and 20 each having one end fixed to the beam 1*a*.

A disk 21 is secured to the main shaft 2 in such a manner that it is received in the hollow portion 17*b* of the drum 17 (see FIGS. 2 and 4). Electric conductor rings 21*a* and 21*b* are concentrically provided in the outer side face of the wall of said disk 21. On the other hand, a micro-switch 22 is attached to the inner side face of the wall of said disk 21. The terminals of this micro-switch 22 are electrically connected to the electric conductor rings 21*a* and 21*b*, respectively. The pin-plunger of said switch 22 is engageable with the convex portion 17*c* of the drum 17. This micro-switch 22 which is normally open is closed when the pin-plunger of this switch 22 is brought into engagement with the convex portion 17*c* of the drum 17. At the time of this engagement, the electric conductor ring 21*a* is brought into electric connection with the electric conductor ring 21*b*.

A disk 23 which is formed integrally with a gear 23*a* is rotatably mounted on the main shaft 2. This gear 23*a* is meshed with a gear 14. The said disk 23, like the aforesaid disk 21, is received in the hollow portion 18*b* of the drum 18. Electric conductor rings 23*b* and 23*c* are concentrically provided on the outer side of the wall of the disk 23. Also, in the same way as in the case of said disk 21, a micro-switch 24 is securely attached to the inner side face of the wall of the disk 23. The terminals of this switch 24 are electrically connected to the electric conductor rings 23*b* and 23*c*, respectively. When the pin-plunger of this micro-switch 24 is brought into engagement with the convex portion 18*c* of the drum 18, said micro-switch 24 which is normally open is closed, so that the electric conductor ring 23*b* is brought into electric connection with the electric conductor ring 23*c*.

Mechanisms which are associated with the aforesaid first "minute" drum 17 and said first "hour" drum 18 exert either one of the following two modes of actions, i.e., rendering the power switch of the load circuit from OFF to ON and from ON to OFF, at the arrival of the pre-set time.

On the other hand, time-setting mechanisms for imparting the said load circuit an action which is the reverse of that described above are shown in FIGS. 1 and 2 as the mechanisms associated with a second "minute" drum 17′ and a second "hour" drum 18′.

These associating mechanisms are altogether similar to those mechanisms associated with the first "minute" drum 17 and the first "hour" drum 18, and therefore, their description is omitted.

In the following description, those members corresponding to the aforesaid members are given reference numerals and symbols having a prime mark. A drum 25 having two opposing flanges is secured to the main shaft 2. These flanges hold, for pivotal movement, a group 26 of "minute"-indicating plates which are omitted in FIG. 2.

Another drum 27 having two opposing flanges of which one constitutes a gear 27*a* is rotatably mounted on the main shaft 2. These flanges hold therebetween, for pivotal movement, a group 28 of "hour"-indicating plates which are omitted in FIG. 2. Said gear 27*a* is in mesh with the gear 15.

Retaining members 29 and 30 are attached to the beam 1*a*. The end portions of these retaining members engage the exposed two indicating numeral plates which are contained in both of the "minute"-indicating plate group 26 and the "hour"-indicating plate group 28 to retain these two indicating plates of the two groups in their indicating positions for a predetermined length of time.

Contact strips 31, 32, 33 and 34 have contact points 31*a*, 32*a*, 33*a* and 34*a*, respectively. These contact points are always in contact with the electric conductor rings 21*a*, 21*b* 23*a* and 23*b*, respectively (see FIG. 5).

The respective contact strips are secured to electrically insulated holding members 35 and 35′, respectively. Both of these holding members 35 and 35′, in turn, are secured to the side plate 1*b*. The contact strips 31 and 33 are electrically connected to each other. A gear 36 is secured to the main shaft 2. A gear 37 has a spur gear portion and also a bevel gear portion both of which are formed integrally therewith. This gear 37 is rotatably mounted on a shaft extending from the side plate 1*b*. The spur gear portion of the said gear 37 is in mesh with the gear 36. A bevel gear 38 is secured to a time-adjusting shaft 40, and is in mesh with the bevel gear portion of the gear 37. This time-adjusting shaft 40 is rotatably supported on the side plate 1*b* and also on a bearing plate 39 which, in turn, is secured to this side plate 1*b*.

As shown in further detail in FIGS. 7*a* through 7*c*, a knob means 41 is slidably mounted on the time-adjusting shaft 40. This knob means 41 is of a pin 41*a* which engages an elongated groove 40*a* provided on the surface of the time-adjusting shaft 40. This pin 41*a* is al-

lowed to be displaced in said groove **40***a* in the axial direction of the time-adjusting shaft **40** within the range of the length of said elongated groove **40***a*. However, this pin **41***a* engages this elongated groove **40***a* in such a fashion that there is left no play between this pin **41***a* and said groove **40***a* with respect to the direction of rotation of said shaft **40**. Accordingly, the knob means **41** is capable of being displaced on the time-adjusting shaft **40** in the axial direction of the latter, whereas with respect to the direction of rotation of said shaft **40**, the said knob means **41** will rotate integrally with this time-adjusting shaft **40**. The knob means **41** is provided, in the surface thereof, with a cam groove **41***b*. This cam groove **41***b* is engaged by the free end portion of a spring-like wire member **42**, the other end of which being secured to the time-adjusting shaft **40** by transversely piercing through this shaft **40** for rotation therewith. A coil spring **43** is wound around the time-adjusting shaft **40** and is sandwiched between a snap ring **44** securely mounted on said shaft **40** and the knob means **41**. The terminals of a micro-switch **45** are connected between the motor **4** and the power source, and also to the re-setting circuit of a circuit (not shown) which is intended for alarming an interruption of power supply.

Whenever the knob means **41** is in its projecting position as shown in each of FIGS. **2**, **3**, **7***a* and **7***b*, the connection between the motor **4** and the power source is cut off. At the same time therewith, the pre-setting contact of the circuit (not shown) for alarming an interruption of power supply is closed.

On the other hand, whenever the knob means **41** is in its retracted or pushed-back position as shown in FIG. **7***c*, the pin-plunger of the micro-switch **45** is pushed so that this micro-switch is changed over of its connection, and thus, actions which are the reverse of the mode of actions described above are effected.

In FIG. **1**, a lamp **52** for indicating that the device is in operation and for the illumination purpose is connected in such a way that it is lighted up whenever the power is being supplied to the motor **4**. A lamp **53**, on the other hand, is provided as an indicator lamp to indicate the occurrence, in the past, of an interruption of power supply. This lamp **53** is connected to a circuit not shown which is assigned for alarming an interruption of power supply. In case, for example, there occurred an interruption of power supply in the past, the lamp **53** flickers repeatedly to alarm the fact that the time being indicated is not correct. This lamp **53** is put out with the re-setting operation described above.

In FIG. **3**, a rotary switch **46** is secured to the side plate **1***b*. As a knob **47** which is mounted on a shaft **46***a* of this switch **46** is turned, the movable contacts not shown of said rotary switch **46** are displaced in their positions on the fixed contacts thereof.

FIG. **6** shows an example of a control circuit **54** which is connected to said rotary switch **46** for the completion of the timer device of the present invention. A maintaining relay **48** has three terminals for its winding. One of these three terminals, namely, the common terminal **48***a*, is connected to one of the terminals of an AC power source. Either one of the remaining two terminals, i.e., the ON terminal extending from the maintaining relay **48** via a diode D and the OFF terminal extending from the same relay **48** via a resistor R, is connected to the other of the terminals of said AC power source via the control circuit **54**.

Let us now assume that an AC input signal is applied to the ON terminal. An armature — which has till then been positioned away from the core of the maintaining relay **48** by the spring force applied to the armature in the direction away from said core — is attracted to the core against this spring force. The once attracted armature is retained continuously in its attracted position even after the suspension of application of said input. On the other hand, the core will be deprived of its attracting force when an AC input signal is applied to the OFF terminal of the maintaining relay **48** during its state of having the armature attracted to its core. Therefore, this armature is restored, by the spring force, to its position of being separated away from the core.

Contact terminal assemblies **46***b*, **46***c* and **46***d* — which are provided in the respective stages of the rotary switch **46** which is illustrated in an exploded fashion — each has a contact changeover mechanism having two contact blocks, respectively. The movable contacts of the respective changeover mechanisms of said contact terminal assemblies are interlocked with each other.

A first switch block **49** is formed with micro-switches **22** and **24** which are connected in series. A second switch block **50** is comprised of micro-switches **22'** and **24'** which are connected in series. An electric load **51** is connected via the contact of the maintaining relay **48** to its power source. The movable contacts of the upper changeover mechanism and the lower changeover mechanism (hereinafter to be referred to as the first changeover mechanism and the second changeover mechanism, respectively) of the contact terminal assembly **46***b* of the rotary switch **46** are both connected to one of the terminals of a power source. The contact terminals (ON) and (OFF) of the first changeover mechanism are connected to the contact terminal (ON) of the upper changeover mechanism (hereinafter to be referred to as the fourth changeover mechanism) and to the contact terminal (OFF) of the lower changeover mechanism (hereinafter to be referred to as the fifth changeover mechanism) of the contact terminal assembly **46***d*, respectively.

The terminals (**1**), (**1–2**), (**3**) and (**3–4**) of the first changeover mechanism are connected in common with each other, and they are connected via the first switch block **49** to both the terminals (**2**) and (**4**) of the lower changeover mechanism (hereinafter to be referred to as the third changeover mechanism) of the contact terminal assembly **46***c*. Also, the lead wire extending from the first switch block **49** is connected to the terminals (**3**), (**3–4**), (**4**) of the fourth changeover mechanism and also to the terminals (**1**), (**1–2**), (**2**) of the fifth changeover mechanism.

The terminals (**1–2**), (**2**), (**3–4**) and (**4**) of the second changeover mechanism are connected in common with each other, and they are further connected via the second switch block **50** to the movable contact terminal of the third changeover mechanism. The terminals (**1–2**) and (**3–4**) of the third changeover mechanism, on the other hand, are connected in common with each other, and they are further connected to the terminals (**1**), (**1–2**), (**2**) of the fourth changeover

mechanism and also to the terminals (3), (3–4), (4) of the fifth changeover mechanism.

The movable contact terminal of the fourth changeover mechanism is connected to the ON terminal of the winding of the maintaining relay **48**. On the other hand, the movable contact terminal of the fifth changeover mechanism is connected to the OFF terminal of the winding of said maintaining relay **48**.

FIG. **8** shows an example of another type of maintaining relay wherein the maintaining relay **48** of FIG. **6** is replaced by a relay circuit **48'** which uses two ordinary relays and which is arranged so as to accomplish the same performance as that done by the maintaining relay **48**. One of the terminals of the winding of the relay **55** is connected to the movable contact terminal of the break contact **55***a* and also to a terminal **48***a* which, in turn, is connected to one of the terminals of the AC power source. The other of the terminals of the winding of this relay is connected to the OFF terminal of the control circuit **54**. One of the terminals of the winding of the relay **56** is connected to the fixed contact terminal of said break contact **55***a*, whereas the other of the terminals of the winding of this relay is connected to the fixed contact terminal of a make contact **56***a* and also to an ON terminal of the control circuit **54**. The movable contact of the make contact **56***a* is connected to the other of the terminals of the aforesaid power source. A make contact **56***b* is connected between the power source and the electric load **51**.

Description will hereunder be directed to the timer device of the present invention and to the operation of the clock having this timer device incorporated therein.

Prior to making this description, the operation of a known clock mechanism will be discussed as follows.

Let us now assume that the knob means **41** is turned manually in order to adjust time when this knob means is in its projecting position. Whereupon, the main shaft **2** is caused to rotate via the bevel gear **38**, the gear **37** and the gear **36**. As a result, an exposed "minute"-indicating plate in the group **26** of the "minute"-indicating plates attached to the drum **25** is turned over. On the other hand, this rotation of the main shaft **2** is not transmitted to the gear **10** owing to the action of the pawl member **11**. Also, the rotation of the main shaft **2** is transmitted to another drum **27** via the gear **12**, the gear **13**, the driven shaft **3**, the gear **15** and the gear **27***a*, so that an exposed "hour"-indicating plate in the group **28** is turned over. Therefore, when the knob means **41** is pushed back after the time has been adjusted by turning this knob means while the latter was in its projecting position, the connection of the micro-switch **45** is changed over and the motor **4** is rotated.

This rotation of the motor **4** is transmitted to the gear **10** with appropriate gear ratios via the crown gear **6**, the pinion **7** and the intermittent motion gear **8**.

During this part of operation, the main shaft **2** is rotated integrally with the gear **10** owing to the action of the pawl member **11** which, in turn, is in engagement with this gear **10**. Accordingly, this main shaft **2** is allowed to rotate intermittently six degrees by the same degrees at the rate of one revolution per minute. The drum **25** is rotated in accordance with this stepwise rotation of the main shaft **2**. Therefore, those "minute"-indicating plates in the group **26** are turned over at the rate of one plate per minute, and thus indication of minutes is effected. On the other hand, in accordance with the rotation of the main shaft **2**, the drum **27** is also rotated via the gear **12**, the gear **13**, the driven shaft **3**, the gear **15** and the gear **27***a*. Owing to the fact that these gears are arranged so as to have appropriate gear ratios, those "hour"-indicating plates in the group **28** are turned over at the rate of one plate per hour, and thus hours are indicated.

The timer device of the present invention is operated in the following manner.

In order to have the timer device operate, it is necessary, as the first step, that the first "hour" drum **18** and the first "minute" drum **17** be set at the selected time positions by manipulating their respective rows of teeth **18***a* and **17***a* which are arranged to protrude to the outside of the clock casing not shown.

On the other hand, in accordance with the motion of the clock mechanism, the disk **21** is kept rotating integrally with the main shaft **2** and, accordingly, with the drum **25**. Also, the disk **23** is kept rotating integrally with another drum **27**, from the driven shaft **3** and via the gear **14** and the gear **23***a*.

Accordingly, as is understood best from FIGS. **4** and **5**, upon arrival of the aforesaid pre-set time, the pin-plungers of the micro-switches **22** and **24** which are secured to the disks **21** and **23** and are provided with normally open contacts, respectively, are both pushed simultaneously by the respective convex portions **17***c* and **18***c* of the first "minute" drum **17** and the first "-hour" drum **18**. Along with this, the said contacts of the micro-switches **22** and **24** are both closed. As a result, only during this period of closure of said contacts, electric connection is established between the terminals *a* and *b* of the contact strips **32** and **34**, or in other words, the first switch block **49** in FIG. **6** closes its circuit only during said period. The length of time of this period of closure of said contacts can be set appropriately by forming the configurations of the convex portions **17***c* and **18***c* as desired.

The electrical relations of the contacts described above hold perfectly true with the electrical relations of contacts in the second "minute" drum **17'** and the second "hour" drum **18'**. More specifically, there occurs conduction between the terminals *a'* and *b'* of the contact strips **32'** and **34'** only at the arrival of the time set by the second "minute" drum **17'** and the second "-hour" drum **18'**, or in other words the second switch block **50** shown in FIG. **6** closes its circuit only at such a time.

Description will hereunder be directed to the respective modes of action of the timer device of the present invention for respective positions of the connection of the rotary switch **46** set thereto by manipulating the knob **47**.

Referring to the circuit diagram of FIG. **6**, let us now assume that the connection of the rotary switch **46** is initially set to the (OFF) position. Whereupon, the respective movable contacts are connected to the (OFF) terminals of the respective changeover mechanism of the contact terminal assemblies. Concurrently therewith, the power source is connected between the common terminal **48***a* and the OFF terminal of the winding of the maintaining relay **48** via the (OFF) terminal of the fifth changeover mechanism

from the (OFF) terminal of the first changeover mechanism. Accordingly, the maintaining relay **48** releases its armature. As a consequence, the power switch which is provided in the circuit of the electric load **51** is retained always in its open state irrespective of the actions of the first and the second switch blocks **49** and **50**. It should be understood that during the aforesaid operation, the remainder of connections other than those described above have nothing to do with this maintaining relay **48**.

On the other hand, when the rotary switch **46** is set to the (ON) position, one of the terminals of the power source is connected from the (ON) terminal of the first changeover mechanism to the ON terminal of the winding of the maintaining relay **48** via the (ON) terminal of the fourth changeover mechanism.

Therefore, the armature of this relay **48** is kept in its state of being attracted always to the core. During this mode of operation, the power switch which is connected to the electric load **51** is kept in its closed state always independently of the actions of the first and the second switch blocks **49** and **50**.

In the case the rotary switch **46** is set to the position (**1**), one of the terminals of the power source is connected — via the terminal (**1**) of the first changeover mechanism, the switch block **49** and the terminal (**1**) of the fifth changeover mechanism — to the OFF terminal of the maintaining relay **48**. Accordingly, if in this instance the armature of the relay **48** is initially located in the position of being attracted to the core, or in other words, if the power switch which is connected to the electric load **51** is initially in its closed state, an OFF signal will be supplied to the maintaining relay **48** as the switches of the first switch block **49** are closed upon the arrival of the pre-set time of the first "hour" drum **18** and the first "minute" drum **17**. At that very moment, the armature is released of its engagement with the core, and as a consequence, the power switch which is connected to the electric load **51** is opened. Thereafter, this condition is retained. More specifically, the aforesaid mode of operation is understood to mean that an ON-OFF action is performed by the timer device. It should be noted that, during the aforesaid operation, the state of the electrical connection of the second switch block **50** which is associated with the second "-hour" drum **18'** and the second "minute" drum **17'** and the state of other connection both exert no electrical actions toward the relay **48**. It should be noted, however, that if the armature of the relay **48** is initially located in the released position, it is mandatory that the rotary switch **46** be first set to the (ON) position and thereafter set to the position (**1**). This requirement applies equally to the instance which will be discussed hereunder.

Next, in case the rotary switch **46** is set to the position (**1–2**) as illustrated, one of the terminals of the power source is connected — via the terminal (**1–2**) of the first changeover mechanism, the first switch block **49** and the terminal (**1–2**) of the fifth changeover mechanism — to the OFF terminal of the winding of the relay **48**. Also, at the same time therewith, said one of the terminals of the power switch is connected also to the ON terminal of the winding of the relay **48** via the terminal (**1–2**) of the second changeover mechanism, the second switch block **50**, the terminal (**1—2**) of the third changeover mechanism and the terminal (**1–2**) of the fourth changeover mechanism. Accordingly, if the operation starts with the armature of the relay **48** being located in its position of being attracted to the core, or in other words, if the power switch connected to the electric load **51** is in the closed state, the switches of the first switch block **49** will be closed upon the arrival of the pre-set time of the first "-hour" drum **18** and the first "minute" drum **17**, so that an OFF signal is applied to the relay **48**. More specifically, the power switch connected to the electric load **51** is opened at the aforesaid time. Thereafter, when the pre-set time of the second "hour" drum **18'** and the second "minute" drum **17'** arrives, the switches of the second switch block **50** are closed. At the time of arrival of this pre-set time, on the other hand, the switches of the first switch block **49** are already in the open state, and therefore, an ON signal is applied to the relay **48** at said time. As a consequence, the power switch which is connected to the electric load **51** is closed again at such a time. These electrical relations are thereafter every 24 hours. In other words, in the aforesaid mode of operation, there will be repeated an ON-OFF-ON cycle of actions of the device.

Furthermore, in case the rotary switch **46** is initially set to the position (**2**), one of the terminals of the power source is connected — via the terminal (**2**) of the second changeover mechanism, the second switch block **50**, and the terminal (**2**) of the third changeover mechanism — to the OFF terminal of the winding of the relay **48**. Accordingly, in this instance, the switches of the second switch block **50** will be closed at the pre-set time of the second "hour" drum **18'** and the second "minute" drum **17'**, so that an OFF signal is applied to the relay **48**. More particularly, the power switch which is connected to the electric load **51** will be opened at the said time, and thereafter this state will be maintained. In this instance, an ON-OFF action is performed.

Also, in case the rotary switch **46** is initially set to the position (**3**), one of the terminals of the power source is connected — via the terminal (**3**) of the first changeover mechanism, the first switch block **49** and the terminal (**3**) of the fourth changeover mechanism — to the ON terminal of the winding of the relay **48**. Accordingly, if in this instance the armature of the relay **48** is initially located in its released state, or in other words, if the power switch which is connected to the electric load **51** is in its open state, the switches of the first switch block **49** will be closed upon the arrival of the pre-set time of the first "hour" drum **18** and the first "minute" drum **17**, so that an ON signal will be applied to the relay **48**. More specifically, the power switch which is connected to the electric load **51** will be closed at the said time, and thereafter this condition of the power switch will be maintained. Thus, an OFF-ON action is performed in this instance. It should be understood, however, that in case the armature of the relay **48** is initially in its attracted position, the rotary switch **46** has to be set to the (OFF) position first and then set to the position (**3**). This requirement applies equally to the instance described below.

Next, in case the connection of the rotary switch **46** is initially set to the position (**3–4**), one of the terminals of the power source is connected — via the terminal

(3–4) of the first changeover mechanism, the first switch block **49** and the terminal (3–4) of the fourth changeover mechanism — to the ON terminal of the winding of the relay **48**. At the same time therewith, said one of the terminals of the power source is connected also to the OFF terminal of the winding of the relay **48** via the terminal (3–4) of the second changeover mechanism, the second switch block **50**, the terminal (3–4) of the third changeover mechanism and the terminal (3–4) of the fifth changeover mechanism. Accordingly, in this instance the mode of operation of the timer device will take a pattern which is just the reverse of that of the aforesaid instance where the rotary switch **46** is initially set to the position (1–2). Or, in other words, the electric connection between the electric load **51** and the power source will be rendered to the closed state and to the opened state in succession at the arrival of the pre-set time of the first "hour" drum **18** and the first "minute" drum **17** and at the arrival of the pre-set time of the second "hour" drum **18'** and the second "minute" drum **17'**, respectively. Such a cycle of actions will be repeated every 24 hours. Thus, the mode of operation in this instance will be the repetition of the OFF-ON-OFF cycle of actions.

Let us now assume that the rotary switch **46** is initially set to the position (4). One of the terminals of the power source is brought into connection –via the terminal (4) of the second changeover mechanism, the second switch block **50**, the terminal (4) of the third changeover mechanism and the terminal (4) of the fourth changeover mechanism — to the ON terminal of the winding of the relay **48**. Therefore, the mode of operation of the timer device in this instance is just the opposite of that in the aforesaid instance in which the rotary switch **46** is initially set to the position (2). More specifically, the power switch which is connected to the electric load **51** is brought from the opened state to the closed state. Thereafter, this latter state is maintained. In other words, an OFF-ON action is performed in this instance.

The maintaining relay **48** shown in FIG. **6** may be replaced also by the relay circuit **48'** shown in FIG. **8**. In such an instance, when a signal is applied to the OFF terminal by the control circuit **54** in the same way as that described above, this will allow the power to be supplied to the winding of the relay **55**, causing the relay **55** to be energized. As a consequence, the break contact **55***a* of this relay **55** is opened, so that the relay **56** is unfailingly rendered to the inoperable state. In this state of the relay **56**, its make contact **56***b* is rendered to the opened state as illustrated. More specifically, in this instance, the electric load **51** is rendered to the state that the supply of power thereto is interrupted.

On the other hand, when a signal is applied to the ON terminal by the control circuit **54**, the power is allowed to be supplied to the winding of the relay **56** via the break contact **55***a* of the relay **55**, causing the relay **56** to be energized. Along therewith, the connection of the make contact **56***b* of this relay **56** is changed from the illustrated position and the contact **56***b* is closed. More specifically, in this case, there is supplied the power to the electric load **51**. Since, in the aforesaid instance, the make contact **56***a* of the relay **56** is closed also at the same time, there is formed a self-maintaining circuit for the relay **56**, and even after the application of the signal to the ON terminal is suspended, the relay **56** is maintained in its operative state.

It should be noted, however, that in the event that the aforesaid two pairs of time-setting drums are by chance set to the same single time, and that, accordingly, if inputs are applied simultaneously to both the ON terminal and the OFF terminal, the break contact **55***a* of the relay **55** is opened owing to the action of this relay **55**. As a consequence, the relay **56** is not energized. In other words, no power is supplied to the electric load **51** in this instance.

Of course, while the present invention has been described with respect to particular embodiments, variation can be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. A multiplex action timer device comprising:

a shaft,

at least two drums for indicating "minute" and "-hour" respectively, mounted for intermittent rotation on said shaft and having a plurality of leaves for indicating time,

two pairs of time-setting members disposed respectively adjacent to said drums on said shaft and one of each pair having "hour"-indicating graduations on the outer peripheral face thereof and the other of each pair having "minute"-indicating graduations on the outer peripheral face thereof, said time-setting members being arranged to be semi-fixedly arrested at the respective points of the indicating graduations,

two pairs of rotating members disposed respectively adjacent to said time-setting members on said shaft for rotation interlockingly with said "minute"-indicating drum and said "hour"-indicating drum,

operating portions formed on one of said time-setting members and rotating members, respectively,

a plurality of micro-switches secured to the other of said time-setting members and rotating members, respectively, and each having a pin-plunger engageable with said operating portions, respectively,

electric conductor rings provided on said members having said micro-switches secured thereto, respectively, and electrically connected to the terminals of said micro-switches,

contact members arranged so that they are in contact with said electric conductor rings, respectively, and that the resulting electric connections of the respective pairs of said contact members are closed whenever said micro-switches connected to the respective pairs of said electric conductor rings are closed,

relay means having a common input terminal, an ON-signal input terminal and an OFF-signal input terminal, said common input terminal being connected to one terminal of a power source and arranged so that, when an ON-signal is applied to said ON-signal input terminal, a power switch of a load circuit is closed and that, when an OFF-signal is applied to said OFF-signal input terminal, said power switch is opened, and

a control circuit for changeover of electric connections and arranged to connect the other terminals of said power source to said relay means to apply said ON-signal or said OFF-signal thereto in such a way that, when the respective pairs of said electric conductor rings are electrically connected to each other, said power switch of said load circuit is operated to establish a condition selected from the following group of switching actions: switching from ON to OFF; from OFF to ON; from OFF to ON and then back to OFF again and thereafter repeating this cycle; and from ON to OFF and then back to ON again and thereafter repeating this cycle, in accordance with the pre-set position of a changeover mechanism connected between said ON-signal input terminal and said OFF-signal input terminal and other terminal of said power source.

2. A multiplex action timer device according to claim 1, in which the operating portions are convex portions formed on said time-setting members, and the said micro-switches and the said electric conductor rings are both secured to the said rotary members.

3. A multiplex action timer device according to claim 1, in which the said "hour"- and said "minute"-indicating graduations of the "hour" and "minute" time-setting members are those marked on the circumferences of these two kinds of time-setting members at positions determined by dividing the circumferences into 24 and 60 equal sections, respectively.

4. A multiplex action timer device according to claim 1, in which said relay means comprises a first relay having an energizable winding connected between said one of the terminals of the said power source and the said OFF-signal input terminal, and a second relay having an energizable winding, one of whose terminals being connected via a break contact of the said first relay to said one of the terminals of the power source, the other of whose terminals being connected to the said ON-signal input terminal, and in which arrangement is provided so that an electric load is connected to the said power source via a make contact of the said second relay.

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