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1968, July 10, 1968
- [33] **Japan**
- [31] **43/20101, 43/37763, 43/40227, 43/40226,**
43/57396, 43/58076 and 43/58075

[56]

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Attorney—McGlew and Toren

[54] ELECTRIC TIMEPIECE

18 Claims, 18 Drawing Figs.

- [52] U.S. Cl. **58/6, 58/50**
R, 58/23 R, 58/125 C
- [51] Int. Cl. **G04h 19/24**
- [50] Field of Search **58/4-6, 23,**
50, 125 C, 145, 152

ABSTRACT: An electric timepiece indicates time by numerals which appear in openings provided on a casing surface of the timepiece. A time indicator mechanism includes time indication elements operable every unit of time such as a minute, a 10 minute interval, an hour and so forth. The driving force of a motor operates according to pulse signals applied at given intervals of time is transmitted selectively to the time indicator mechanism through a driving force transmission mechanism. The transmission mechanism selectively actuates the time indicator mechanism to advance the minute time indication element at each operation of the motor. An advance mechanism responds to movement of each time indication element to its highest numeral, and constrains the transmission mechanism to selectively actuate the time indicator mechanism so as to advance the next higher order time indication element one step.

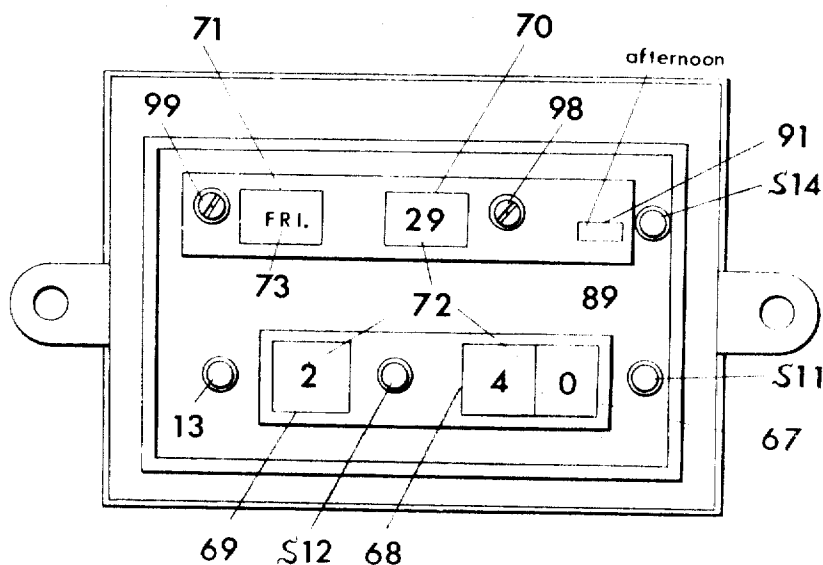


Fig. 1

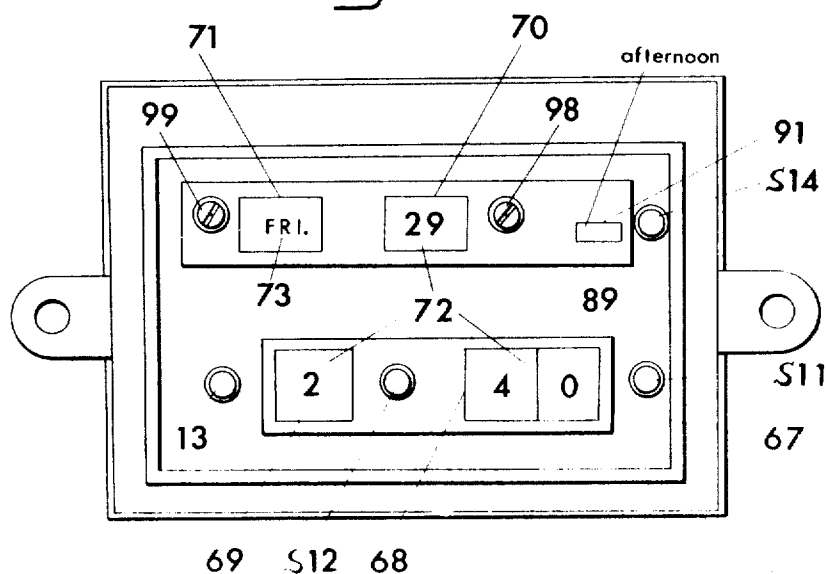
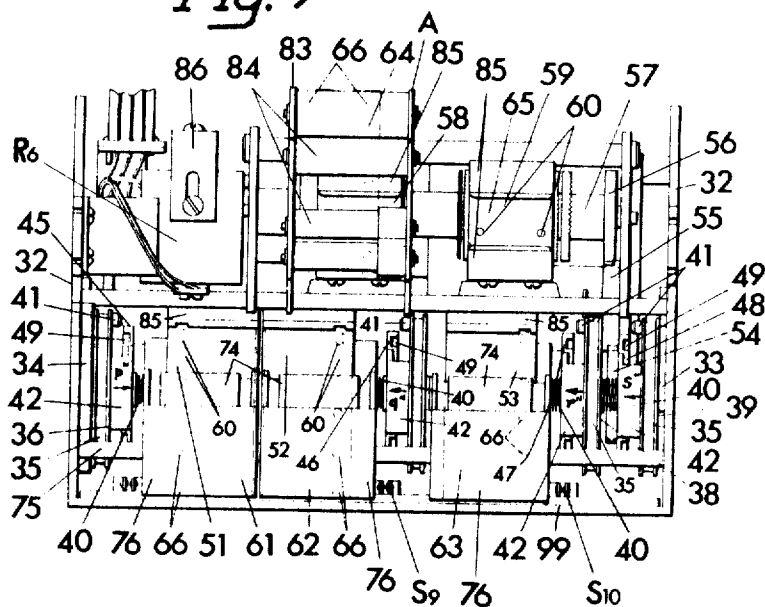


Fig. 7



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Fig. 2

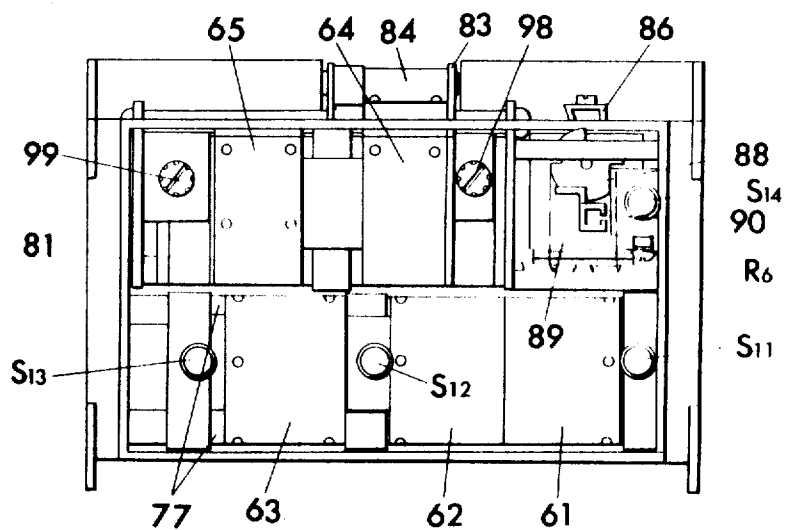


Fig. 11

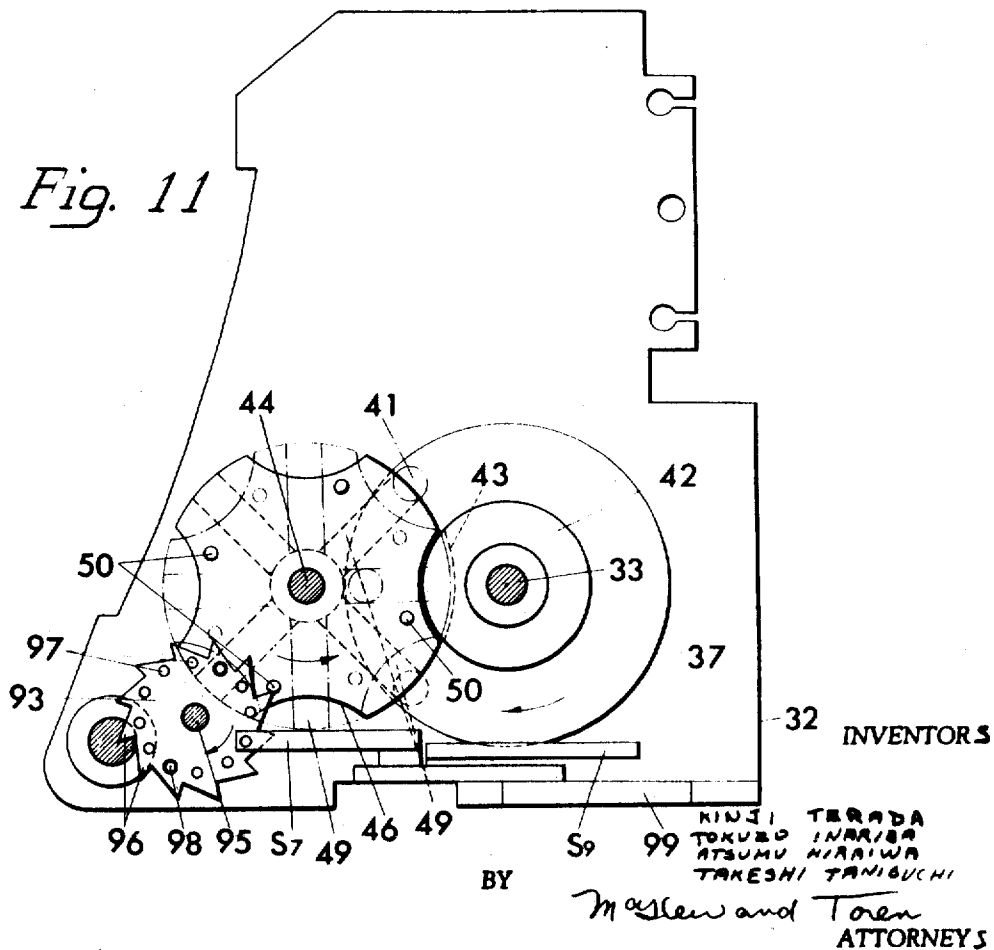


Fig. 3

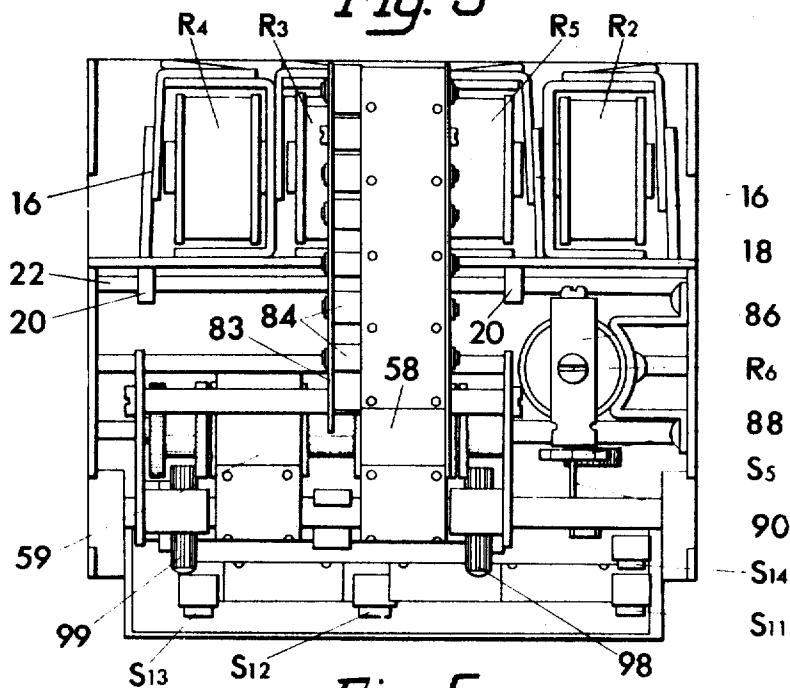
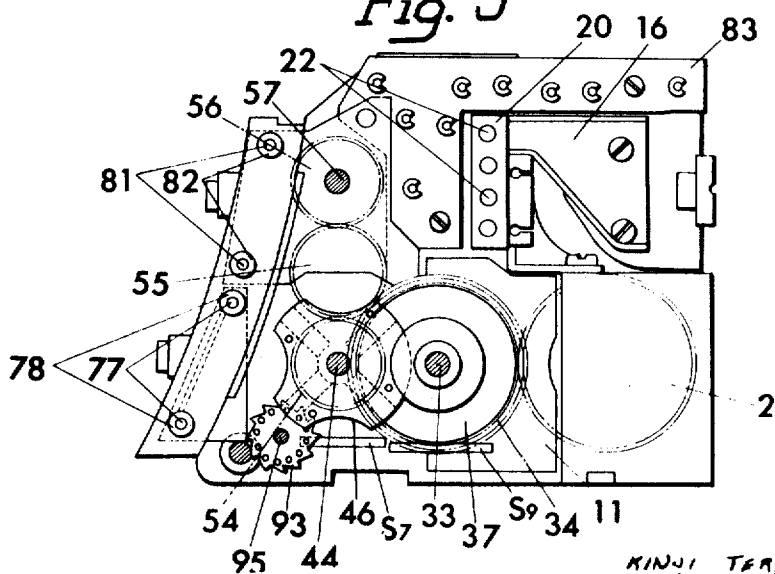


Fig. 5



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Fig. 4

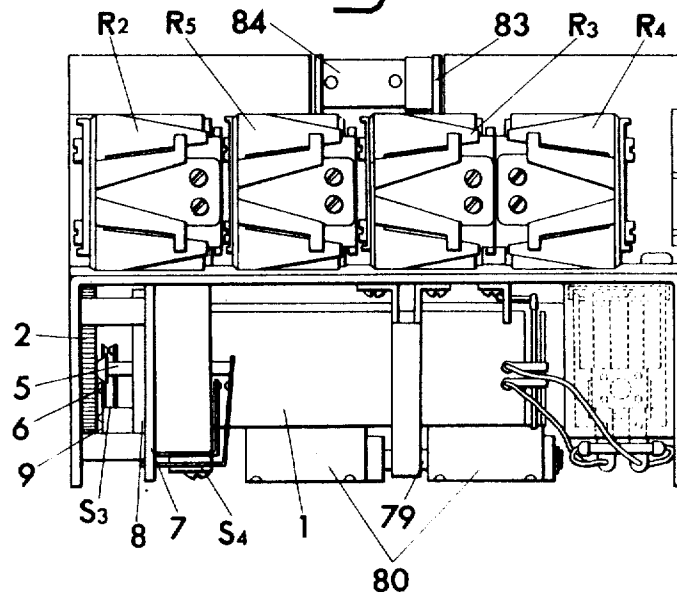


Fig. 13

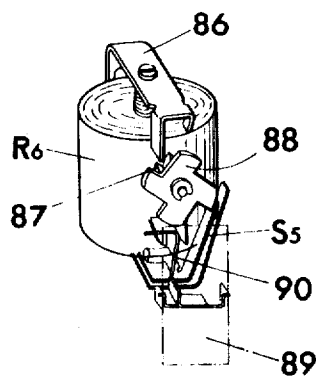
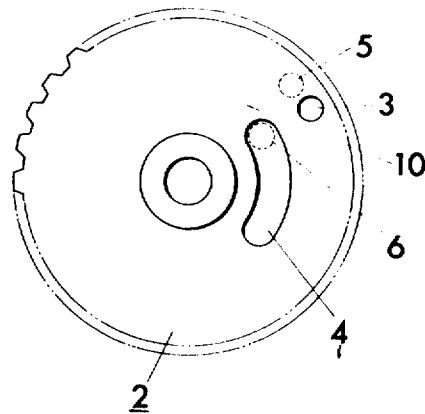
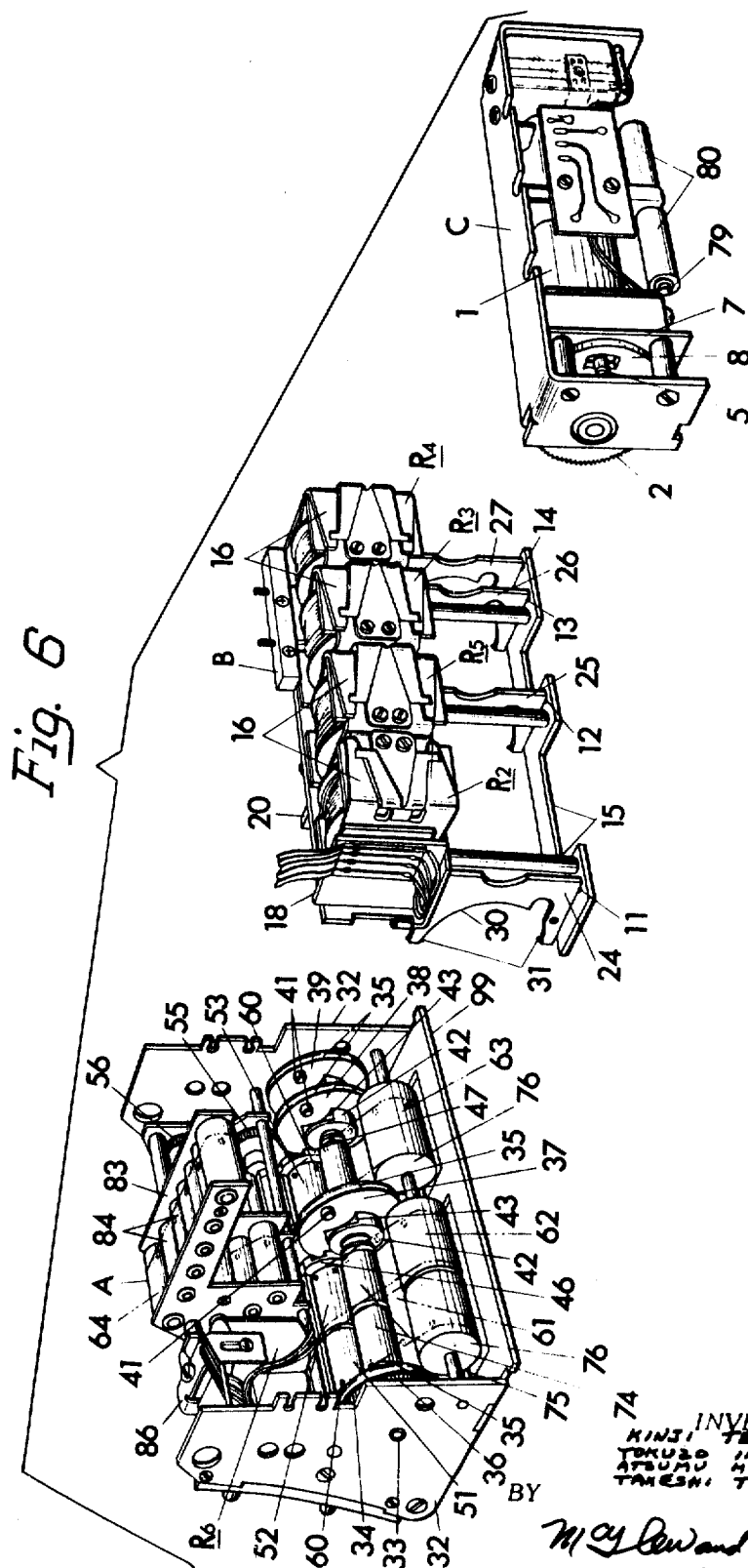


Fig. 10



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Fig. 8

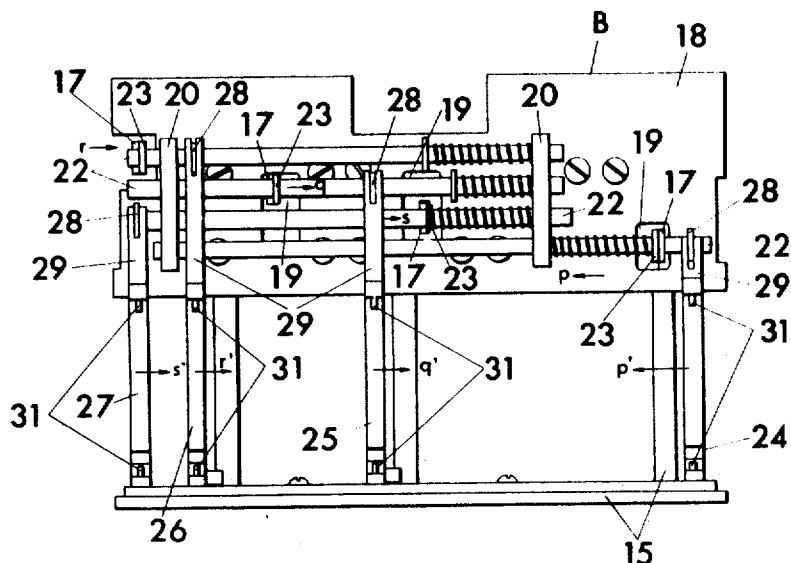
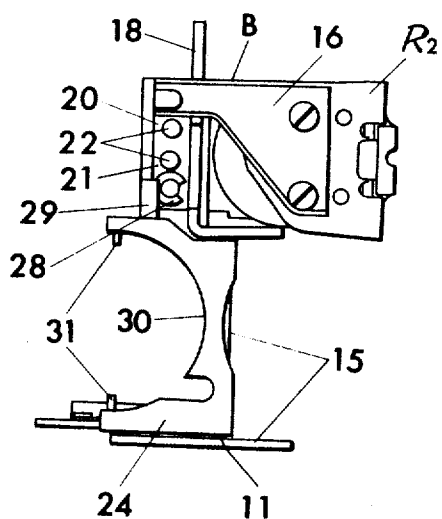


Fig. 9



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Fig. 12

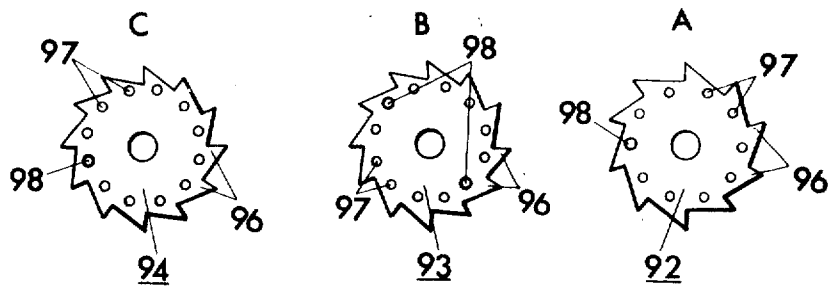
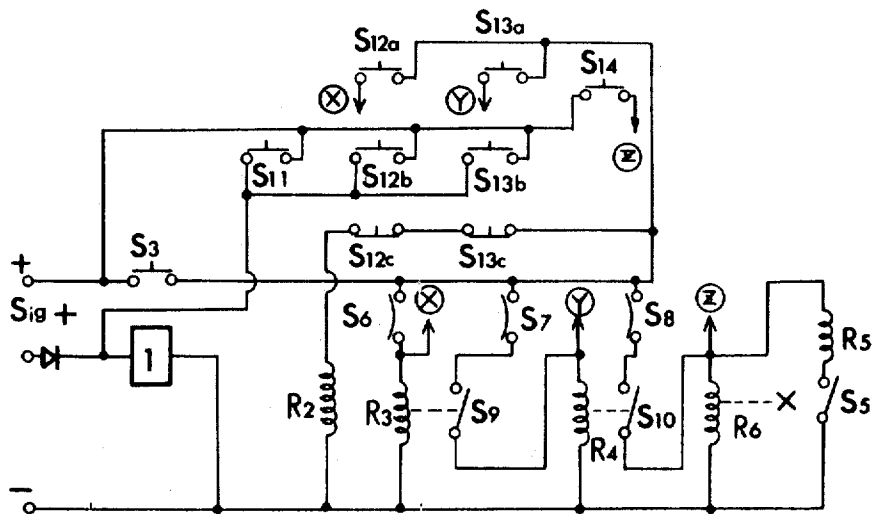


Fig. 18



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Fig. 14

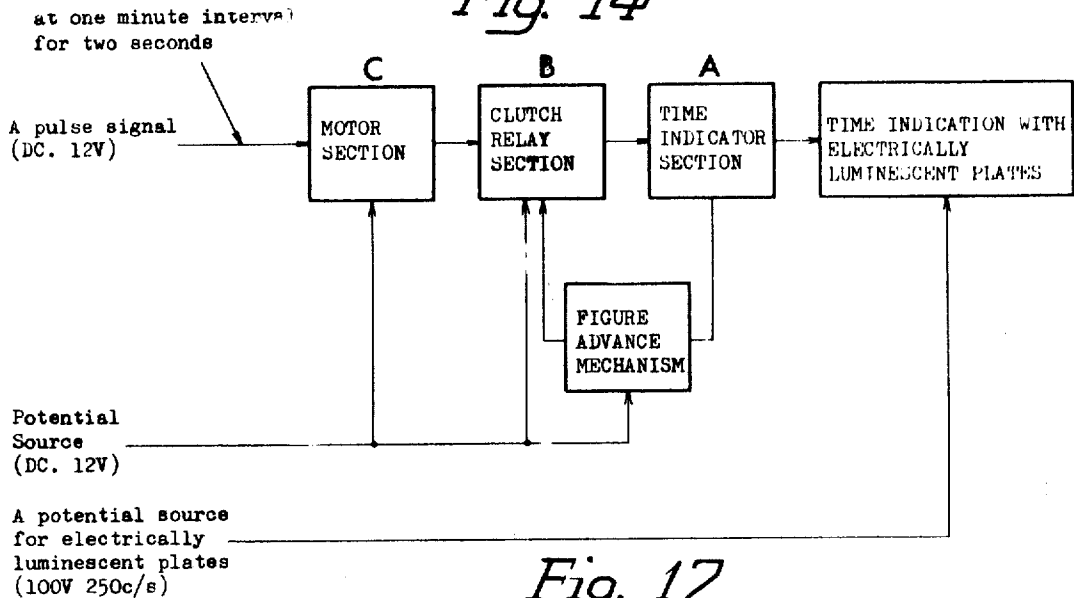
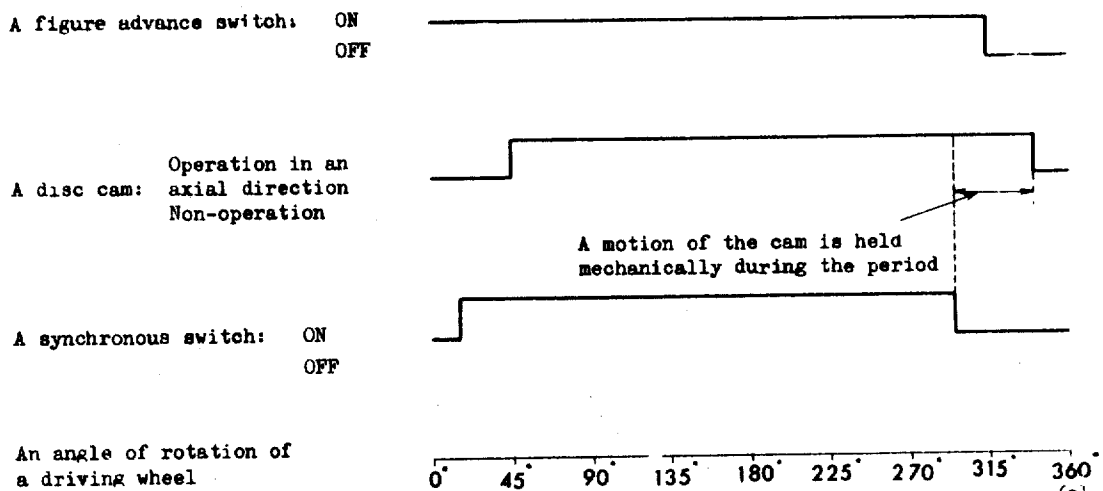


Fig. 17



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Fig. 15

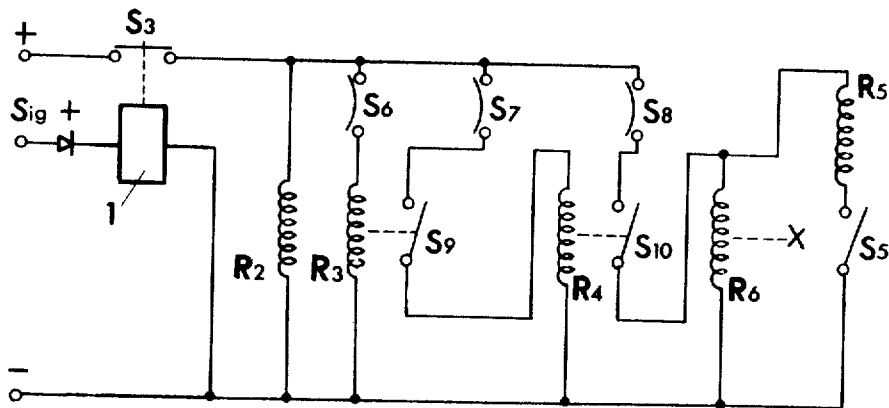
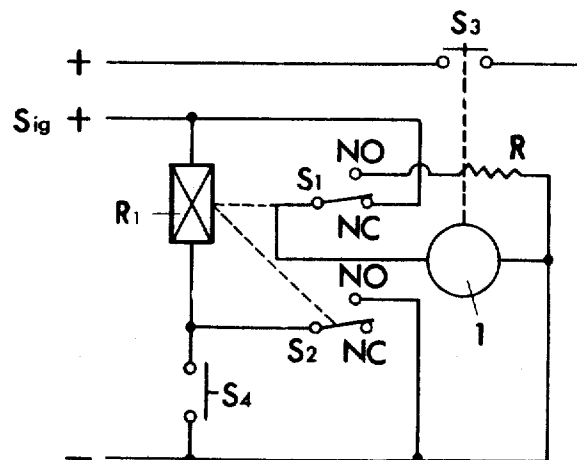


Fig. 16



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ELECTRIC TIMEPIECE

The present invention relates to electric timepieces, particularly for indicating time by numerals which appear in openings provided on a casing surface of the timepiece. The invention relates particularly to such timepieces wherein a time indicator mechanism includes time indication elements operable every unit of time such as a minute, a 10-minute interval, an hour and so forth, and wherein the driving force of a motor which operates according to a pulse signal to be applied at a given interval of time is transmitted selectively to the time indicator mechanism through a force transmission mechanism.

An object of the present invention is to provide an electric timepiece wherein operation of the time indicator mechanism is precisely effected by a motor operating according to a pulse signal which is applied at a given interval of time by a synchronous motor and so forth, so that the electric timepiece can operate precisely even in places subject to vibration, for example in an automobile.

Another object of the present invention is to provide an electric timepiece wherein a time is indicated with numerals appearing in openings provided on a casing surface of the timepiece, and said numerals are individually advanced intermittently and instantaneously upon specific lapses of time and advance of a lower figure to a higher is effected intermittently and instantaneously, so that figures each representing a unit of time appear regularly in the openings, whereby which any one can read a time clearly.

A still further object of the present invention is to provide an electric timepiece wherein endless tapes impressed with a series of numerals representing a corresponding unit of time are transferred by tape feed rolls, said plural endless tapes being accommodated within spaces inevitably formed among respective elements, so that the entire size of the electric timepiece is greatly minimized.

A still further object of the present invention is to provide an electric timepiece wherein an indication of respective unit of time is effected by endless tapes with a series of numerals representing each unit of time impressed thereon, and illumination is applied to said endless tapes on the reverse side thereof so as to show each of said numerals clearly.

A still further object of the present invention is to provide an electric timepiece wherein clutch relays are connected in a row in relation to each of unit time elements of the time indicator mechanism, said clutch relays being actuated individually or in plurality through a figure advance mechanism according to rotation of the motor and serving to transmit the driving force of the motor selectively to respective unit time elements of the indicator mechanism.

A still further object of the present invention is to provide an electric timepiece wherein the indicator mechanism is operated intermittently by opening or closing a main circuit to the potential source, in synchronism with rotation of the motor which operates according to the pulse signal, so that power consumption can be extremely reduced.

A still further object of the present invention is to provide an electric timepiece constructed so, at the time when one operation of the indicator mechanism is finished, the motor is stopped at a given position, irrespective of the residual pulse signal, so as to assure the intermittent operation of the indicator mechanism within a period of pulse signal application, as well as to constantly ensure the exact start position thereof.

A still further object of the present invention is to provide an electric timepiece wherein clutch relays serving as a transmission mechanism of a driving force to the time indication mechanism are connected in parallel in relation to the main electric circuit, figure advance switches are connected in series in relation to the relays, said switches being closed only when the numeral N-1 (9 for minute units, 5 for 10-minute units, 11 or 23 for hour units) preceding the highest numeral N (10 for minute units, 6 for 10-minute units, and 12 or 24 for

hour units) of the lower unit of time is advanced, thereby actuating the relays intermittently, and control switches are connected to the electric circuit including relays for actuating elements of three advanced units of time (an hour, if a minute is regarded as a prime or lowest unit of time), the control switches being closed only when the relay for actuating elements of the lower unit of time (the relay for 10-minute elements in this case) is in actuation, thereby eliminating an unnecessary or erroneous advance of the figure.

A still further object of the present invention is to provide an electric timepiece wherein the main electric circuit to the potential source is energized or deenergized under control of a cam switch in association with rotation of the motor, and the figure advance from the lower unit of time to the higher is effected by switches which close or open the relay circuit of the higher unit of time, in association with pawl wheels actuating according to an intermittent motion of respective unit time elements of the time indicator section, each of which corresponds to each of clutch relays connected to the main electric circuit. At the same time when the cam switch is opened, the highest numeral of the lower unit of time is advanced to shift the higher figure, and immediately after that, the switches for figure advance are also opened, so that contacts of said switches are prevented from burning loss which may often occur at the time of closing or opening.

A still further object of the present invention is to provide an electric timepiece wherein the highest numeral of hour indication is 12, a relay for shifting a morning or afternoon indication is connected in parallel with a relay for day elements, said relay for shifting indication of a morning or afternoon operating through the switch for advancing the hour representing figure to that of a day, and a switch is connected in series with the relay for day indication elements, said switch alternately holding its on or off position according to operation of the relay for shifting a morning or afternoon indication, whereby an indication of morning or afternoon is shifted every 12 hours, while at the same time, the highest numeral representing an hour is advanced to shift the day indication figure.

A further object of the present invention is to provide an electric timepiece wherein correction switches tuned into the on or off position with one touch are provided, for example, if indication of a primal unit of time, a minute in this case, is wrong, the correction switch connected to the main electric circuit is closed to correct the erroneous indication, if the higher unit of time is erroneously indicated, another correction switch operates to open the circuit including the relay for the primal unit of time, and close the electric circuits including the relay for said unit of time and the motor, thereby correcting individually the erroneous time indication.

In the accompanying drawings showing a preferred embodiment of an electric timepiece according to the present invention;

FIG. 1 is a front view of an electric timepiece,

FIG. 2 is a front view of the same, shown with a casing removed,

FIG. 3 is a plan view of the same,

FIG. 4 is a rear side view of the same,

FIG. 5 is a right-side view of the same,

FIG. 6 is an exploded perspective view, showing a section of time indicator mechanism, a section of clutch relay mechanism, and a motor section,

FIG. 7 is a rear side view of the time indicator section,

FIG. 8 is a front view of the clutch relay section,

FIG. 9 is a right side view of the same,

FIG. 10 is a front view of a driving wheel,

FIG. 11 is a view illustrating an operative relation among a disc cam, a cross cam and a pawl wheel for figure advance,

FIG. 12 a, b, c are front view of pawl wheels for figure advance,

FIG. 13 is a perspective view of an element for shifting an indication of morning or afternoon,

FIG. 14 is a view showing an operational relation among respective sections,

FIG. 15 is a diagram of an electric circuit,

FIG. 16 is a detailed diagram of an electric circuit at the motor section,

FIG. 17 is a view illustrating an operative period of time between the figure advance switches and the synchronous switch, and,

FIG. 18 is an entire diagram incorporated with a corrector circuit with a corrector switches.

The present invention having objects as set forth will be described with reference to the preferred embodiment shown in the drawings.

An electric timepiece of the present invention consists, in general of a motor identified as C in FIGS. 6 and 14, a clutch relay section B, an unit time indicator section A and a figure advance section.

The motor section C serves as a driving part. The latter includes a motor operating according to a pulse signal which is applied thereto at intervals of 1 minute. The clutch relay section B serves as a transmission part which transmits the driving force of the motor selectively to the time indicator section A. The latter includes minute indicator elements, 10-minute indicator elements, hour indicator elements and day indicator elements and so forth. The unit time indicator section A is a time indication part which shows the advance of time minute-by-minute, in cooperation with the motor section and the clutch relay section. The figure advance section is a switch system incorporated into the time indicator section A, which mechanically calculates lapses of corresponding units of time, and forms a closed circuit so as to actuate the clutch relay corresponding to the indicator elements of the next higher unit of time.

Thus, the time indicator section A consists of the unit time indicator mechanism incorporated with the figure advance switches, with which the clutch relay section B and the motor section C are removably combined for convenience of assembly. Both the clutch relay section B and the motor section C comprise mechanical construction in combination with electric circuits, while the figure advance section mechanically controls switches arranged at these electric circuits.

The entire diagram of the electric circuit is shown in FIG. 15 while the electric circuit of the motor section C is illustrated in detail in FIG. 16. Now, in FIG. 16, switches S_1 and S_2 each have a normally closed contact NC and a normally opened contact NO. If the pulse signal (DC, 12 v.) is applied for 2 seconds, a motor 1 starts and causes one rotation of a driving wheel 2 (FIG. 10) within the period of signal application (2 seconds). The driving wheel 2, as seen in FIG. 10 is provided at an inner side surface with an outer circumferential aperture 3 and an inner circumferential slot 4 with a bent shape. Facing the aperture 3 and slot 4 are operating pieces 5 and 6 shown in FIG. 4, which serve to close or open the switches S_3 and S_4 of FIGS. 15 and 16. The operating piece 5 slides through to a slot provided on a fitting member 7 and an insulating plate 8 contained within the motor section C, and has an end in contact with one contact of switch S_4 . The operating piece 6 is secured fixedly to the movable contact of the synchronous switch S_3 provided through the insulating plate 9 in relation to the fitting member 7. The piece 6 is adapted to be pressed normally in a longitudinal direction of slot by the action of said contact.

The operating pieces 5 and 6 are maintained at the positions as shown in FIG. 10 just before the initiation of the motor 1. Immediately when the motor 1 starts and rotates the driving wheel 2, the operating piece 6 is displaced from the slot 4 onto a plane surface 10 of the driving wheel 2 to close the synchronous switch S_3 , whereby the main electric circuit connected to the clutch relay section B is energized. After a predetermined rotation of the driving wheel 2 is finished, the operating piece 6 is restored into the slot 4 to open the switch S_3 , thereby deenergizing the main electric circuit. Further rotation of the driving wheel 2 causes the operating piece 5 to enter the aperture 3, and thereby close the synchronous switch S_4 . This closes the circuit of relay R_1 , whereby the movable contacts of switches S_1 and S_2 are turned into the

open position from the normally closed position to cut off the electric circuit to the motor 1 while the residual pulse signal is held until the motor 1 is stopped after locating the operating pieces 5 and 6 in their initial positions.

The clutch relay section B as shown in FIGS. 6, 8, 9, and 15 comprises a relay for minute elements a relay R_2 for 10-minute elements R_3 , a relay R_4 for hour elements, and a relay R_5 for day elements, and clutch plates 24, 25, 26 and 27 mounted to said relays R_2 , R_3 , R_4 and R_5 , respectively. These relays are arranged upwardly of a frame member 15 in order such that, at the leftmost position as seen from the rear side of the timepiece, is located the relay R_2 for minute elements. The relay R_3 for day elements is located adjacent thereto, the relay R_4 for 10-minute elements is next, and at the rightmost position is the relay R_5 for hour elements. Each of the relays has a movable contact 16 with offset ends 17 (FIG. 8) extending to a front portion through slots provided through a bulkhead 18. The bulkhead 18 is provided at the front part thereof with an upright portion 20 with transverse slots 21, through which four rods 22 slide in a transverse direction. Each of rods 22 passes through between offset ends of each movable contact 16. Each rod has a stopper piece 23 fittedly secured thereto adjacent to the offset ends, so that offset ends 17 of each movable contact 16 when they are in an operative position, come into abutment with the stopper pieces 23 to move each of said rods 22 in a direction of attraction of movable contact 16, that is to say, in the directions of the arrows p , q , r , and s in FIG. 8.

Downwardly on the frame member 15 of the clutch relay section, four clutch plates 24, 25, 26 and 27 are each mounted on pivots 11, 12, 13 and 14. They are pivotally supported upright by the pivots 11, 12, 13 and 14 at their rear portions, in a manner permitting a swingeable motion at their front portions. This can best be seen in FIGS. 6, 7 and 8. Each of said clutch plates 24, 25, 26 and 27 is provided with a connecting rod 29 extending to another stopper piece 28 of the rod 22, whereby said clutch plates and rods are in operative connection. Accordingly, the motions of said movable contacts in arrow directions p , q , r , and s due to actuation of said relays R_2 , R_3 , R_4 and R_5 cause the clutch plates to move in rotation in the directions of arrows p' , q' , r' and s' . Each of said clutch plates 24, 25, 26 and 27 has a semicircular cutout portion 30 formed at the front portion, each of which accommodates a below-mentioned disc cam, and pins 31 projected inwardly at upper and under open ends thereof.

Mounted downwardly at a rear portion of the unit time indicator section A is a transverse driven shaft 33. The latter has one end to be fixed, in assembling, with a driven wheel 34, with which the driving wheel 2 of the motor section C is meshed. Four disc cams 36, 37, 38 and 39 each having a circumferential slot 35, are mounted on the shaft 33 at positions corresponding to those of said clutch plates 24, 25, 26 and 27, so as to permit a sliding rotation in a transverse direction with rotation of said driven shaft. The relation between clutch plates and disc cams is such that, at the time of assembling, pins 31 of each of four clutch plates 24, 25, 26 and 27 face within the circumferential slot 35 of each of disc cams corresponding to said clutch plates. At the same time each clutch plate 24, 25, 26 or 27, in its operation, causes respective disc cams 36, 37, 38 or 39 to move axially during rotation in the direction of arrows p'' , q'' , r'' or s'' , respectively. (See FIG. 7). When clutch plates 24, 25, 26 and 27 are in their nonoperative position, disc cams 36, 37, 38 and 39 are restrained from unnecessary transverse motion, by the action of springs provided around the driven shaft 33. Each of disc cams 36, 37, 38 and 39 is provided at one surface with a projection 41 adjacent to an outer circumference thereof, and connected at a central portion thereof to a bulged base portion 42 with a cutout 43.

At a lower portion of the sideplate 32 of the time indicator section A and frontwardly of said driven shaft 33, a fixed support shaft 44 carries rotatable cross cams 45, 46, 47 and 48. The latter effect a given angular rotation while in engagement

with corresponding disc cams 36, 37, 38 and 39 only when said disc cams 36, 37, 38 and 39 are moved transversely by clutch plates 24, 25, 26 and 27. As shown in FIG. 11 each of cross cams 45, 46, 47 and 48 is provided with crosswise slots 49 extending radially from a central part to an outer circumferential edge thereof and has four equally spaced pins 50 each provided on one side surface. The cross cams are normally maintained out of operative relation with disc cams 36, 37, 38 and 39, but when disc cams 36, 37, 38 and 39 are rotated to move transversely according to motion of clutch plates 24, 25, 26 and 27, the projection 41 of each disc cam is brought into engagement with the said crosswise slot 49, so that each of cross cams 45, 46, 47 and 48 is rotated by a quarter every one rotation of each disc cam 36, 37, 38 and 39, as shown in FIG. 11.

Cross cams 45, 46, 47 and 48, to which are fixed a drum 51 for minute elements, a drum 52 for 10-minute elements and a drum 53 for hour elements, respectively, are operatively associated with a drum 58 for a day elements and a drum 59 for week elements through the intermediary of a driving gear wheel 54, an idler wheel 55, a driven gear 56 and a driven shaft 57. Thus rotation of each of cross cams 45, 46, 47 and 48 causes rotation of each of drums 51, 52, 53, 58 and 59. By the rotation of each drum, pins 60 implanted thereon are respectively brought into engagement with pin holes 66 provided on respective endless tapes for time indication 61, 62, 63 and 64 and another endless tape for week indication 65, whereby each of said endless tapes 61, 62, 63, 64 and 65 is moved continually and exactly by a given distance to show respective unit of time in each of openings 67, 68, 69, 70 and 71.

Each of the time indication tapes 61, 62, 63, 64 and the week indication tape 65 are formed endlessly with white numerical patterns 72 on a blackground.

A minute indication tape 61 with a comparatively shorter length is arranged over roll 76 on transverse shaft 75 provided rearwardly of the driven shaft 33, from said driven shaft 33, about upper and under rolls 78 mounted on transverse support shafts 77 arranged frontwardly of the unit time indicator section A. The 10-minute indication tape 62 and hour indication tape 63 each have a length slightly longer than the minute indication tape 61. They are arranged like the minute indication tape, but also about rolls 80 mounted on a support shaft 79 arranged within the motor section C. The week indication tape 65 located upwardly is arranged between the drum 59 and rolls 82 carried by support shafts 81. The day indication tape 64 is longest and arranged in a zigzag path about a number of rolls 84 of a roll group 83.

Each of drums 51, 52, 53, 58 and 59 is provided upwardly and downwardly with a tape holder 85. Behind each of openings 67, 68, 69, 70 and 71 there is provided an electric luminescent plate. Each of the time indication tapes is fed between the luminescent tape and the opening. An electric circuit to the relay for four elements includes a solenoid R_4 which is actuated one time every 12 hours, by means of the figure advance mechanism, and has a movable contact 86. This appears in detail in FIG. 13. A cam 88 is provided integrally with a pawl wheel 87 which is advanced one pawl by the movable contact 86, so as to move alternately upwardly or downwardly a lever 90 of a plate 89 for morning or afternoon indication. Thereby an indication of morning or afternoon in an opening 91 is shifted every 12 hours. The cam 88 operates a switch S_5 , consisting of two resilient plates, which holds the on or off position alternately every 12 hours.

Pawl wheels 92, 93 and 94 (FIGS. 5, 11 and 12) secured adjacent to cross cams 45, 46 and 47 respectively for minute elements, 10-minute elements and hour elements. At every lapse of unit time, the pawl wheels 92, 93 and 94 actuate to close figure advance switches S_6 , S_7 and S_8 . Each switch S_6 , S_7 and S_8 is arranged intermediately between circuits including relays actuating higher figures, thereby advancing respective figures from the lower unit of time to the higher. In detail, the respective pawl wheels 92, 93, and 94 carried by the transverse support shaft 95 are arranged rotatably in relation to respective

cross cams 45, 46 and 47 carried by the support shaft 44 provided rearwardly of the shaft 95 at the lower part of the time indicator section in such manner that the pawl wheel 92 for minute elements corresponds to the cross cam 45 for minute elements, the pawl wheel 93 for 10-minute elements to the cross cam 46 for 10-minute elements, and the pawl wheel 94 for hour elements to the cross cam 47 for hour elements. As seen in FIG. 12, the pawl wheel 92 for minute elements is provided with 10 equally spaced circumferential teeth 96 and 10 equally spaced circumferential cavities 97 including one conductive cavity 98, with which the figure advance switch S_6 , consisting of two resilient plates makes contact, as the pawl wheel is moved. The pawl wheel 92 is rotated by one tooth every quarter rotation of the cross cam 45, by the pin 50 thereof, and actuates to close the electric circuit of the relay R_3 for 10-minute elements, every 10 minutes, since the two resilient plates of the switch S_6 are brought into contact with the conductive cavity 98 every 10 minutes, whereby the figure representing the primal unit of time is advanced to the higher figure.

The pawl wheel 93 is provided with 12 circumferential teeth 96 having 12 cavities including two conductive cavities and effects one rotation every 2 hours, during which said pawl wheel 93 conducts to close the electric circuit of the relay for hour elements R_4 every 60 minutes. The pawl wheel 94 is provided with 12 circumferential teeth 96 and 12 cavities including one conductive cavity 98. Every 12 hours the pawl wheel 94 actuates the solenoid R_4 for morning and afternoon indication arranged at the electric circuit of the relay R_4 for hour elements. In this case, the pawl wheels 92, 93 and 94 are maintained stationary and kept from being unexpectedly actuated, since two resilient plates of each of switches S_6 , S_7 and S_8 are in contact therewith.

At a base plate portion 99 (FIG. 7) of the time indication section and within the range of motion of the under portions of the clutch plates 25 and 26 (FIG. 6) for 10-minute elements and hour elements, control switches S_9 and S_{10} are incorporated. These are arranged to close at the time of actuation of the clutch plates 25 and 26, so that unnecessary or erroneous figure advance is prevented.

In the electric timepiece having the construction as described hereinabove, when pulse signals are applied at 1-minute intervals, the driving wheel 2 intermittently effects one rotation at intervals of 1 minute, and substantially in synchronism therewith, the synchronous switch S_3 is closed to actuate the relay for minute elements R_2 . And then, the cross cam 45 is rotated by a quarter, by the motor 1 and the relay R_2 for minute elements in cooperation with each other, to move the minute indication tape 61 instantaneously a given distance. Thus a correct time is indicated intermittently and instantaneously minute-by-minute. It is the matter of course that the pawl wheel 92 for minute elements is rotated every one tooth per minute. The highest numeral N at a minute indication tape is 10. Just before the numeral N-1 (9 in this case) is shifted to the advanced figure, in other words, just before the cross cam for minute elements 45 is going to stop its rotation after it has been revolved by a given distance to display the numeral 9 impressed on the minute indication tape 61 on the opening 67, the pawl wheel 92 which has been in rotation by the pin 50 of the cross cam 45 is brought its conductive cavity 98 into contact with the switch S_6 . This closes the electric circuit of the relay R_3 for 10-minute elements R_3 . Consequently, when the next pulse signal is applied, both relays for minute elements and 10-minute elements R_2 and R_3 are actuated synchronously to advance the figures representing a minute and 10 minutes to the higher figures, respectively. Thus, numerals which appear on the openings 87 and 88 are advanced to the next synchronously.

The driving wheel 2, the synchronous switch S_3 , disc cams 36, 37 and 38 and figure advance switches S_6 , S_7 and S_8 are in an operational relation as shown in FIG. 17.

As seen from the drawing, the disc cams 36, 37 and 38 are mechanically maintained in an axial motion after the

synchronous switch S_3 is opened to release these disc cams from the compulsory motion in the axial direction to the relays R_2 , R_3 and R_4 , and the cross cams 45, 46 and 47 are maintained in a slight rotation. During the period, the figure advance switches S_6 , S_7 and S_8 are closed or opened. It should be noted that the figure advance switches S_6 , S_7 and S_8 are always closed always prior to closing of the synchronous switch S_3 , and are always open after the synchronous switch S_3 has been opened. This advantageously prevents contacts of switches S_6 , S_7 and S_8 from being damaged due to burning out.

The figure advance from a 10 minutes to an hour, and from an hour to a day is effected in the same way as in that from a minute to a 10 minute. However, since the hour elements are adapted to effect one cyclical motion every 12 hours, the solenoid R_6 for shifting indication of morning or afternoon is arranged in parallel in relation to the relay R_6 for day elements, and a switch S_9 which holds the on or off position every actuation of the solenoid for shifting morning or afternoon indication R_6 , is connected in series to the relay for day elements R_6 , whereby while indication of morning or afternoon is shifted every 12 hours, the hour representing figure is advanced to the higher figure, i.e. the day figure.

In such operation of the figure advance switches, during the period when the figure is going to be advanced from the 10 minute to the hour, the relay for hour elements R_4 connected in parallel in relation to the potential source will be actuated 10 times, unless the control switch S_9 is not incorporated.

For the purpose of eliminating an unnecessary actuation of the relay R_4 , the control switch S_9 is connected in series in relation to the figure advance switch S_7 . The switch S_9 is adapted to be closed only when the relay R_3 for the 10 minute elements is actuated so that figures representing respective unit of time are advanced synchronously in parallelism with each other. For example, when the time is 1 o'clock and 48 minutes, and the pulse signal is applied, the time will be 1 o'clock and 49 minutes. At this time, the switch S_9 is closed to advance the figure which represents a minute, as well as the figure which represents 10 minutes, at the time of application of the subsequent pulse signal, whereby the time becomes 1 o'clock and 50 minutes. Then, the switch S_7 is closed to advance the figure from a 10 minute to the higher. If the control switch S_9 is not incorporated, an hour indicating numeral will be erroneously advanced. For example, from 2 o'clock 51 minutes to 3 o'clock and 52 minutes by application of a subsequent pulse signal. For preventing such erroneous advance of an hour indicating numeral, the control switch S_9 is adapted to be closed only when the relay for 10-minute elements is in actuation, as set forth, whereby the time indication is exactly and orderly effected in such a way as 1 o'clock and 51 minutes, 1 o'clock and 52 minutes and 1 o'clock and 59 minutes. At the next moment, that is, when the highest numeral of the minute indication tape is advanced, the relay for 10-minute elements actuates to close the control switch S_9 , so that both the 10-minute indicating numeral and the minute indication numeral are advanced at one time, whereby the exact time, in this case 2 o'clock, is indicated. The control switch S_9 arranged at the electric circuit which connects the hour elements with the day elements operates similarly as described hereinabove.

Correction or adjustment of time indication in the electric timepiece according to the present invention is effected electrically by closing or opening corrector switches S_{11} , S_{12} , S_{13} and S_{14} (FIG. 18) provided at the main electric circuit to the motor or intermediately at the mean circuit connecting the relays actuating the higher unit time elements and the motor. As an alternative, it may be effected mechanically by screws 98 and 99 in mesh with drums for time indication tapes.

The diagram of electric circuits incorporated with corrector switches is shown in FIG. 18. These corrector switches include the switch S_{11} for correcting a minute indication S_{11} , the switch S_{12} for correcting a 10-minute indication, the switch S_{13} for correcting an hour indication and the switch S_{14} for correcting an indication of morning or afternoon.

An erroneous minute indication is corrected by closing the normally opened switch S_{11} provided at the main electric circuit to the motor 1, an erroneous indication at a 10 minute is corrected by closing the composite switch S_{12} including the normally opened switch S_{12a} to the motor 1 connected to the main electric circuit, the normally opened switch S_{12b} to the relay for 10-minute elements R_3 , and the normally closed switch S_{12c} to the relay for minute elements R_2 , each of which is synchronously closed or opened. The erroneous hour indication is corrected by one operation of the composite switch S_{13} including the normally opened switch S_{13a} to the motor at the main electric circuit, the normally opened switch S_{13b} to the relay for hour elements R_4 and the normally closed switch S_{13c} to the relay for minute elements R_2 , each of which is closed or opened synchronously.

Correction of a morning or afternoon indication is effected by closing the switch S_{14} of the solenoid R_6 , since it has no relation with rotation of the motor 1.

An erroneous indication of a day or a day of week is made mechanically by turning, with a driver or the like, the screws 98 and 99, each of which is in meshed relation with each toothed wheel of the drum for day elements 58 and the drum for the week elements 59.

The electric timepiece of the present invention having such construction as described hereinabove can attain objects as set forth in foregoing passages.

What is claimed is:

1. An electric timepiece comprising a plurality of indication means for displaying time digitally, each of said indication means exhibiting a group of characters, the characters of each group representing time lengths of magnitudes different from the magnitudes of characters in the other groups, motor means operating intermittently in response to pulse signals to be applied at given intervals, a plurality of clutch relay means each associated with a different one of the time units and each being responsive to the operation of said motor means, indicator moving means for intermittently and instantaneously moving selected ones of said indication means a predetermined distance in response to cooperative operation of said motor means and the ones of said relay means associated with the same time lengths as the selected ones of said indication means, figure-advance means responding to said indicator moving means for actuating said clutch relay means on the basis of the operation of said indicator moving means, whereby said indication means may indicate a time in openings provided on a casing about the timepiece.

2. An electric timepiece comprising a motor operating according to pulse signals to be applied at given intervals, a plurality of clutch relays each responsive to operation of said motor and each associated with one of a plurality of respective time lengths of different magnitudes, a figure-advance mechanism, a time indicator mechanism, a plurality of indication means each having a series of characters thereon to indicate units respective time lengths, said indicator mechanism having moving means for moving selected ones of said indication means intermittently and instantaneously a predetermined distance in response to operation of said motor and clutch relays in cooperative relation with each other, said figure-advance mechanism having actuating means responding to said moving means for actuating selected ones of said clutch relays on the basis of the operation of said moving means, clutch plates in said clutch relays each including a bent-shaped cutout portion with pins extending inwardly thereof and pivoting means for permitting a swingeable motion of the first part thereof, a driven shaft responsive to said motor, a plurality of disc cams each having a circumferential slot and an offset pin at one side surface thereof, said cams each being mounted on said shaft to rotate with said shaft and to permit sliding motion in an axial direction, said disc cams being arranged in alignment with respective ones of said clutch plates, each of said clutch plates engaging their pins with the circumferential slot of each disc cam to effect axial movement of said disc cams during rotation of said disc cams,

driven wheels each having radial slots arranged to be freely rotatable adjacent to said disc cams, each of said driven wheels being intermittently revolved by one of said offset pins when said offset pin is brought into engagement with one of said radial slots as said disc cams effect an axially sliding motion, a plurality of drums responsive to said driven wheels and moved intermittently, said indication means engaging said drums for responding thereto.

3. An electric timepiece as claimed in claim 1, wherein said clutch relay means each comprise a relay coil for actuating respective time elements, said coils being arranged in a row at a substantially equal spacing, a frame member supporting said relay means, and clutch plates corresponding to said relay coils arranged in a row at unequal spacings, each of said clutch plates having a front and rear portion and being pivoted at its rear portion relative to the frame member for permitting the front portion to swing in a direction transverse to the axis of the pivot, said relay means having movable contacts responsive to said coils, said clutch plates being moved by action of movable contacts, said relay coils being actuated by the motor, said clutch plates being arranged for transmitting the driving force to the time indication mechanism.

4. An electric timepiece, comprising a motor operating according to pulse signals to be applied at given intervals, a plurality of clutch relays each responsive to the operation of said motor and each associated with one of a plurality of respective time elements, a time indicator mechanism, a plurality of indication means each having a series of numerals impressed thereon to indicate respective units of time, said indicator mechanism having moving means for moving selected ones of said indication means intermittently and instantaneously over a predetermined distance in response to operation of said motor and clutch relays in cooperative relation with each other, a figure-advance mechanism, said figure-advance mechanism having actuating means responding to said moving means for actuating means selected ones of said clutch relays on the basis of the operation of said moving means, said indicator mechanism including a plurality of endless tapes each exhibiting a series of characters representing respective units of time and having pin holes, said indicator mechanism further including a plurality of drums for carrying said endless tapes and having pins engageable with said pin holes of respective endless tapes.

5. An electric timepiece, comprising a motor operating according to pulse signals to be applied at given intervals, a plurality of clutch relays each responsive to operation of said motor and each associated with one of a plurality of respective time lengths, a figure-advance mechanism, time indicator mechanism, a plurality of indication means each having a series of characters thereon to indicate units of respective time lengths, said indicator mechanism having moving means for moving selected ones of said indication means intermittently and instantaneously a predetermined distance in response to operation of said motor and clutch relays in cooperative relation with each other, said figure-advance mechanism having actuating means responding to said moving means for actuating selected ones of said clutch relays on the basis of the operation of said moving means, switch means responding to the motor, a main electric circuit responsive to said switch means for energizing the relays, said switch means responding to rotation of the motor to open immediately after on a cyclical operation of said motor, and second switch means responsive to the rotation of the motor for cutting off the pulse signals applied to the motor after a predetermined motor rotation and including relay means for keeping the motor cut off from the signals to the end of each signal.

6. An electric timepiece as claimed in claim 5, wherein said second switch means comprises a relay switch and a disc cam operating said switch, said switch being connected to the motor in parallel relation to the main electric circuit, said second switch means including a motor relay connected in series with said relay switch and a plurality of control switches connected in series with the motor and magnetically actuated

by said motor relay, said relay switch being closed instantaneously every predetermined rotation of the disc cam to actuate the motor relay, said control switches being set to be turned by the motor relay into the off position to cut off the electric circuit to the potential source of the motor, and circuit means in said second switch means to maintain the motor relay in actuation.

7. An electric timepiece as claimed in claim 5, wherein said second switch means includes a relay switch and a disc cam operating said relay switch, said relay switch being connected in parallel relation to the electric circuit to the signal source for the motor, said second switch means including a motor relay connected in series with said relay switch and a plurality of control switches each connected in series with a positive side and negative side of the signal source of the motor so as to actuate said motor relay, said relay switch being closed instantaneously every predetermined rotation of the disc cam to actuate the motor relay, said control switches being set to be turned by the motor relay into the off position to cut off the potential source to the motor, thereby restraining electrical rotation of the motor, and said second circuit means including holding circuit responsive to said control switches for holding said relay until the end of each of the signals.

8. An electric timepiece, as claimed in claim 5, wherein said second switch means comprises a relay switch and a disc cam operating said relay switch and connected in parallel in relation to the main electric circuit to the signal source to the motor, said second switch means further including a motor relay connected in series with said switch and control switches connected in series with the motor and operated by said motor relay, said relay switch being closed instantaneously every predetermined rotation of disc cam to actuate the motor relay, said control switches being turned by said motor relay to cut off the signal source to the motor, said circuit means forming with said control switches a holding circuit for said relay, said first switch means including a synchronous switch associated with said disc cam for operating the indicator mechanism during rotation of the motor.

9. An electric timepiece comprising a motor operating according to pulse signals to be applied at given intervals, a plurality of clutch relays each responsive to operation of said motor and each associated with one of a plurality of respective time elements of ascending order, a figure-advance mechanism, a time indicator mechanism, a plurality of indication means each having series of N numerals thereon to indicate units of respective time elements, said indicator mechanism having moving means for moving selected ones of said indication means intermittently and instantaneously a predetermined distance in response to operation of said motor and clutch relays in cooperative relation with each other, said figure-advance mechanism having actuating means responding to said moving means for actuating selected ones of said clutch relays on the basis of the operation of said moving means, in moving selected ones of said indication means, a main electric circuit, said relays for respective time elements being connected in parallel in the main electric circuit, said actuating means having a plurality of advancing switches responsive to said moving means and serving for actuating a clutch relay of a higher time element in response to said moving means moving the indication means that exhibits units of the next lower time element and being connected in series in relation to a plurality of said relays for respective time elements, said relay for the lowest element of time being connected directly into the main electric circuit, said switches being closed by said moving means only when the numeral N-1 lesser than the highest numeral N of a lower element of time is advanced into the higher numeral, said figure-advance means having additional switches responsive to said clutch relays and closed only at the time of energization of the relays for lower time elements, said additional switches being connected in series to the relays for time elements higher than the lowest two.

10. An electric timepiece comprising a motor operating according to pulse signals to be applied at given intervals, a plurality of clutch relays each responsive to operation of said motor and each associated with one of a plurality of respective time elements of ascending order, a figure-advance mechanism, a time indicator mechanism, a plurality of indication means each having a series of numerals impressed thereon to indicate respective units of time, said indicator mechanism having moving means for moving selected ones of said indication means intermittently and instantaneously by a predetermined distance in response to operation of said motor and clutch relays in cooperative relation with each other, said figure-advance mechanism having actuating means responding to said moving means for actuating selected ones of said clutch relays on the basis of the operation of said moving means in moving selected ones of said indication means, a main electric circuit for connection to a potential source, said electric circuit being operable under control of a plurality of first switches in association with rotation of the motor, said moving means including a plurality of pawl wheels each associated with one of the time elements and advance means responsive to operation of said clutch relays for advancing each of said pawl wheels for each operation of said clutch relay associated with the same time element, said figure-advance means including a plurality of pawl switches, a conductive member on each of said pawl wheels for actuating said pawl switches in response to a predetermined rotation of each of said pawl wheels; said figure-advance mechanism forming with said pawl switches control circuit means for actuating, in response to operation of one of said pawl switches of one time element, the clutch relay associated with the time element of the next higher order, whereby for each closing of a pawl switch of one time element the pawl of the next higher time element is advanced; said figure-advancing means including a feed mechanism attached to respective ones of said pawl wheels for advancing said indicator mechanism.

11. An electric timepiece as claimed in claim 10, wherein each of said pawl wheel has a plurality of teeth and a series of cavities including a cavity lined with a conductive material, said pawl switches each including two resilient plates having projections which are brought into contact with said conductive material as said pawl wheels are rotated.

12. An electric timepiece comprising a motor operating according to a pulse signal to be applied at a given interval, a plurality of clutch relays each responsive to operation of said motor and each associated with one of a plurality of respective time elements, said time elements being minutes, 10-minute units, hours and days, a figure-advance mechanism, a time indicator mechanism, a plurality of indication means each having series of numerals thereon to indicate respective units of time, said indicator mechanism having moving means for moving selected ones of said indication means intermittently and instantaneously a predetermined distance in response to operation of said motor and said clutch relays in cooperative relation with each other, said figure-advance mechanism having actuating means responding to said moving means for actuating selected ones of said clutch relays on the basis of the operation of said moving means in moving selected ones of said indication means, said figure-advance mechanism including a plurality of switch means each corresponding to one of said time elements and each connected to one of said clutch relays for actuating the one of said clutch relays corresponding to the next higher time element and said time indicator means, said figure-advance mechanism including advancing means responsive to said moving means for actuating each of said switch means once each time the moving means for actuating each of said switch means once each time the moving means senses that the clutch relay corresponding to the same time element has operated a number of times equal to the next higher time element, the highest numeral for the hour indication

being 12, said figure-advance mechanism including a shift relay for shifting between indications of morning and afternoon being connected in parallel with said relay for days, said relay for days being actuated through said switch means corresponding to the hours, said figure-advance mechanism including shift switch means in series with said relay for days, said shift switch means being held alternately its on and off position in association with said relay for morning or afternoon indications.

13. An electric timepiece as claimed in claim 12, wherein said shift relay for a morning and afternoon indication comprises a shifting pawl wheel arranged to operate rotatably and a shift cam secured to said pawl wheel, said shift switch being engaged to said shift cam to be held alternately an open and closed position.

14. An electric timepiece as claimed in claim 1, wherein said indication means includes indication plates, indication tapes with the numerals, and illumination means having an electroluminescent material provided at a reverse side of said indication plates; a transparent portion on each of said indication tapes, said plates, tapes and illumination means being aligned one behind the other.

15. An electric timepiece comprising a motor operating according to pulse signals to be applied at given intervals, a plurality of clutch relays each responsive to operation of said motor and each associated with one of a plurality of respective unit time elements, a figure-advance mechanism, a time indicator mechanism, a plurality of indication means having a series of characters thereon to indicate respective units of time said indicator mechanism having moving means for moving selected ones of said indication means intermittently and instantaneously a predetermined distance in response to operation of said motor and clutch relays in cooperative relation with each other, said figure-advance mechanism having actuating means responding to said moving means for actuating selected ones of said clutch relays on the basis of the operation of said moving means in moving selected ones of said indication means, said time indication means including endless tapes each having the numerals thereon in a series, said indication means having means for illuminating said endless tapes at their reverse sides.

16. An electric timepiece comprising a motor operating according to pulse signals to be applied at given intervals, a plurality of clutch relays each responsive to operation of said motor and each associated with one of a plurality of respective time elements, said time elements being minutes, 10-minute units, hours and days, a figure-advance mechanism, a time indicator mechanism, a plurality of indication means having a series of numerals impressed thereon to indicate means respective units of time, said indicator mechanism having means for selecting and moving said indication means intermittently and instantaneously a predetermined distance in response to operation by said motor and clutch relays in cooperative relation with said each other, said figure-advance mechanism having actuating means responding to said moving means for actuating selected ones of said clutch relays on the basis of the operation of said moving means in moving selected ones of said indication means, a plurality of corrector switches in series with said clutch relays for advancing said clutch relays and thereby correcting erroneous indication of corresponding time.

17. A timepiece as claimed in claim 1, wherein said figure-advance means enables the clutch relay means associated with time length magnitude greater than the lowest magnitude in response to said moving means advancing said indication means of the next lower magnitude to a predetermined character.

18. A timepiece as claimed in claim 17, wherein said predetermined character is the highest of the time units of that magnitude.