

[54] **DIRECTLY READABLE DIGITAL CLOCK**[75] Inventor: **Takashi Funaki**, Shimosuwa-machi, Japan[73] Assignee: **Kabushiki Kaisha Sankyo Seiki Seisakusho**, Nagano-ken, Japan[22] Filed: **July 7, 1970**[21] Appl. No.: **52,797**[30] **Foreign Application Priority Data**

July 11, 1969	Japan	44/65206
July 17, 1969	Japan	44/56049
July 19, 1969	Japan	44/68942
July 19, 1969	Japan	44/57141

[52] U.S. Cl. **58/19, 58/38, 58/125 C, 200/38**[51] Int. Cl. **G04c 21/16**

[58] Field of Search .58/16, 19, 21.15, 38, 50, 125 C; 200/38

[56] **References Cited****UNITED STATES PATENTS**

2,721,441	10/1955	Boyles	58/19
3,264,817	8/1966	Beguin	58/21.15
3,407,402	10/1968	Morrison et al.	58/19 X
3,495,396	2/1970	Funaki	58/19
3,247,335	4/1966	Holzer	200/38 C

Primary Examiner—Richard B. Wilkinson
 Assistant Examiner—Lawrence R. Franklin
 Attorney—McGlew and Toren

ABSTRACT

[57]

In the directly readable digital clock disclosed a sector-shaped cam is keyed to an operating shaft. The operating shaft can be turned to one of four discreet positions. In each of the positions, a lever arm rests on the peripheral surface of the cam. At the end of a time period set into the clock, a timer knocks the lever off the cam periphery and onto a pin extending eccentrically from the cam. In the first cam position, the cam surface initially pushes the lever on to a position that closes a radio switch and opens an alarm switch. In the other three shaft positions the cam causes the lever arm initially to open both the radio switch and the alarm switch. In the first position, at the end of the timing cycle, the pin catches the lever arm in virtually its original position so that the radio switch remains on and the alarm switch off. In the second position, the pin also catches the lever in the original position so that both switches remain off. In the third position, the pin catches the lever so as to allow closing of the radio switch only. In the fourth position, the pin catches the lever so as to allow closing of both positions. A settable crown gear is engageable with a shaft-driven spur gear so that the crown gear can be turned from its set position to a final position by the clock. In its set position, a control cam, keyed to the crown gear causes a lever member to prevent movement of the lever arm in a direction in which it would open the radio switch or close the alarm switch. A notch in the control cam withdraws the lever member and renders it ineffective when the control cam reaches its final position. The radio switch may also be used to turn on other electrical appliances.

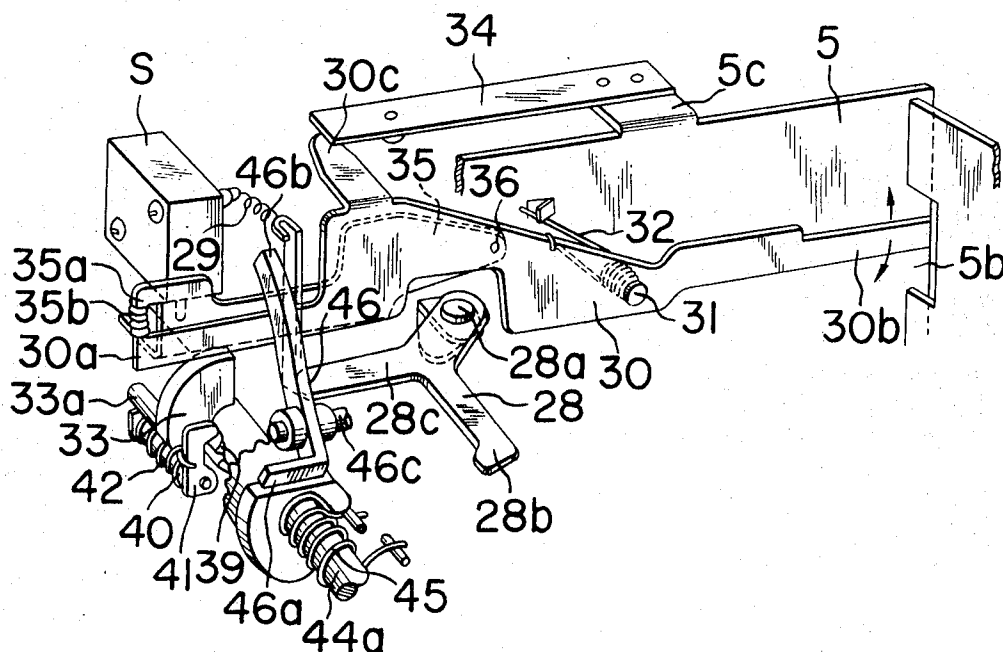
8 Claims, 14 Drawing Figures

FIG. 1

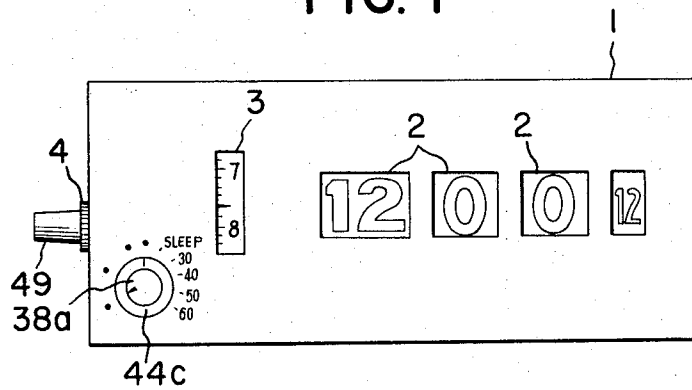
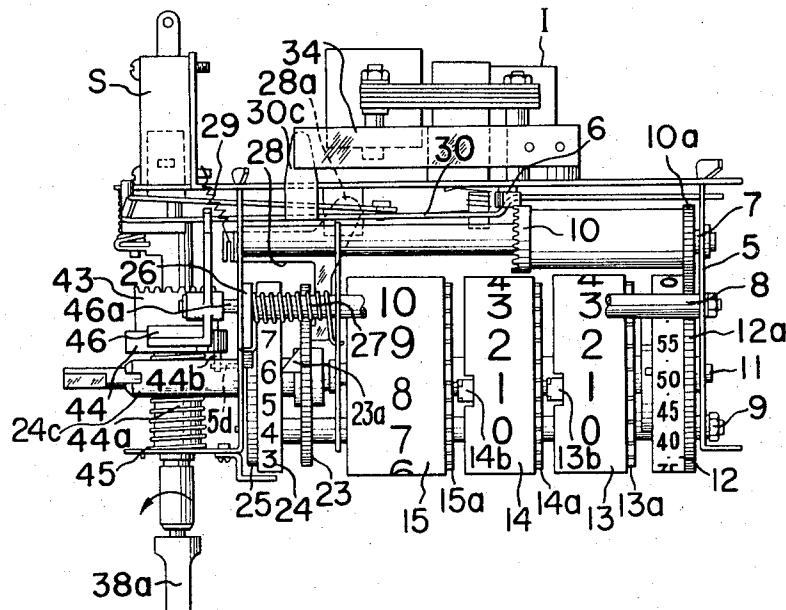


FIG. 2



INVENTOR

TAKASHI FUNAKI

BY

McGraw & Toren

ATTORNEY

FIG. 3

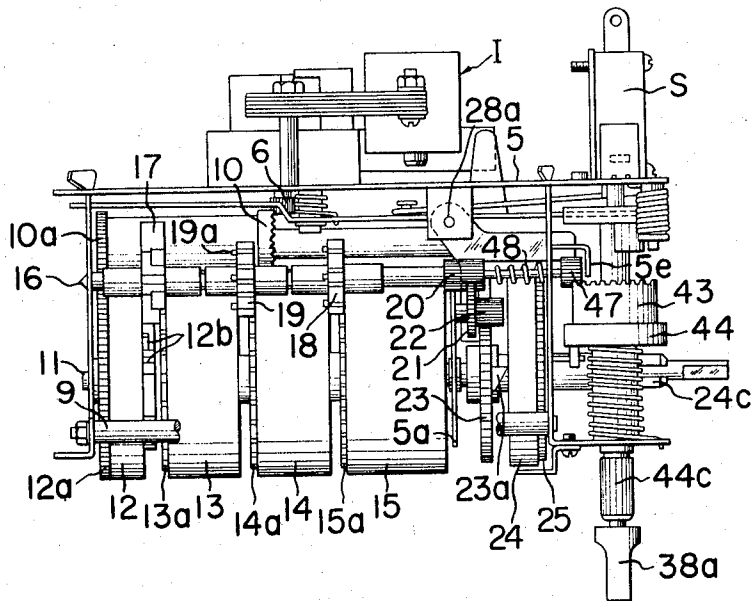
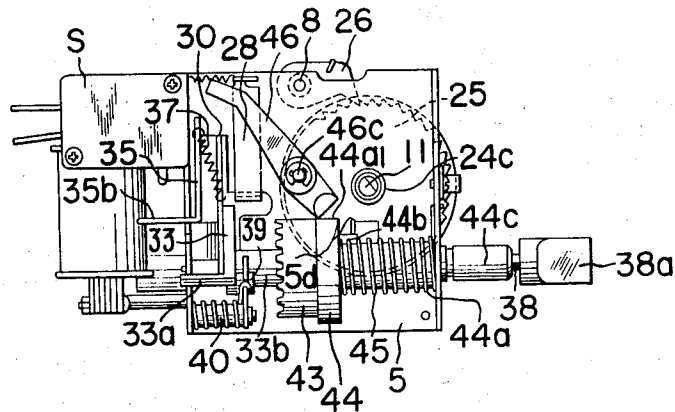


FIG. 4



INVENTOR

TAKASHI FUNAKI

McGraw & Toner

BY

ATTORNEY

FIG. 5

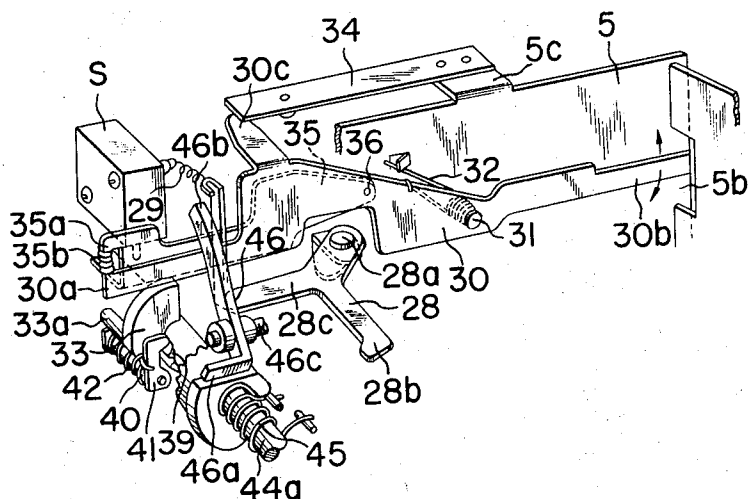
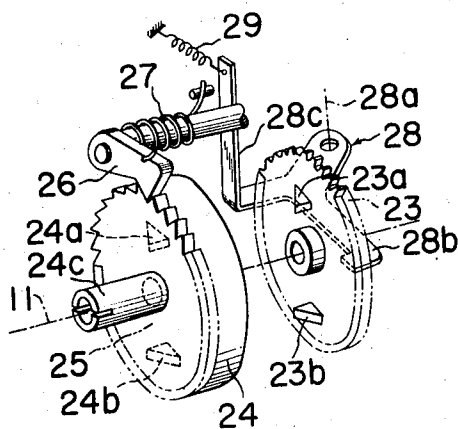


FIG. 6



INVENTOR

TAKASHI FUNAKI

McGraw & Toren

BY

ATTORNEY

FIG. 7

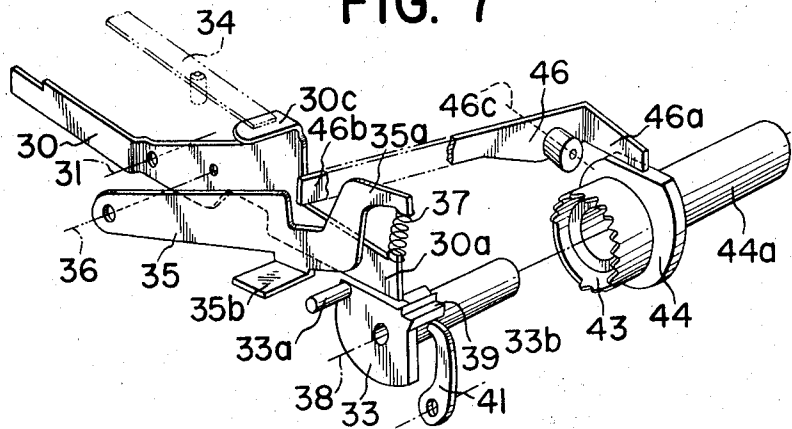


FIG. 8

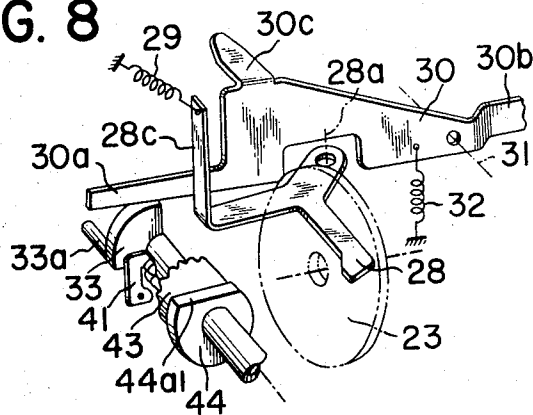
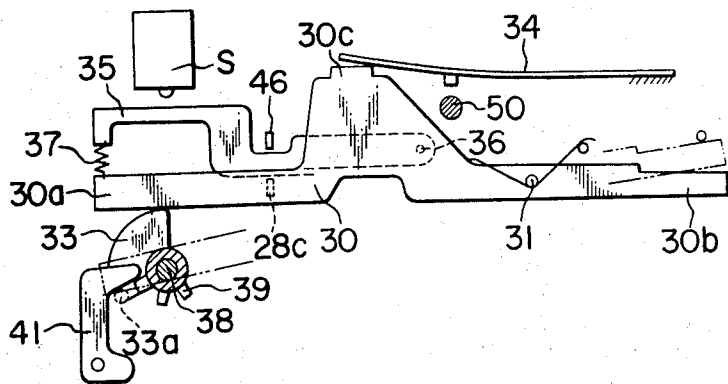


FIG. 9



INVENTOR

TAKASHI FUMAKI

McGraw & Torres

BY

ATTORNEY

FIG. 10

(ON)

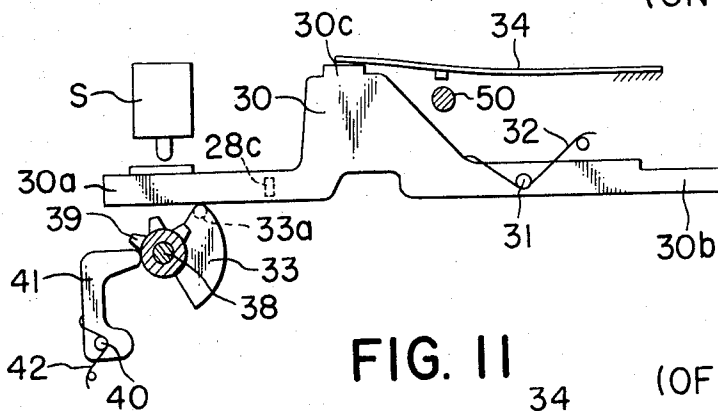


FIG. 11

(OFF)

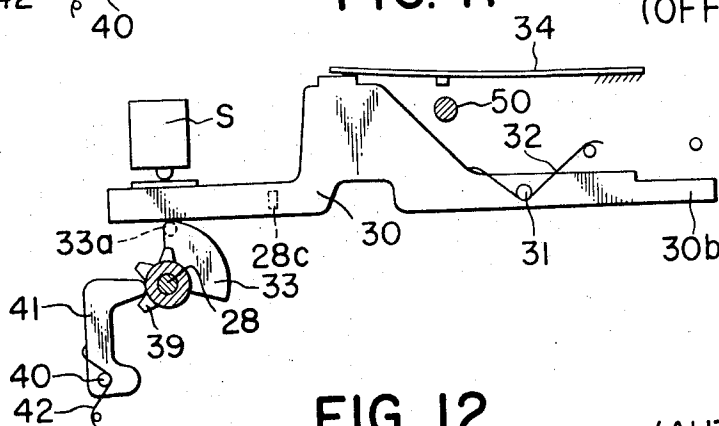
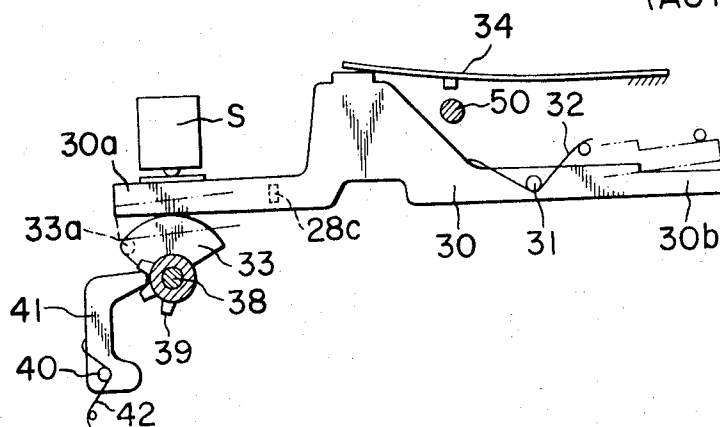


FIG. 12

(AUTO)



INVENTOR

TAKASHI FUNAKI

BY

McGraw & Toren

ATTORNEY

FIG. 13

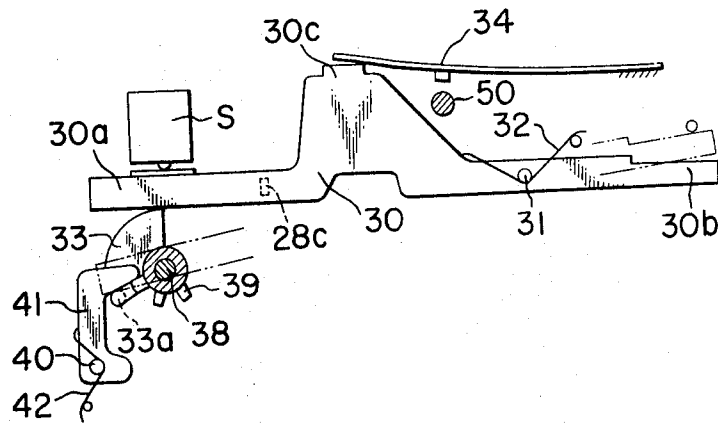
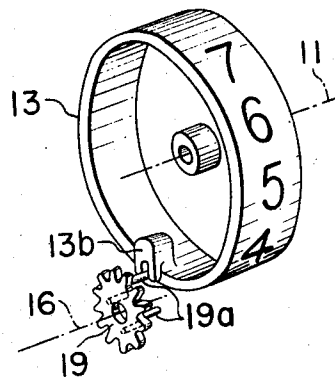


FIG. 14



INVENTOR

TAKASHI FUNAKI

BY

McGraw & Tom

ATTORNEY

DIRECTLY READABLE DIGITAL CLOCK

BACKGROUND OF THE INVENTION

The present invention relates to a directly readable digital clock, and more particularly to means for automatically operating timer and alarm mechanisms which are interlocked with the digital clock.

Digit-indicating clocks, namely, so-called digital clocks equipped with timer and alarm mechanisms are known.

With such clocks, using conventional timer and alarm means, it is possible to activate a timer switch to turn on a radio set or to feed an electric current to an electric pot if its operating time is previously set to a desired time by means of a time setting mechanism by turning a timer operating shaft. However, it is impossible to obtain operations, wherein, for instance, a time setting wheel is set at 7 o'clock by means of the time setting mechanism and the operation of the timer is switched over to "Auto Alarm" and moreover a load switch is connected to a radio set so that a user sleeps while letting an electric current flow to the radio set and one hour later the electric power source for the radio set is turned off, and at 7 o'clock tomorrow morning a buzzer is rung and an electric current flow to the radio set again by means of the timer and alarm mechanisms which are interlocked with the time setting mechanism.

There exists a conventional device, in which an automatic alarm means adapted to ring an alarm buzzer by means of a timer is provided with an up-and down moving lever operated by operating a knob protruding from the front face of the device. The lever is branched into a lever means for engaging a stopper means which is forwarded and retracted by a time setting mechanism, a lever means which opens and closes a three-contact switch, and a lever means which locks the electro-magnetic vibrating plate of the buzzer. Operations of a switch and a buzzer which respond to the time setting mechanism are selectively established. Therefore, according to said device, switching operations to "Auto", "Auto Alarm", "On" and "Off" can be easily achieved without erroneous operations. However when a usual two-contact switch is employed, it is impossible to set the device from the condition where a setting time is set up by the time setting mechanism to the condition where the switch is always kept on state adapted to pass an electric current by switching an operating lever. Therefore, it is forced to use a three-contact switch which has a neutral point. However, the three-contact switch must be constructed so that a movable contact located at a center of the switch keeps its off-condition out of contact with either fixed contacts which are in pair and located at both sides of the neutral position. Consequently, this device has the disadvantage that an expensive three-contact switch of high quality must be employed.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved directly readable digital clock, and more particularly to a sleep setting means adapted to automatically operate timer and alarm mechanisms provided in without the, said digital clock disadvantages mentioned above.

Another object of the present invention is to provide an improved digital clock, in which there is provided a small gear wheel which is frictionally mounted on an auxiliary shaft supporting fixedly thereon a shifting pinion which transfers the shifting force of a "minute" indicating wheel to a "tens of minutes" indicating wheel, said small gear wheel being selectively engaged with a notched crown gear of a sleep setting knob member loosely mounted on an operating shaft which is used to set the timer and alarm mechanisms, thereby to drive said sleep member with a reduced speed.

A further object of the present invention is to improve the timer and alarm mechanisms of a so-called digital clock as mentioned above.

A still further object of the present invention is to provide an improved time setting cam adapted to the digital clock mentioned above.

The above-mentioned and other objects of the invention have been attained by a directly readable digital clock including a switch means and electro-magnetic vibrating means adapted to cause various desired operations of the digital clock, which comprises, a cam member comprising a sector-shaped cam plate mounted fixedly on an operating shaft adapted to set a timing switch and an alarm device, and an electric pin protruded from cam surface of said cam plate; operating lever members adapted to open and close the switch means and to control an electro-magnetic vibrating means when said lever members are shifted onto said eccentric pin from said sector-shaped cam surface of said cam member and an actuating lever member adapted to swing said operating lever members through time setting mechanisms driven by a timepiece device.

More in detail, according to the invention, the digital clock is constructed so that if a user sets a timer setting wheel, for example, at 7 o'clock tomorrow morning by switching over the clock to "Auto Alarm" while he sets a sleep setting knob means at one hour and by connecting a load switch to a radio set, an electric power source is automatically suspended by the action of said sleep means thereby to stop the electric current flowing to the radio set even if he sleeps leaving the clock as it is, and further a buzzer is operated to ring by means of the timer and alarm mechanisms which have been preset, and simultaneously a current is allowed to pass through the radio set, said sleep knob means having a function of time-switch in addition to its own function independently of the time-setting wheel, thereby to cause utilization of said sleep means as a time switch.

Further, according to the present invention, the clock is made simple in construction and accurate in operation by avoiding a three-contact switch and therefore by enabling the setting of time and alarm at desired states by a single operating lever. In other words, in the present invention, a cam member having a sector-shaped cam surface and an eccentric pin protruding axially is fixedly mounted on an operating shaft which sets the timer and the alarm, and an electro-magnetic vibrating plate of the buzzer can be disengaged by a freely swinging operating lever which is mounted by means of a shaft on the base plate; and further a switch is opened and closed by a freely rotatable operating arm which is mounted on said operating lever, a lever, pressing said operating lever from the side of the lever

keeping step with the sliding action of the time setting mechanism is mounted on a shaft, and the operating lever abutting on the cam surface of said cam member and said operating arm are depressed so that selectively, said switch is opened and closed and also the alarm is rung.

Furthermore, in the present invention, the rotation of the "Minute" indicating wheel which is a driving source of the time setting cam is converted to that of the "tens of minutes" indicating wheel, and the rotation of the "tens of minutes" indicating wheel in turn intermittently rotates the time setting cam by means of a specially shaped shifting pinion thereby to drive the time setting cam. The characteristic features and functions of the digital clock according to the invention will become more apparent by the following description taken in connection with the accompanying drawings, in which the same members are indicated by the same reference numerals and characters.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of a digital clock according to the present invention;

FIG. 2 is a plan view of the digital clock shown in FIG. 1 from which a case is removed;

FIG. 3 is a bottom view of the digital clock shown in FIG. 2.

FIG. 4 is a right side view of the digital clock shown in FIG. 2 from which a case is removed;

FIG. 5 is a perspective view indicating the relationship between an operating lever and a sleep means, which operate a timer and an alarm, according to the present invention;

FIG. 6 is a perspective view indicating relationship between a lever and a gear wheel in a time setting cam, said members being used in the digital clock shown in FIG. 2;

FIG. 7 is a perspective view indicating relationships among a cam member, an operating lever and a sleep member in a timer, said members being used in the digital clock shown in FIG. 2;

FIG. 8 is a perspective view indicating relationship between a cam member and an operating lever in a timer, said members being used in the digital clock shown in FIG. 2;

FIG. 9 is an explanatory diagram indicating the operations of a timer and an alarm in the digital clock shown in FIG. 2;

FIG. 10 to 13 are explanatory diagrams indicating the operating conditions of a timer and an alarm in the digital clock shown in FIG. 2; and

FIG. 14 is a perspective view indicating the main parts of a time setting cam driving means according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The drawings illustrate one embodiment of the present invention.

In FIG. 1, a case of a digital clock includes a plurality of indicating windows 2 provided on its front center portion. The indicating windows are designed so that numerals indicating the "hour", "minute", and "second" can be observed in them. The numerals of the time setting wheel are displayed in an indicating window 3 which is provided next to said indicating win-

dows 2. The time setting wheel is set to show a desired numeral by turning a knob 4 protruding from one side of the case.

As shown in FIG. 2, the back part of a U-shaped base plate 5, supports an electric motor 1 equipped with an electro-magnetic device. A gear wheel 6 is securely mounted on the output shaft of said motor so that the gear wheel 6 penetrates through the back plate of the base plate 5 and rotates inside the base plate 5. Fixedly mounted shafts 7, 8 and 9 extend horizontally inside said base plate 5, and a pipe-shaped crown gear 10 engaging the gear wheel 6 is mounted on said shaft 7. The wheel 6 and gear 10 serve as reduction gears. A gear wheel 10a is provided on one side of the crown gear forming one unit therewith, and the gear wheel engages with a gear wheel 12a which is coupled with a "second" indicating wheel 12 loosely mounted on a main shaft 11. At the left side of the "second" indicating wheel 12, a "minute" indicating wheel 13 and a "tens of minutes" indicating wheel 14 are loosely mounted on said main shaft 11. The end face of each of the indicating wheels 13, 14 and 15, gear wheels 13a, 14a and 15a respectively engage pinions 17, 18 and 19 which as will be explained, are respectively coupled in the form of one unit; while of said indicating wheels 12, 13 and 14, tooth-forming plates 12b, 13b, and 14b protrude from the other sides of the wheels 12, 13 and 14 (Refer to FIG. 2 and FIG. 3.).

Referring to FIG. 3, an auxiliary shaft 16 is rotatably mounted over said indicating wheels 12, 13, 14 and 15 parallel to the base plate 5 loosely mounted on the auxiliary shaft are shifting pinions 17 and 18 which rotate while engaged respectively with the tooth-formed plate 12b of said "second" indicating wheel 12 and the tooth-formed plate 14b of said "tens of minutes" indicating wheel 14. In addition, a pinion 19 rotatably provided between shifting pinions 17 and 18 rotates while fixedly coupled with the auxiliary shaft 16. On one side of the shifting pinions 19, four pins 19a protrude horizontally. The pins 19a engage the tooth-formed plate 13b of the "minute" indicating wheel 13 so that the pinion 19 is rotated one-fourth turn by means of the tooth-formed plate 13b. The pinion 19 is designed so that the "tens of minutes" indicating wheel 14 is rotated per one full turn of said pinion 19. That is, the pinion 19 is rotated one full turn per 40 minutes.

A gear wheel 20 is mounted next to the shifting pinion 18 on the auxiliary shaft 16. The gear wheel 20 is engaged with a stepped gear 21 which is loosely mounted on a shaft provided horizontally on one side of a partition plate 5a of the base plate 5. The stepped gear is engaged with a time setting gear 23 mounted on said shaft 11 through a wide gear wheel 22 coupled with said stepped gear 21. In other words, the time setting gear is pivotally mounted on the peripheral surface of a tubular shaft 24c of the time setting wheel 24 which is loosely mounted on an end portion of said main shaft 11. Protruding from one side of the time setting gear 23, are approximately triangular lugs 23a and 23b. The protruding portions of the lugs 23a and 23b are selected to be different distances from the center of the time setting gear 23. On the other hand; on one side of the time setting wheel 24, recessed portions 24a and 24b are provided on the rotation passageways of said lugs 23a and 23b whereby said lugs

are made to be engaged with or disengaged from said recessed portions 24a and 24b. Moreover, on the other side of the time setting wheel 24, a gear wheel 25 is coupled thereto to form one unit. The gear wheel 25 is rotated in only one direction by means of a pawl 26 which is loosely mounted on one end of the fixed shaft 8. In other words, the pawl 26 is biased into engagement with the tooth of the gear wheel 25 by means of a spring 27 wound on the fixed shaft 8.

An arm 28b of a bell-crank-shaped lever 28, the base portion of which is pivotally mounted on said base plate 5 by means of a shaft 28a, is pressed against the side of the gear 28 by means of a contractible spring 29 which is connected to the other arm 28c of said lever. In addition, the combination of the time setting gear 23 and the time setting wheel 24 is hereinafter called the time setting cam. The time setting gear 23 slides in the axial direction of the tubular shaft 24c against the abutment force of the lever 28 by turning a knob 4 provided on the outer end of the tubular shaft 24c of the time setting wheel 24. When time setting gear 23 is rotated to a predetermined time setting position by means of the gear wheel 21, the lugs 23a and 23b are engaged with the corresponding recessed portions 24a and 25b of the time setting wheel 24 so that the time setting gear 23 rotates together with the time setting wheel 24 as a unit.

In FIG. 5; next to the arm 28c of the lever 28, an operating lever 30 is biased in the counterclockwise direction by the elastic force of a spring 32 mounted on a support shaft which is pivotally secured on the back plate of the base plate 5. The end part 30a of said operating lever is pressed against the operating peripheral surface of a cam member for actuating a timer and an alarm. As shown in FIG. 5, a tail end portion 30b of the operating lever 30 is inserted into a slot 5b provided on the side wall of the base plate 5, and the upper and the lower edges of said slot 5b regulate the swinging range of said operating lever 30. At an approximately middle - upper portion of the operating lever 30, there is a tongue-shaped plate 30c forming one body with the operating lever 30. Immediately above the tongue-shaped plate 30c, the end portion of an electro-magnetic elastic vibrating plate 34 whose base portion is fixedly secured to a portion 5c of the base plate 5, forms a vibrating member of the electro-magnetic device of the electric motor I and worked as a striking lever of the alarm. The base portion of an operation lever 35, on one side of the lever 30 is pivotally mounted by means of a pin 36 so as to swing freely. The end portion 35a of said operating lever is shaped like a fur-seal's head. Therefore, as shown in FIG. 7, a stretchable coil spring 37 between the end portion 35a and the end portion 30a of the operating lever 30 holds up the end portion of the operating lever 35. At the middle lower edge of the operating lever 35, an abutment plate 35b which is horizontally bent forms one body with the operating lever 35. As shown in FIG. 4, the plate 35b is positioned so as to directly depress the contact piece of a switch which is of normally closed type. Moreover, the operating lever 30 is loosely mounted on the shaft 31 so that it swings on the shaft 31 and also swings forwardly and backwardly while taking its fulcrum at the lever 31.

On one side of the base plate 5, an operating shaft 38 with a knob 38a, which is used to set the timer and the alarm, is freely rotatably. An end portion of the shaft 38 is secured to a cam member 33 so as to form one unit therewith. The peripheral edge of the cam member 33 sector shaped as shown in FIG. 5, and the lower edge 30a of the operating lever 30 is pressed to come into contact with the peripheral surface of the cam member 33 by the elastic force of a spring 32 (refer to FIG. 5). On the left side (in FIG. 7) of the cam member 33, an eccentric pin 33a protrudes in the axial direction. The eccentric pin 33a supports the end portion 30a of the operating lever 30 which is pushed down by the arm 28c of the bell-crank-shaped lever 28. The end portion 30a is pushed upwardly onto the cam edge against the elastic force of the springs 32 and 37 by manually turning the knob 38a keyed to the peripheral surface of the tubular shaft 33b of the cam member 33, is a partial gear 39 comprising three teeth. As shown in FIG. 5, a pawl 41 pivotally mounted on the base plate 5 by means of a shaft 40 is engaged with the tooth of the partial gear 39. The pawl temporarily holds the cam member by the elastic force of a spring 42 (Refer to FIG. 5 and FIG. 9).

As shown in FIG. 7, a sleep member which is formed by combining a notched crown gear 43 and a notched disk-plate 44 is rotatably mounted on the circumference of the tubular shaft 33b. The sleep member is forced to turn counterclockwise by means of a spring 45 wound on the tubular shaft 44a of the sleep member as explained referring to FIG. 2, the turning degree being limited by means of a stopper 5d (refer to FIG. 4) to the extent that a pin 44b can turn approximately one turn. In addition, one end portion of the tubular shaft 44a is extended outwardly and forms a sleep setting knob 44c. A bent arm 46a of a locking lever 46 is pivotally mounted on a support shaft 46c serves to come into contact with the upper peripheral surface of the above-mentioned notched disk-plate 44, an arm 46b of said locking lever 46 being extended so as to hold down the upper edge of the operating arm 35 as shown in FIG. 5 and FIG. 7. Therefore, when the arm 46a of the locking lever 46 is depressed onto the circumferential surface of the notched disk 44 by manually turning the sleep setting knob 44c, the arm 46b of the same lever is turned on the shaft 46c so as to temporarily lock the operating arm 35. The thus temporarily locked arm 35 is interrupted in the tendency to move upward which is caused by the elastic force of the spring 37. Therefore even though the time setting mechanism works, the depressing piece 35b of the operating arm 35 cannot press the contact member that opens the switch S.

As shown in FIG. 3, 43, a gear wheel 47 located on one side of the notched crown gear 43 and loosely mounted on an auxiliary shaft 16 is pressed toward inside of the bearing 5e of the base plate 5 by means of a stretchable spring 48 provided on the gear wheel 20, thereby engaging the notched crown gear 43. Therefore, the gear wheel 47 is rotated through the intermediary of the spring 48 by the intermittent rotation of the gear wheel 20, and then rotates the notched crown gear 43. However, when the notched portion 44a of the notched disk-plate 44 is turned upwardly without turning the sleep setting knob 44c of the sleep member, as

shown in FIG. 4, the notched crown gear 43 is disengaged from the gear wheel 47. In addition, referring to FIG. 1, the numeral 49 shows a knob which adjusts the time indication of "minute" by directly turning the "minute" indicating wheel 13.

The action of the sleep means according to the present invention is explained as follows when a timer and an alarm mechanism are operated by the sleep means (Refer to FIG. 2 and FIG. 8.):

When the time setting wheel 24 is set at a desired position (for instance, 7 o'clock tomorrow morning) by turning the knob 4, the time setting gear 23 will be positioned, as shown in FIG. 2, abutting against the lever 28. By turning the knob 38a coupled with the operating shaft 38, as shown in FIG. 9, the cam member 33 is previously set as shown in FIG. 9 against the elastic force of the spring 42 provided on the pawl 41. On the other hand, a time setting (for instance, at 1 o'clock) is achieved by turning the sleep setting knob 44c against the elastic force of the spring 45. Then, the notched crown gear 43 and the notched disk plate 44 which form one unit with the knob 44 will turn clockwise, and the notched crown gear 43 engages the gear wheel 47 loosely mounted on the auxiliary shaft 16, whereby the gear wheel 47 is turned by the pressing force of the stretchable spring 48. Furthermore, when the locking lever 46 in contact with the notched portion of the notched disk plate 44 is turned counterclockwise (in the state of FIG. 4) about the shaft 46c, the arm 46b of the lever 46 pushes the upper edge of the operating arm 35a of the operating lever 30. This interrupts the tendency of the operating lever 30 to move upward so as to hold it temporarily. Therefore, even if the time setting mechanism operates, it becomes impossible for the operating arm 35 to depress the contact piece of the switch S.

Then, when the gear wheel 6 on the output shaft of the motor I is rotated, said gear wheel slowly rotates a crown gear 10 engaged therewith. Therefor the gear wheel 10a keyed to an integral with the crown gear rotates the gear wheel 12a of the "second" indicating wheel 12 at a rate of one turn per minute. As a result of this, the tooth-formed plate 12b provided on one side of the "second" indicating wheel 12 rotates the shifting pinion 17, and the pinion in turn rotates the gear wheel 13a of the "minute" indicating where 13 one tenth turn. Next, the tooth-formed plate 13b provided on one side of the "minute" indicating wheel pushes the pin 19a of the shifting pinion 19 so that said shifting pinion and the gear wheel 20 fixedly mounted on the auxiliary shaft 16 are rotated one-fourth turn, while the shifting pinion 19 rotates the "tens of minutes" indicating wheel 14 one-sixth turn. Moreover, the "tens of minutes" indicating wheel 14 turns the pin of the pinion 18 by means of the tooth-formed plate 14b of said "tens of minutes" indicating wheel; therefore, the pinion 18 rotates the "hour" indicating wheel 15 by one sixth turn.

A gear wheel 47 loosely mounted on the auxiliary shaft 16 rotates the notched crown gear 43 slowly and counterclockwise in synchronism with the rotation of the pinion 19 so that the gear part of the notched crown gear is disengaged from the gear wheel 47, for instance, predetermined one hour later and becomes the state as shown in FIG. 4. Consequently, the operating arm 35

temporarily held by the arm 46b of the lever 46 becomes free, whereby the operating arm 35 is turned around the shaft 36 by the elastic force of a stretchable spring 37 (refer to FIG. 7) so as to upwardly move the end portion 35a thereof; upwardly. Therefore, the depressing piece 35b of the operating arm depresses the contact piece of the switch S, which is normally closed. This opens the switch, which may, for example, interrupt the electric current flowing to a radio receiver.

As shown in FIG. 3 and FIG. 6, the gear wheel 20 rotates the time setting wheel 23 at a speed lower than that of the former (20) through the step down gears 21 and 22 which are engaged with the gear wheel 20. When the time setting gear 23 is rotated and the projected lugs 23a and 23b of said time setting gear are brought in engagement with the corresponding recessed portions 24a and 24b of the time setting wheel 24 by the elastic force of the spring 29 for restraining the lever 28, the arm end 28c of the lever strikes the inside surface of the operating lever 30 so as to detach the end portion 30a of the operating lever 30 from the peripheral surface of the cam member 33. Consequently, as shown with dot-dash lines in FIG. 9, the end portion 30a of the operating lever 30 is turned counterclockwise about the shaft 31 by the elastic force of the spring 32 until the end portion 30a contacts the eccentric pin 33a.

Therefore, the end portion 35a of the operating lever 35 is detached from the contact piece of the switch S, thus closing the switch S. As a result, an electric current flows to operate the timer. At the same time, the electromagnetic vibrating plate 34 is relieved from the restriction of the tongue-shaped plate 30c so that it severely strikes the lever 50 of the electromagnetic device to ring the alarm.

The actions of the timer and alarm mechanisms according to the present invention are as follows:

For clarity and convenience, an operating arm is omitted from the description relating to FIGS. 10 through 13 which illustrate the relationships between the cam member and the operating lever in the timer and alarm mechanisms.

I. In case that the timer works, (Refer to FIG. 2 and FIG. 10):

When the time setting wheel 24 is set at a desired position by turning the knob 24c, the time setting gear 23 is positioned as shown in FIG. 2 against the abutment force of the lever 28. On the other hand, the cam member 33 is set as shown in FIG. 10, against the elastic force of the pawl 41, by turning the knob 38a which is coupled with operating shaft 38.

When the gear wheel 6 on the output shaft of the electric motor I is rotated, said gear wheel slowly rotates the crown gear 10 engaged therewith, so that the gear wheel 10a coupled with said crown gear rotates the gear wheel 12a of the "second" indicating wheel 12 at a rate of one turn per minute, and the toothformed plate 12b provided on one side of the "second" indicating wheel 12 in turn rotates the shifting pinion 17. Moreover, the pinion 17 rotates the gear wheel 13a of the "minute" indicating wheel 13 located next to said "second" indicating wheel 12 one tenth turn, and further the tooth-formed plate 13b provided on one side of the "minute" indicating wheel pushes

and turns the pin 19a of the shifting pinion 19 so that both said shifting pinion and the gear wheel 20 fixedly mounted on the auxiliary shaft 16 are rotated one-fourth turn. On the other hand, the shifting pinion 19 rotates the "tens of minutes" indicating wheel 14 one-sixth turn. The "tens of minutes" indicating wheel 14 turns the pin of the pinion 18 by means of the tooth-formed plate 14b of the wheel 14 so that the pinion 18 rotates the "hour" indicating wheel 15 one sixth turn.

The gear wheel 20 rotates the time setting wheel 23 at a speed lower than that itself through the step down gears 21 and 22 which are engaged with the gear wheel 20. When the time setting gear 23 rotates and the projected lugs 23a and 23b of the time setting gear 23 are engaged with the corresponding recessed portions 24a and 24b of the time setting wheel 24 by the elastic force of the spring 29 restraining the lever 28, the arm end 28c of the lever 28 strikes the side surface of the operating lever 30 to push it toward the reverse side of a sheet in FIG. 10, but the end portion 30a of said operating lever 30 is only laid on the eccentric pin 33a of the cam member 33, so that the elastic force of the spring 32 fails to turn the lever 30 about the shaft 31. Therefore, the normally closed switch S of the timer remains closed and an electric current flows from the beginning. On the other hand, the electro-magnetic vibrating plate 34 is held by the tongue-shaped plate 30c of the operating lever 30 so that it cannot strike the lever 50 of the electro-magnetic device. In addition, it should be noted that the eccentric pin 33a is positioned diagonally above the operating lever 38.

II. In case that the timer does not work (Refer to FIG. 11):

When the time setting wheel 24 is set at a desired position by using the knob 24a again, the time setting gear 23 is positioned as shown in FIG. 2 against the abutment force of the lever 28.

When the knob 38b of the operating shaft 38 is turned counterclockwise by one tooth of the partial gear 39 as shown in FIG. 11, the operating lever 30 is turned clockwise on the shaft 31 against the elastic force of the spring 32 so that the end portion 30a of the operating lever 30 depresses the contact piece of the normally closed switch S to interrupt the current flowing to the timer, so that the timer does not operate and the electro-magnetic vibrating plate 34 cannot strike the lever 50 of the electro-magnetic device. Now, it should be noted that the eccentric pin 33a is just above the operating lever 38. Therefore, in this case, even though the time setting mechanism is preset, the timer does not work.

III. In case that the timer automatically works (Refer to FIG. 12):

When the time setting wheel 24 is set at a desired position by using the knob 24c, the time setting gear 23 is positioned as shown in FIG. 2 against the abutment tendency of the lever 28. When the knob 38a of the operating shaft 38 is turned counterclockwise by one tooth of the partial gear 39 as shown in FIG. 12, the operating lever 30 is turned counterclockwise about the shaft 31 owing to the elastic force of the spring 32 so that the end portion 30a of said operating lever 30 is laid on the peripheral edge of the cam member 33. Accordingly, the contact piece of the switch S is depressed thereby to interrupt the current flowing to the timer.

Further, the electro-magnetic vibrating plate 34 cannot strike the lever 50 of the electro-magnetic device. Therefore, when the electric motor I rotates the gear wheel 6 so that the projected lugs 23a and 23b are engaged with the recessed portions 24a and 24b of the time setting wheel 24 by the elastic force of the spring 29, the arm end 28c of the lever strikes the side surface of the operating lever 30 so as to detach the end portion 30a of the operating lever 30 from the peripheral surface of the cam member 33 whereby the end portion 30a of the operating lever 30 is turned counterclockwise about the shaft 31 by the elastic force of the spring 32 until it is brought in contact with the eccentric pin 33a. As a result, the end portion 30a of the operating lever 30 is detached from the contact piece of the normally closed switch S and the switch S is closed thereby to let an electric current flow to operate the timer.

In addition, in this case, the alarm does not work. Therefore, if the switch S is of a normally opened type, it is also possible to make the switch open so as to interrupt the flowing electric current.

IV. In case that the timer and the alarm automatically work (Refer to FIG. 13):

For the final case; when the time setting wheel is set at a desired position by using the knob 24c, the time setting gear 23 is positioned as shown in FIG. 2 against the abutment tendency of the lever 28. Further, when the knob 38a integral with the operating shaft 38 is turned counterclockwise by one tooth of the partial gear 39 as shown in FIG. 13, the operating lever 30 is turned about the shaft 31 owing to the elastic force of the spring 32 so that the end portion 30a of said operating lever 30 rests on the peripheral surface of the cam member 33. As a result, the contact piece of the switch S, which is normally closed, is pressed in so as to interrupt an electric current flowing to the timer. Furthermore, it becomes impossible for the electro-magnetic vibrating plate 34 to strike the lever 50 of the electro-magnetic device.

Next, when, as in the case of operating the timer as mentioned above, the electric motor I rotates the gear wheel 6 so that the projecting lugs 23a and 23b are engaged with the corresponding recessed portions 24a and 24b of the time setting wheel 24 by the pressing force of the spring 29 constraining the lever 28, the arm end 28c of the lever 28 strikes the inside surface of the operating lever 30 thereby to detach the end portion 30a of the operating lever 30 from the peripheral surface of the cam member 33, whereby, the end portion 30a of said operating lever 30 is turned counterclockwise about the shaft 31 until it is brought in contact with the eccentric pin 33a as shown with dot-dash lines in FIG. 13.

As a result, the end portion 30a of the operating lever 30 is detached from the contact piece of the switch S, thereby closing the switch S, thus passing an electric current adapted to operate the timer. At the same time, the electro-magnetic vibrating plate 34 is relieved from the restriction of the tongue-shaped plate 30c, and as a result it severely strikes the lever 50 of the electro-magnetic device so as to ring the alarm.

As described above, according to the present invention, the operating lever and operating arm, which operate the timer and the alarm, are designed so that

they are temporarily held by the sleep member provided on said operating shaft and also by the locking lever, independently of the cam members for the timer and alarm mechanisms. Therefore, the electric current following to the timer is interrupted after a certain period of time and then the timer and alarm mechanisms can be operated after lapse of a set time predetermined by the time setting mechanism. Therefore, the digital clock according to the present invention has not only practically superior effects but also a simple construction, and further avoids trouble and erroneous operations, and can be offered at a low price.

Furthermore, according to the present invention; the sleep member consisting of the notched crown gear and the notched disk-plate on the operating shaft, which crown gear and disk-plate is made to temporarily hold the operating lever and arm for operating the timer and alarm mechanisms, can interrupt the current flowing to the timer by the reduced rotation of the small gear wheel frictionally mounted on the auxiliary shaft after a certain time lapse and then can operate the timer and alarm mechanisms through the locking lever. Therefore, it is not necessary to provide a separate reduction mechanism, and the digital clock can be constructed to be small in size with advantages such as simple construction and low price.

Furthermore, according to the present invention; by temporarily holding the cam member on the operating shaft by means of a clickstop, the operating lever adapted to operate the switch for the timer and the vibrating plate for the alarm can be set at an appointed position by means of the eccentric pin of the cam member. Therefore, the construction of the digital clock is simplified, and as a result, it can be made small in size and avoids trouble and erroneous operation.

Moreover, by selectively setting the cam member on the operating shaft, the relation with the time setting mechanism can be cut off, so that even if it becomes a set time, the operation of the switch can be achieved independently of the time setting mechanism. Furthermore a simple two-contact switch can be used as the switch in place of a three-contact switch which has been conventionally employed therefore, thus achieving advantages such as low cost.

According to the embodiment of the invention, the operating arm operates together with the operating lever, but it goes without saying that the operating lever may be operated independently.

It should be especially noted that the shifting pinion with a plurality of pins is fixedly mounted on an auxiliary shaft, without providing any other reduction mechanism which has been conventionally used, and the time setting cam is driven through the gear wheel on the auxiliary shaft at a reduced speed.

Further, in the present invention, the shifting pinion which combines the "minute" indicating wheel and the "tens of minutes" indicating wheel rotates one forth turn per every full turn of the "minute" indicating wheel; in other words, the shifting pinion rotates one full turn per every 40 minutes. Therefore, the reduction ratio, which has been obtained conventionally from the reduction mechanism necessary for rotating the time setting cam of this type one full turn per every 12 hours, can be obtained from a very simple mechanism by skilfully utilizing the rotation of the shifting pinion.

Consequently, the conventional reduction mechanism is eliminated, number of parts to be used are reduced, and the assembly becomes simple. Furthermore, according to the present invention, the time adjustment can be accomplished by turning the main shaft from outside the case as in the conventional digital clock. Moreover, as causes for trouble are minimized because of the reduction of the constructional parts, the digital clock according to the present invention has practically superior effects.

I claim:

1. A control mechanism for a directly readable digital clock having a clock mechanism and switch means for opening and closing an electric circuit as well as electromagnetic vibrating means for producing an alarm and wherein said switch means and said vibrating means are settable in a plurality of combinations of states, said mechanism comprising a selector shaft rotatable to a plurality of discreet positions, cam means having a sector-shaped cam plate secured to said shaft and an eccentric pin protruding from said cam plate, operating lever means engageable with said cam plate and movable by said cam plate to a plurality of positions in which said lever means controls the states of said switch means and said electromagnetic vibrating means in one plurality of the combinations, said lever means being engageable with said pin so as to assume one of a plurality of positions for controlling the states of said switch means and said electromagnetic vibrating means in a second plurality of the combinations, timing means responsive to said clock mechanism for shifting said lever means from engagement with said plate into engagement with said pin.

2. A mechanism as in claim 1, further comprising a control shaft settable from an initial position to a plurality of set positions, a notched crown gear fitted on said control shaft, a disk-plate having a notch and coupled with said crown gear, a pivotally mounted operating arm biased against said disk-plate to enter the notch when said control shaft is in the initial position, said operating arm being movable out of the notch by rotation of said control shaft from the initial position, said arm, when out of said notch, being effective to constrain said lever means to assume one of said plurality of positions, and spur gear means responsive to operation of the clock mechanism for engaging said notched crown gear and turning said notched crown gear until said arm enters the notch.

3. A digital clock, comprising a main shaft, a plurality of time indicating wheels with numerals on their circumferential surfaces pivotally mounted on said shaft, a shifting pinion shaft parallel with said main shaft, a plurality of shifting pinions on said pinion shaft engaging said wheels for transferring rotation of said time indicating wheels from one wheel to the other, switch means for controlling an electric circuit, electromagnetic vibrating means for producing an alarm, said switch means and said vibrating means being settable in a plurality of combinations of states, operating lever means including a pivotally mounted operating lever for controlling said switch means and said electromagnetic vibrating means, a selector shaft rotatable to a plurality of positions, cam means comprising a sector-shaped cam plate fixed on said selector shaft and an eccentric pin protruding from said cam plate, said operat-

ing lever means being engageable with said cam plate and when engaged therewith being movable to one of a plurality of positions controlling the states of said switch means and said electromagnetic vibrating means in a plurality of the combinations, said operating lever means being shiftable to engage said pin and when engaging said pin being capable of controlling the states of said switch means and said electromagnetic vibrating means in a second plurality of the combinations, timing means responsive to said main shaft for shifting engagement of said operating lever means from said cam plate to said pin, sleep setting means having a sleep setting shaft, said sleep setting means including a notched disk-plate and a crown gear integral with said disk-plate and fitted loosely and coaxially on said sleep setting shaft, said disk-plate having a notch, said selector means including spur gear means operatively engaging said shifting pinion shaft and engaging said crown gear, and stopping lever means movable from a position in said notch of said disk-plate out of the notch into a position for inhibiting the operation of said operating lever and controlling said switch means and said vibrating means, said spur gear means being engaged with said crown gear for rotating said crown gear until said stopping lever reenters the notch in said disk-plate.

4. A digital clock, as in claim 3, wherein one of said shifting pinions is fixedly mounted on the pinion shaft.

5. A digital clock, comprising a clock mechanism, switch means for opening and closing an electric current, electro-magnetic vibrating means for producing an alarm, said switch means and said vibrating means being settable in a plurality of combinations of states, a selector shaft rotatable to a plurality of discrete positions, cam means having a sector-shaped cam plate secured to said shaft and an eccentric pin protruding from said cam plate, operating lever means engageable with said cam plate and movable by said cam plate to a plurality of positions in which said lever means controls the states of said switch means and said electromagnetic vibrating means in one plurality of the combinations, said lever means being engageable with said pin so as to assume one of a plurality of positions controlling the states of said switch means and said electromagnetic vibrating means in a second plurality of combinations, timing means responsive to said clock mechanism for shifting said lever means from engagement with said plate into engagement with said pin, said clock mechanism including a main shaft and "second", "minute", "tens of minutes", and "hour" indicating

wheels with numerals on their circumferential surfaces mounted on said main shaft, said clock mechanism further including a plurality of shifting pinions engaging said wheels and adapted to successively transfer rotation of said time indicating wheels, and said timing means including time setting cam means mounted on said main shaft.

6. A digital clock, as in claim 5, wherein a pinion shaft supports said pinions, said one of said pinions transferring rotation of the "minute" indicating wheel to the "tens of minutes" indicating wheel being fixedly mounted on said pinion shaft.

7. A digital clock, as in claim 5, further comprising a control shaft settable from an initial position to a plurality of set positions, a notched crown gear fitted on said control shaft, a disk-plate having a notch and coupled with said crown gear, a pivotally mounted operating arm biased against said disk-plate to enter the notch when said control shaft is in the initial position, said operating arm being movable out of the notch by rotation of said control shaft from the initial position, said arm, when out of said notch, being effective to constrain said lever means to assume one of said plurality of positions, and spur gear means responsive to operation of the clock mechanism for engaging said notched crown gear and turning said notched crown gear until said arm enters the notch.

8. A digital clock, comprising a clock mechanism, switch means for opening and closing an electrical circuit, vibrating means for producing an alarm, said switch means and said vibrating means being settable in a plurality of combinations of states, said mechanism comprising a selector shaft rotatable to a plurality of discrete positions, cam means having a sector-shaped cam plate secured to said shaft and an eccentric pin protruding from said cam plate, operating lever means engageable with said cam plate and movable by said cam plate to a plurality of positions in which said lever means controls the states of said switch means and said electromagnetic vibrating means in one plurality of the combinations, said lever means being engageable with said pin so as to assume one of a plurality of positions for controlling the states of said switch means and said electromagnetic vibrating means in a second plurality of the combinations, timing means responsive to said clock mechanism for shifting said lever means from engagement with said plate into engagement with said pin.

* * * * *

50

55

60

65