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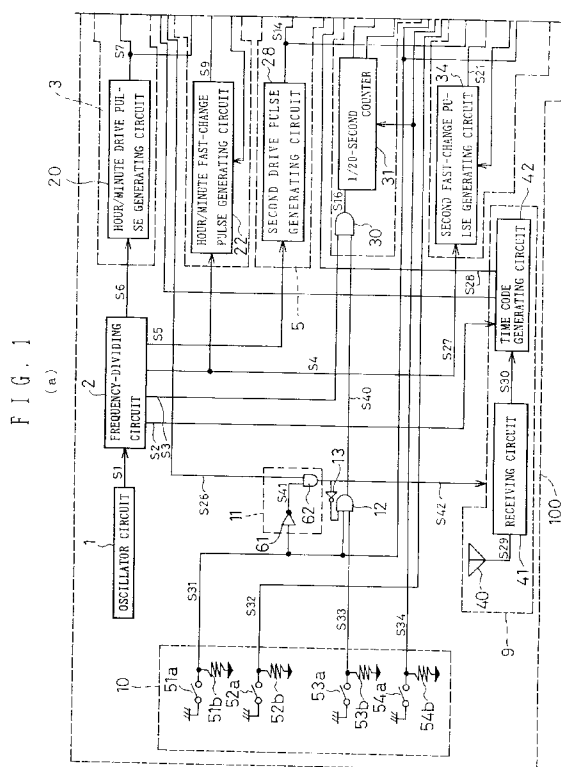
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06.12.1995 JP 317725/95(71) Applicant: CITIZEN WATCH CO. LTD.
Shinjuku-Ku Tokyo 163-04 (JP)(72) Inventor: Yasuoka, Tadashi,
c/o Citizen Watch Co., Ltd.
Honmachi, Tanashi-shi, Tokyo (JP)(74) Representative: Skone James, Robert Edmund
GILL JENNINGS & EVERY
Broadgate House
7 Eldon Street
London EC2M 7LH (GB)

(54) Watch with a radio signal controlled correction function

(57) In a multifunction watch having as an object the provision of a radio-signal-controlled time correction function, a receiving enabling means (41) is provided which enables operation of a time code receiving means (42) only when a display contents selection means is selecting the contents of a time-measuring means. Additionally, either a function mode stopping means which stops the function mode operating means or a function

mode display prohibiting means is provided for the case in which this receiving enabling means is enabling operation of the time code receiving means. This enables the achievement of a high-performance receiving circuit by preventing the simultaneous operation of the time code receiving means and the function mode operating means, the latter operating at high speed and having a high noise level, which leads to deterioration of receiving performance.



Description

The present invention relates to a watch with a radio signal controlled correction function.

With advances in quartz watches, the time accuracy of watches has advanced dramatically. However, when even further time accuracy is required, it is necessary to perform correction of a quartz watch periodically from an external source. Time signals from a radio or TV broadcast are used as a such as means for correction, and a watch to which a radio receiving function has been added and with a radio signal correction function has already been used in fixed-installation clocks, VCRs, and the like. There are long-wave standard radio signals modulated by time/calendar information as a time code, this being widely used in Europe. By using a radio signal with this time code, it is not necessary, as with the use of a radio or TV time announcement, to set the watch beforehand, so that it is possible to capture the time accurately when the radio signal correction is completed, even if the time on the watch was not correct. A watch such as this, with a radio signal correction function, has been disclosed in, for example, unexamined patent publication (KOKAI) No. 5-142365. It is, therefore, with a radio signal corrected watch that receives a radio signal having a time code, not only to have accuracy of time-keeping, but also to eliminate the need to set the time, making watch extremely easy to used. A chronograph-type watch that has a stopwatch function has been disclosed in, for example, in unexamined patent publication (KOKAI) No. 3-211490. As watches having a radio signal controlled correction function became recognized in the marketplace, there were demands to provide the radio signal control correcting function watch with features provided on previous watches, such as a local time function, an alarm function, and chronographic functions.

However, when other functions are simply added to above-described radio signal corrected watch, power supply noise for another function and noise from operating signals of these other functions cause a deterioration in receiving performance. While in recent years, with the adoption of microcomputers in electronic watches, it has become common for chronographic functions to be implemented using a program used for a microcomputer, high-speed processing is required for the obtaining of a time code from a received radio signal, making the achievement of both this and other functions difficult.

To provide a solution to the above-noted shortcomings in the prior art, an object of the present invention is to provide a radio signal time correction function in a watch having a variety of other functions, including chronographic functions.

SUMMARY OF THE INVENTION

To achieve the above-noted object, a radio signal correction function watch according to the present in-

vention has the following basic technical constitution. Specifically, the watch is a radio signal controlled correction function watch having a power supply, an oscillation means, a means for frequency-dividing an oscillation signal from the above-noted oscillation means to generate a frequency-divided signal, a time-measuring means to keep time based on the above-noted frequency-divided signal, a functional mode operating means for performing operation of functions other than time-measuring, a display contents selection means for selecting information from either the above-noted time-measuring means or the above-noted functional mode operating means, a display means for displaying the information selected by the above-noted display contents selection means, a switching means for operating the above-noted functional mode operating means and the above-noted display contents selection means, a time code receiving means for receiving a standard radio signal and sending time data to the above-noted time-measuring means, and a reception enabling means for causing the above-noted time code receiving means to operate only when the above-noted display contents selection means is selecting the information from the above-noted time-measuring means.

FIG. 1 is a block diagram which shows the configuration of the first example of a watch having a radio signal controlled time correction function according to the present invention.

FIG. 2 is a block diagram which shows the configuration of the second example of a watch having a radio signal controlled time correction function according to the present invention.

FIG. 3 is an outer view of the second example of a watch having a radio signal controlled time correction function according to the present invention.

FIG. 4 is a block diagram which shows the configuration of the third example of a watch having a radio signal controlled time correction function according to the present invention.

FIG. 5 is a block diagram which shows the configuration of the fourth example of a watch having a radio signal controlled time correction function according to the present invention.

An embodiment of the present invention will be described in detail below. FIG. 1 is a block diagram of a watch 100, which has radio signal controlled correction function which receives a radio wave signal including time code data therein, and which has a chronographic function as an operating mode, this watch being the first example of the present invention. In FIG. 1, the reference numeral 1 denotes an oscillator circuit, which is the oscillation means, 2 is a frequency-dividing circuit, which is the frequency-dividing means that divides the output, oscillation signal S1, of the oscillator circuit 1, thereby obtaining a frequency-divided signal S2 which is required in generating a time code, a frequency-divided signal S3 which is required in generating a 1/20-second count, a frequency-divided signal S4 which is re-

quired in generating a pulse for fast changing of the hour, minute, and second, a frequency-divided signal S5 which is required in generating a drive for each second, and a frequency-divided signal S6 which is required in generating an hour/minute drive for each minute. In this same drawing, 20 is an hour/minute drive pulse generating circuit which generates an hour/minute drive pulse S7 for each minute from the frequency-divided signal S6, 21 is an hour/minute counter which performs hour/minute time-measuring by counting each pulse of the hour/minute drive pulse S7, this hour/minute counter 21 being capable of correction of time-measuring data according to a time data signal S27 from a time code generating circuit 42, and outputting hour/minute counter data signal S8. When a pre-established time is reached by the time-measuring data, the hour/minute counter 21 outputs a receiving operating signal S26 as a high level to cause a time code receiving means 9 to go into the operating condition, and when a given amount of time has elapsed, the receiving operating signal S26 is changed to a low level, so that the time code receiving means 9 is put into the non-operating condition. A time-measuring means 3 is formed by the hour/minute drive pulse generating circuit 20 and the hour/minute counter 21.

The reference numeral 22 denotes an hour/minute fast-change pulse generating circuit, this circuit generating, by means of the frequency-divided signal S4 from the frequency-dividing circuit 2, a fast-change pulse S9 for the purpose of fast changing of an hour/minute motor, this circuit operating by the change to a high level of a comparison signal S12 from a comparison circuit 25, to be described later. The reference numeral 23 denotes a selection circuit, which when the comparison signal S12 is low level outputs a selected pulse signal S10 as the hour/minute drive pulse S7, and which when the comparison signal S12 is high level, outputs the selected pulse signal S10 as the fast-change pulse S9. Reference numeral 24 denotes an hour/minute hand position counter, which counts the selected pulse signal S10 to count the positions of the hour and minute hands, and which outputs an hour/minute hand position data signal S11. Reference numeral 25 is a comparison circuit which compares an hour/minute count data signal S8 with the hour/minute hand position data signal S11, thereby making a comparison between the hour/minute counter 21 and the hour/minute hand position counter 24, and the comparison circuit 25 outputs the comparison signal S12 as a low level, if these coincide to each other while outputting a high level of the comparison signal S12 if these do not coincide. There is a possibility, such as for example when the time-measuring data of the hour/minute counter 21 is corrected by means of the time data signal S27 from the time code generating circuit 42, that the values of the hour/minute counter 21 and the hour/minute hand position counter 24 will not coincide, in which case this comparison circuit 25 outputs a high-level comparison signal S12, so that the se-

lected pulse signal S10 output by the selection circuit 23 is the fast-change pulse S9 until the count data values of the hour/minute counter 21 and the hour/minute hand position counter 24 coincide. Reference numeral 26 denotes an hour/minute motor which provides drive, by means of the selected pulse signal S10. A display means is formed by the hour/minute fast-change pulse generating circuit 22, the selection circuit 23, the hour/minute hand position counter 24, the comparison circuit 25, the hour/minute motor 26, and a set of hour and minute hands 27.

Reference numeral 28 denotes a second drive pulse generating circuit which generates a second drive pulse S14 for each second from the frequency-divided signal S5, and 29 is a second counter which performs second time-measuring by counting each pulse of the second drive pulse S14, this being able to correct the second count data in accordance with the time data signal S28 from the time code generating circuit 42, and outputting a second count data signal S15. A time-measuring means 5 is formed by the second drive pulse generating circuit 28 and the second counter 29.

Reference numeral 30 denotes an AND gate, to which is input a function mode stopping signal S40 from a function mode stopping means 12, to be described later. When the function mode stopping signal S40 is low level, the output of this AND gate 30 is low level, and when the function mode stopping signal S40 is high level, the output of the AND gate 30 is the frequency-divided signal S3 which is required for 1/20-second (chronological second) counting. Reference numeral 31 denotes a 1/20-second counter which, when the signal S16 is the frequency-divided signal S3, counts this frequency-divided signal S3, outputting a chrono-second signal S17 while also outputting a 1/20-second data signal S35. The 1/20-second counter 31 in which a second is divided by 20, has a reset terminal, which is reset when a switching signal S34 from the switching means 10 is high level. Reference numeral 32 denotes a chrono-second counter, which counts the chrono-second signal S17 from the 1/20-second counter 31, and outputs a chrono-second count data signal S18. The chrono-second counter 32 has a reset terminal, which is reset when the switching signal S34 from the switching means 10 is high level. Reference numeral 33 denotes a selection circuit which outputs the 1/20-second count data signal S35 when a switching signal S32 from the switching means 10 is high, and outputs the chrono-second count data signal S18 when the switching signal S32 from the switching means 10 is low. A function mode operating means 6 is formed by the AND gate 30, the 1/20 second counter 31, the chrono-second counter 32 and the selection circuit 33.

Reference numeral 7 is a selection circuit, which is a display contents selection means which, when a switching signal S31 from the switching means 10 is low level, outputs as a selected counter data S20 as a second count data signal S15 for the second counter 29,

while switching signal S31 is high level, it outputs as a selected counter data S20 a selected count data signal S19 from the function mode operating means 6. Reference numeral 34 denotes a second fast-change pulse generating circuit which generates from the frequency-divided signal S2 from the frequency dividing means 2 a fast-change pulse S21 for the purpose of fast drive of a second motor 38, this operating by a comparison signal S24 from a comparison circuit 37 changing to high level.

Reference numeral 35 denotes a selection circuit which outputs as a selected pulse S22 the second drive pulse S14 from the second drive pulse generating circuit 28 when the switching signal S31 from the switching means 10 is low level, and which outputs as the selected pulse S22 the fast-change pulse S21, when the switching signal S31 from the switching means 10 is high level. Reference numeral 36 denotes a second hand position counter which counts each pulse of the selected pulse signal S22 to count the second hand position, and which outputs a second hand position data signal S23. Reference numeral 37 denotes a comparison circuit which compares the second counter data signal S15 and the second hand position data signal S23, and which outputs the comparison signal S24 as a low level if these coincide and a high level if these do not coincide. Reference numeral 38 denotes the second motor, which is driven by the selected pulse signal S22, this motor driving the second hand 39. A Display means 8 is formed by the second fast-change pulse generating circuit 34, the selection circuit 35, the second hand position counter 36, the comparison circuit 37, the second motor 38, and the second hand 39.

Reference numeral 40 denotes an antenna which receives a radio signal containing a time code and in which is generated the radio signal S29. Reference numeral 41 denotes a receiving circuit which demodulates the radio signal S29 to generate the demodulated signal S30, and 42 is a time code generating circuit which derives a time code from this demodulated signal S30 and generates a time data signal S27 which is the hour/minute time data and a time data signal S28 which is the second time data. The time code generating circuit 42 generates the time code by sampling the demodulated signal S30 by means of the frequency-divided signal S2 from the frequency dividing means 2. The antenna 40, the receiving circuit 41, and the time code generating circuit 42 form a time code receiving means 9, this operating when the receiving enable signal S42 from a receiving enabling means 11, to be described later, is high level.

Reference numeral 10 denotes a switching means which is formed by switches 51a, 52a, 53a, and 54a, which are connected to the VDD level (high level) when in the ON condition, and pull-down resistors 51b, 52b, 53b, and 54b, which are connected to the VSS level (low level). Switch 51a is the display mode switch, which makes switching signal S31 high level (VDD level) when

in the ON condition and which makes switching signal S31 low level (VSS level) via pull-down resistor 51b when in the OFF condition. Switch 52a is the chronograph display switch, which makes switching signal S32 high level (VDD level) when in the ON condition and which makes switching signal S32 low level (VSS level) via pull-down resistor 52b when in the OFF condition. Switch 53a is the chronograph operating switch, which makes switching signal S33 high level (VDD level) when in the ON condition and which makes switching signal S33 low level (VSS level) via pull-down resistor 53b when in the OFF condition. Switch 54a is the chronograph reset switch, which makes switching signal S34 high level (VDD level) when in the ON condition and which makes switching signal S34 low level (VSS level) via pull-down resistor 54b when in the OFF condition.

Reference numeral 11 denotes a receiving enabling means, which is formed by an inverter gate 61 and an AND gate 62. The switching signal S31 from the switching means 10 is input to the inverter gate 61, which inverts this switching signal S31 and outputs it as a switching signal S41. To the AND gate 62 are input this switching signal S31 and the receiving operating signal S26 from the hour/minute counter 21, whereupon this AND gate 62 outputs the receiving enable signal S42.

Reference numeral 12 denotes an AND gate, which is a function mode stopping means, to which are input the switching signal S31 and the switching signal S33 from the switching means 10 and a signal which is derived by inverting the signal receiving enable signal S42, using an inverter gate 13, whereby a function mode stopping signal S40 is generated.

Next, the operation of a radio signal correction function watch having chronograph function according to an embodiment of the present invention will be described using FIG. 1. When the switch 51a, which is the display mode switch, is off the display mode is the time display mode and, because the switching signal S31 is low level, via the inverter gate 61 the switching signal S41 becomes high level, the receiving operating signal S26 from the hour/minute counter 21 becoming the receiving enable signal S42 that is output from the AND gate 62. Additionally, because the switching signal S31 is low, the selection circuit of the display content selection means 7 outputs the second count data signal S15 from the second counter 29 as the selected count data signal S20. Thus, the comparison circuit 37 of the display means 8 compares the counter data of the second counter 29 and the second hand position counter 36 and outputs the comparison signal S24 as a low level if these coincide. Because of this, the second fast-change pulse generating circuit is stopped, and the second drive pulse from the second drive pulse generating circuit 28 is selected as the selected pulse signal S22, so that the second hand 39 is driven in accordance with seconds so as to indicate the time measured.

In this condition, the hour/minute hands 27 of the display means indicate the hours and minutes. When

the switch 51a, which is the display mode switch, is in the ON condition, the display mode is the chronograph display mode and, because the switching signal S31 is high level, switching signal S41 via the inverter gate 61 becomes low level, so that the receiving enable signal S42 output by the AND gate 62 become low level. In the above-noted condition in which the switch 51a is OFF, in the time display mode, as a display mode, the time code receiving means 9 is controlled by the receiving operating signal S26 from the hour/minute counter 21. When the switch 51a is ON and the display mode is the chronograph display mode, the time code receiving means 9 does not operate, regardless of the receiving operating signal S26. Additionally, because with the switch 51a OFF, so that the time display mode is selected, because the switching signal S31 is low level, the function mode stopping signal S40 output by the AND gate 12 serving as the function mode stopping means, is low level, so that the function mode operating means 6, which performs chronograph operation, does not operate. When the switch 51a is ON and in the chronograph display mode, because the switching signal S31 is a high level, the function mode stopping signal S40 output by the AND gate 12, which is the function mode stopping means, becomes the switching signal S33 which is output from the switch 53a, so that function mode operating means 6 which performs chronograph operation can be controlled.

When the switch 52a, which is the chronograph display switch is OFF, the switching signal S31 is high level and the switching signal S32 is low level, so that the 1/20-second count data signal S35 of the 1/20-second counter 31 becomes the selected count data signal S20, via the selection circuit 33 and the display content selection means 7. Thus, the comparison circuit 37 compares the counter data of the 1/20-second counter data signal S35 and the second hand position counter 36 and outputs the comparison signal S24 as a high level, so that the fast-change pulse generation circuit is operated, until these coincide. As a result, the second hand 39 is driven so that the movement of the second hand 39 coincide with the 1/20-second count data signal S35. In the same manner, when the switch 51a, which is the display mode switch, and the switch 52a, which is the chronograph display switch, are ON, because the switching signal S31 and the switching signal S32 are at a high level, the chrono-second count data signal S18 of the chrono-second counter 32 becomes the selected count data signal S20, via the selection circuit 33 and the selection circuit of the display content selection means 7. Thus, the comparison circuit 37 compares the counter data of the chrono-second count data signal S18 and the second hand position counter 36 and outputs the comparison signal S24 as a high level, so that the fast-change pulse generation circuit is operated, until these coincide. As a result, the second hand 39 is driven so as to coincide with the chrono-second count data signal S18. In this manner, the second hand 39 can

be switched by the switch 51a, which is the display mode switch, between seconds time-measuring and chronograph display, the chronograph display using the second hand 39 being switched by the switch 52a, which is the chronograph display switch, between a 1/20-second display and a chrono-second display.

The operation of the above-noted chronograph function uses the switch 53a, which is the chronograph operation switch, and the switch 54a, which is the chronograph reset switch, the switching signal S33 being high level if the switch 53a is in the ON condition, so that the function mode stopping signal S40 output from the AND gate 12 becomes high level, the frequency-divided signal S3 being input to the 1/20-second counter 31 via the AND gate 30 so that chronograph operation is performed. With the switch 53a in the OFF condition, because the switching signal S33 becomes low, the function mode stopping signal S40 becomes low level, so that the output signal S16 from the AND gate 30 becomes fixed at low level, thereby stopping chronograph operation. In addition, with the switch 54a in the ON condition, since the switching signal S34 becomes high level, the 1/20-second counter 31 and chrono-second counter 32 are reset. In the above-noted manner, the chronograph function of the radio signal controlled correction function watch 100 starts by setting the switch 53a to on, stops by setting the switch 53a to off, and is reset by setting the switch 54a to on. By setting the switch 51 to ON, the second hand 39 indicates the chronograph function, and by setting the switch 52a to OFF, the second hand 39 indicates the 1/20 chrono-second display, while the switch 52a is ON condition, the second hand 39 indicates chrono-second display. If the switch 51a, which is the display mode switch, is set to on, the chronograph function operates even if the second hand 39 is selected for chronograph display.

With the switch 51a, which is the display mode switch, is set to off in the time display mode, when the time-measuring data of the hour/minute counter 21 reaches a pre-established time, the receiving operation signal S26 changes to high level, this becoming, via the AND gate 62, a high-level receiving enable signal S42. Thus, the time code receiving means 9 goes into the operating condition, the time code generating circuit 42 sampling the demodulated signal S30 from the receiving circuit 41, by means of the frequency-divided signal S2 from the frequency dividing means 2. Thereafter, when the generation of the time code is completed, the time data signal S27 and the time data signal S28 are generated. The time data signal S27 corrects the time-measuring data of the hour/minute counter 21, so that the hour and minute hands of the display means 4 indicate the time-measuring data after correction, while the time data signal S28 corrects the second count data of the second counter 29, so that the second hand 39 of the display means 8 indicates the second count data after correction.

When the time code receiving means 9 is operating,

because the receiving enable signal S42 is high level, this is input, via the inverter gate 13, to the AND gate 12, which is the function mode stopping means, thereby preventing the passage of the switching signal S31. Thus, even if the switch 51a is accidentally switched on during receiving, the function mode operating means 6 will not operate.

Specifically, as is clear from the above-noted description of the above example, in a radio signal controlled correction function watch according to the present invention, in addition to the above-noted basic technical constitution, it is possible to provide a function mode changing prevention means which does not operate the above-noted function mode operating means during operation of the above-noted time code receiving means. It is also possible, in a radio signal controlled correction function watch according to the present invention, to use a chronograph operating means which performs operation of a chronograph function as the above-noted function mode operating means. In addition, in the present invention it is desirable that the above-noted chronograph operating means make a display of shorter than one second.

FIG. 2 is a block diagram which shows the configuration of a second example of a radio signal controlled correction function watch according to the present invention. Because this configuration is basically the same as shown in FIG. 1, part of the parts which are common with FIG. 1 have been omitted. The difference between this example and the first example which is shown in FIG. 1 is that, whereas a chronograph mode is used as the basic mode in the first example, this example uses a time difference mode, which displays local time by using a time difference counter.

Elements in FIG. 2 which are the same as in FIG. 1 have been assigned the same reference symbols.

The radio signal controlled correction function watch which is the second example of the present invention will be described below, with reference to the drawing thereof. FIG. 2 is a block diagram of a radio signal controlled correction function watch having a local time function, in which 1 is an oscillator circuit, which is an oscillation means, 2 is a frequency-dividing circuit, which frequency divides the oscillation signal S1 which is output from the oscillator circuit 2, this circuit generating the frequency-divided signal S52 which is required for hour/minute and second time keeping, and frequency-divided signal S53 which is required for hour/minute hand drive for each minute and for second hand drive for each second. The frequency-dividing circuit 2 has a reset function such that when a reset signal S78 is high the reset condition is achieved, thereby stopping the dividing operation. Reference numeral 31 denotes an hour/minute drive pulse generating circuit which generates the hour/minute drive pulse S54 from the frequency-divided signal S53, and which, when a non-coincident signal S55 from an hour/minute hand position determining circuit is high level, continuously outputs the

hour/minute drive pulse S54. Reference numeral 32 denotes an hour/minute counter which performs hour/minute time-measuring by counting the frequency-divided signal S52, which can count up for one minute in accordance with the rising edge of an hour/minute correction signal S71 from a correction contents selection means 111, to be described later, and which corrects time-measuring data by means of a time-data signal S82 from a time code generating circuit 143. The hour/minute counter 32 outputs time-measuring data as the hour/minute time count data signal S56 and outputs a high-level established-time receiving operating signal S73 when the time-measuring data reaches a pre-established time. Then, when either a given amount of time has elapsed or the time data signal S82 is input, the receiving operating signal S73 is made low level. Reference numeral 133 denotes a time-difference counter which generates time-difference data with respect to a reference, which is the time-measuring data from the hour/minute count data signal S56 of the hour/minute counter 132, and which outputs a local time count data signal S57. The time-difference data of the time-difference counter 133 is counted up for one hour at the rising edge of the time-difference correction signal S57 from the correction contents selection means 111, to be described later. The reference numeral 134 denotes an hour/minute hand position-determining circuit, which has within it a hand position counter (not shown in the drawing) which is linked to the hour/minute hands. When a home time display signal S65 from a switching means 10, to be described later, is high level, this hour/minute hand position-determining circuit 134 compares the coincidence between the hour/minute count data signal S56 from the hour/minute counter 32 and the internal hand position counter and, if they are not coincident, outputs a high-level non-coincident signal S55. Additionally, when the local time display signal S66 from the switching means 70, to be described later, is in high level the hour/minute hand position determining circuit 134 compares the coincidence between the time-difference count data signal S57 from the time difference counter and the internal hand position counter and, if they are not coincident, outputs a high-level non-coincident signal S55. In addition, when a reference hand position display signal S67 from the switching means 10 is high level, the hour/minute hand position determining circuit 134 compares the coincidence between a hand reference position data signal (not shown in the drawing) and the internal hand position counter and, if they are not coincident, outputs a high-level non-coincident signal S55. The hour/minute drive pulse generating circuit 31, the hour/minute counter 132, the time-difference counter 133, and the hour/minute hand position determining circuit 134 form the time-measuring means 103. Reference numeral 35 is an hour/minute motor which is driven by the hour/minute drive pulse S54 from the hour/minute drive pulse generating circuit 31, this motor in turn driving the hour/minute hands 36. The hour/minute

motor 35 and hour/minute hands 36 form the display means 4.

Reference numeral 51 is a second drive pulse generating circuit which generates a second drive pulse S61 from the frequency-divided signal S53, and which also continuously outputs the second drive pulse S61 when the non-coincident signal S63 from the second hand position-determining circuit is high level. Reference numeral 52 is a second counter which performs time-measuring each second by counting the frequency-divided signal S52 and which also has its time-measuring data cleared by means of the time data signal S82 from the time code generating circuit 143. The second counter 52 outputs time-measuring data as a second count data signal S62. Reference numeral 153 denotes a second-hand position determining circuit, which has within it a hand position counter (not shown in the drawing). When a receiving enable signal S92 from a receiving enabling means 112 is low level, the second-hand position determining circuit 153 compares the coincidence between the second count data signal S62 from the second counter 52 and the hand position counter and, if they are not coincident, outputs a high-level non-coincident signal S63. When the receiving enable signal S92 is high level, the second-hand position determining circuit 153 compares the coincidence between a hand position data signal in a receiving condition (not shown in the drawing) and the hand position counter and, if they are not coincident, outputs a high-level non-coincident signal S63. In addition, when the reference hand position display signal S67 from the switching means 7 is high level, the second-hand position determining circuit 153 compares the coincidence between a second-hand reference position data signal (not shown in the drawing) and the hand position counter and, if they are not coincident, outputs a high-level non-coincident signal S63. The second drive pulse generating circuit 51, second counter 52, and second-hand position determining circuit 153 form the time-measuring means 105. Reference numeral 54 is a second motor which is driven by the second drive pulse S61 from the second drive pulse generating circuit 51, and which drives the second hand 55. The second motor 54 and second hand 55 form the display means 6.

Reference numeral 10 is a switching means having switch positions 71a, 72a, and 73a, one of which is connected to the VDD level (high level) when ON, switches 74a and 75a, which are connected to the VDD level (high level) in the ON condition, and pull-down resistors 71b, 72b, 73b, 74b, and 75b, which are connected to the VSS level (low level). When the switch position 71a, which is a home time display switch (hereinafter referred to as the HT switch) is in the ON condition, a home time display signal S65 is high level (VDD level), and when it is in the OFF condition the home time display signal S65 is connected to a low level (VSS level) via the pull-down resistor 71b. Reference numeral 72a denotes a local time display switch (hereinafter referred to as the

LT switch). When this LT switch position 72a is in the ON condition, a local time display signal S66 is at the high level (VDD level), and when the switch is in the OFF condition, the local time display signal S66 is connected to a low level via the pull-down resistor 72b. Reference numeral 73a denotes a reference hand position display switch (hereinafter referred to as the KT switch). When this KT switch position 73a is in the ON condition, a reference hand position display signal S67 is at the high level (VDD level), and when the switch is in the OFF condition, the reference hand position display signal S67 is connected to a low level via the pull-down resistor 73b. The switch positions 71a, 72a, and 73a form a rotary switch position 71. Reference numeral 74a denotes a correction condition setting switch (hereinafter referred to as the JT switch). When this JT switch 74a is in the ON condition, a correction selection signal S68 is at the high level (VDD level), and when the switch is in the OFF condition, the correction selection signal S68 is connected to a low level via the pull-down resistor 74b. Reference numeral 75a denotes a correction switch. When this correction switch 75a is in the ON condition, a correction signal S69 is at the high level (VDD level), and when the switch is in the OFF condition, the correction signal S69 is connected to a low level via the pull-down resistor 75b. Reference numeral 11a denotes an AND gate which outputs the correction signal S69 from the correction switch 75a as the correction signal 70 when the correction selection signal S68 from the SJ switch 74a is at a high level. Reference numeral 11b denotes an AND gate which outputs the correction signal S70 from the AND gate 11a as the hour/minute correction signal S71 when the home time display signal S65 from the HT switch position 71a is at a high level. Reference numeral 11c denotes an AND gate which outputs the correction signal S70 as the time difference correction signal S72 when the local time display signal S66 from the LT switch position 72a is at a high level. These AND gates 11a, 11b, and 11c form a correction contents selection means 111.

Reference numeral 112 denotes an AND gate, which is a receiving enabling means, and which, when the home time display signal S65 from the HT switch position 71a is at a high level, outputs the established-time receiving operating signal S73 from the hour/minute counter 32 as the receiving enable signal S92. Reference numeral 41 denotes an antenna which picks up a radio signal having a time code, and in which the radio signal S80 is developed. Reference numeral 42 is a receiving circuit which demodulates the radio signal S80 to generate the demodulated signal S81. Reference numeral 143 denotes a time code generating circuit, which generates a time code from the demodulated signal S81, and which, at the 0-second point, which occurs approximately simultaneously with the completion of the generation of the time code, supplies the time data signal S82 to the hour/minute counter 32 and the second counter 52. The antenna 41, the receiver circuit 42 and

time code generating circuit 143 from the time code receiving means 113, which operates when the receiving enable signal S92 from the receiving enabling means 12 is at a high level.

The operation of a radio signal controlled correction function watch 200 according to this example of the present invention, the configuration of which is as noted above, will be described, using FIG. 2 and FIG. 3. FIG. 3 shows an outer view of the radio signal controlled correction function watch of this example. When the HT switch position 71a is in the ON condition, because the home time display signal S65 is at the high level, the hour/minute hand position determining circuit 134 compares the hour/minute count data signal S56 from the hour/minute counter 32 with the internal hand position counter. For example, the frequency-divided S52, which is a pulse that occurs every second, is counted for 20 seconds, whereupon the hour/minute counter 32 increments the hour/minute count data by 1, at which point, because the hour/minute count data signal S56 of the hour/minute counter 32 does not coincide with the hand position counter, the hour/minute hand position determining circuit 134 outputs the non-coincident signal S55 as a high level. By doing this, the hour/minute drive pulse generating circuit 31 outputs the hour/minute drive pulse S54. In addition to the hour/minute drive pulse S54 providing one drive to the hour/minute motor 35 of the display means 4, by having the hand position counter of the hour/minute hand position determining circuit 134 incremented by 1, coincidence is achieved with respect to the hour/minute count data signal S56, so that the non-coincident signal S55 changes to the low level, thereby prohibiting the next hour/minute drive pulse S54 of the hour/minute drive pulse generating circuit 31. In this manner, the hour/minute hands 36 are step driven by 1/3 of a minute, that is, by 20 second steps, so as to indicate the home time display. In the same manner, the second hand 55 is driven one step each second by the second-hand position determining circuit 153.

Next, when the user operates the rotary switch 71, which is shown in FIG. 2, so as to place the LT switch position 72a in the ON condition, because the local time display signal S66 changes to the high level, the hour/minute position determining circuit 134 compares the coincidence between the time difference count data signal S57 from the time difference counter 33 and the hand position counter. The time difference counter 33 generates time difference data based on the reference of time-measuring data of the hour/minute count data signal S56 from the hour/minute counter 32, and outputs a local time count data signal S57, the hour/minute hand position determining circuit 134 outputting the non-coincident signal S55 at a high level until this local time count data signal S57 and the internal hand position counter coincide. Thus, the hour/minute drive pulse generating circuit 31 outputs an hour/minute drive pulse S54, and the hour/minute motor 35 drives the hour/minute hands 36 so as to display local time. In this con-

dition, the display means 6 operates in the same manner as for home time.

If the user further operates the rotary switch 71 so that the KT switch position 73a is placed in the ON condition, because the reference hand position display signal S67 changes to high level, the hour/minute hand position determining circuit 134 compares the coincidence between the reference hand position data signal and the hand position counter, and if there is no coincidence, it outputs the non-coincident signal S55 at a high level until the coincidence will be realized. Thus, the hour/minute drive pulse generating circuit 31 outputs an hour/minute drive pulse S54, the hour/minute motor 35 driving the hour/minute hands 36 so as to display the reference hand position. The second-hand position determining circuit 153 operates in the same manner, and as a result the second hand 55 displays the reference position. This hand position counter at this reference position is at the zero position, the hand being adjusted at the reference position. In the reference hand position display condition, in addition to enabling verification of correct hand position, since there is no hand movement, there is little power consumption of a battery, making it effective for use in long periods of storage.

Specifically, in the radio signal controlled correction function watch 200 according to the present invention, the HT switch position 71a is in the ON condition, if the home time display signal S66 is at the high level, the AND gate 112, which is a receiving enabling means, outputs the established-time operating signal S73 as the receiving enable signal S92, thereby placing the time code receiving means 113 in the operating condition. The time code generating circuit 143 generates a time code from the demodulated signal S81 output from the receiving circuit 42, and when this is completed, the time data signal S82 is output at approximately simultaneously with the time when the time code generating operation has been completed. The time data signal S82 corrects the time-measuring data of the hour/minute counter 32, the hour/minute hands 36 of the display means 4 indicating the time-measuring data after correction, the second count data of the second counter 52 being cleared, and the second hand 55 of the display means 6 returning to the 0-second position. In this manner, the radio signal controlled correction function watch 200 receives a radio signal having a time code, and performs correction based thereon. If the hour/minute counter 32 reaches 3 AM and the established-time receiving operating signal S73 is output at a high level, even if the receiving enable signal S92 changes to a high level in the home time display mode and the time code generating means 113 goes into the operating condition, if the radio signal controlled correction function watch 200 is in a location in which reception of the radio signal with the time code is not possible, it is not possible for the time code generating circuit 143 to output the time data signal S82, and when a pre-established amount of time (for example, 5 minutes) elapses, the

hour/minute counter 32 returns the established-time receiving operating signal S73 to the low level, the time code receiving means 113 being placed in the non-operating condition to end receiving operation. At this point, if a switch position other than the HT switch position 71a, that is, if either the LT switch position 72a or HT switch position 73a is in the ON condition, either if the home time display signal S65 is at the low level (local time display condition) or if in the reference hand position display condition the AND gate 112 which serves as the receiving enabling means outputs the receiving enable signal S92 at a low level without regard to the established-time receiving operating signal S73 from the hour/minute counter 32, the time code generating means 113 is prohibited from operating. That is, receiving is not possible in any condition except the home time display condition.

In a radio signal controlled correction function watch 200 according to the present invention, if the home time display condition is used and it is possible to receive the radio signal having the time code, setting of the time is unnecessary, and the watch is extremely accurate. It is also possible, using the local time display condition, to use the watch in areas outside the home time region, such as overseas. When doing so, the local time is used as the reference, with time difference data in units of one hour being added. For this time difference data when the SJ switch 74a of the switching means 10 is set to the ON condition, making the correction selection signal S68 high level, if the correction switch 75a is set to ON, the correction signal S69 is set to the high level, and the AND gate 11a outputs the correction signal S70 as a high level. Because the home time display signal S65 is low level, the output of the AND gate 11b does not change. However, because the local time display signal S66 from the switch position 72a is at a high level, the AND gate 11c outputs the correction signal S70 as the time difference correction signal S72. As a result, the time difference counter 33 counts up by one hour at the rising edge of the time difference correction signal S72, each time the correction switch 75a is set to ON. In this manner, the hour/minute hands 36 in the local time display condition are set to the difference with respect to the home time, this being added for the display.

The second example of a radio signal controlled correction function watch 200 as described above also not only receives a radio signal having a time code and provides high time accuracy, but also eliminates the need for time setting, making it extremely easy to use. This radio signal controlled correction function watch 200 performs receiving operation only in the usually used home time display condition, and when in a location such as overseas where it is not possible to receive the time code radio signal or in a home time region location in which such reception of the time code radio signal is not possible, it is possible to use the watch in the local time display condition, thus preventing the operating of the time code receiving means 113, which has

a large operating current consumption. Receiving operation can also be prohibited when storing for a long period of time and when verifying the reference hand position, thereby providing a savings in current consumption.

A third example of a radio signal controlled correction function watch according to the present invention is described below, with reference made to FIG. 4.

Environmental problems have gained in importance in recent years, and in the field of watches as well, progress has been made with the adoption of clean energy sources as power-generating means substitutes for batteries, which are replaced and discarded. It is necessary to adopt a clean energy source in a radio signal controlled correction function watch as well. Types of alternative clean energy sources include mechanical electrical generation and solar cells used as an electrical power generating circuit, these being used to charge a chargeable cell such as a secondary cell, which is used as an electrical power generating means. If not charged for a long period of time, the voltage of a secondary cell drops, causing the watch functions to stop. It is therefore necessary to recharge the cell after stopping to a voltage that enables operation of the watch functions. When the voltage of the battery drops, there are cases in which an old battery must be replaced by a new battery. When doing this, although the watch function operation is started, the time information existing before stopping is lost, so that in the past it was necessary to set the time again. By providing a radio signal controlled correction function watch with an electrical power generating means, it is possible to correct the time data when the watch is restored to the operating condition from the stopped condition, by performing a receiving operation. However, in radio signal controlled correction function watches in the as shown in the above-mentioned first and second embodiments, there were many functions and a plurality of display conditions, and the display condition enabling receiving was limited to the home time display condition. The third example of the present invention has as an object the elimination of the need for the user to set the time after restoration to a voltage which enables watch operation after the stopped condition, regardless of the display condition.

The third example of the present invention will be described below, with reference being made to FIG. 4. FIG. 4 is a block diagram of a radio signal controlled correction function watch 300 that is an embodiment of the present invention, in which elements that are the same as in FIG. 2, which shows the second example, are assigned the same reference symbols. Reference numeral 81 denotes electrical power generating circuit, which in this embodiment of the present invention is a solar cell, this solar cell generating a power generation signal S125, which is supplied to a charging circuit 82. The charging circuit 82 charges a secondary cell 83 by means of a charging signal S126, prevents reverse flow of the charging signal S126 from the secondary cell 83,

and prevents overcharging of the secondary cell 83. The electrical power generating circuit 81, the charging circuit 82, and the secondary cell 83 form an electric power generating means 80. Reference numeral 90 denotes a voltage detecting circuit, which is a voltage detecting means, which monitors the drop in the voltage of the power supply signal S127 which is output from the secondary cell 83, and which outputs a voltage detection signal S128 at a high level when the voltage drops below the level at which the watch stops. Reference numeral 14 denotes a hand position storage circuit, which is a non-volatile memory which, when the voltage detection signal S128 from the voltage detecting circuit 90 changes from low level to high level, inputs and stores the storage signal S108, which is the hour/minute hand position information from the hour/minute hand position determining circuit 134. When the voltage detection signal S128 changes from high level to low level, the hand position storage circuit 14 sends the stored data to the hour/minute hand position determining circuit 134 as the storage signal S109. Reference numeral 134 indicates the hour/minute hand position determining circuit, which is formed by adding to the hour/minute hand position determining circuit 134 of the above-described radio signal controlled correction function watch 200 an output of the storage signal S108 of the hour/minute hand position information and inputs of the storage signal S109 from the hand position storage circuit 14 and the voltage detection signal S128 from the voltage detecting circuit 90, this circuit outputting the hour/minute hand position information as the storage signal S108 when the voltage detection signal S128 changes from low level to high level. When the voltage detection signal S128 changes from high level to low level, the storage data of the hand position storage circuit 14 is input as the storage signal S109, this being used with this timing as the hour/minute hand position information. The hour/minute drive pulse generating circuit 131, hour/minute counter 132, time difference counter 133, hour/minute hand position determining circuit 134, and hand position data storage circuit 14 form the time-measuring means 3.

Reference numeral 153 denotes a second-hand position determining circuit, which along with the second drive pulse generating circuit 51 and second counter 52 form the time-measuring means 105. Reference numeral 143 denotes a time code generating circuit. The antenna 41, receiving circuit 42, and time code generating circuit 43 form the time code receiving means 113.

Reference numeral 121 denotes an automatic receiving condition setting means, this being formed by the NOR gates 121a, 121b, and 121c, which, when the power supply voltage drops and the voltage detection signal S128 changes to the high level, hold their information, and which when the voltage detection signal S128 changes back to low level, output an automatic receiving signal S140 as a high level.

The operation of a radio signal controlled correction function watch 300 having a configuration as described

above is described below.

With the solar cell 81 receiving light and the secondary cell 83 receiving sufficient charging by the charging circuit 82, the voltage detecting circuit 90 detects that the power supply signal S127 from the secondary cell 83 is greater than the watch stopping voltage of 1.3 volts, and outputs the voltage detection signal S128 at a low level. When this is done, the frequency-dividing circuit 2 performs frequency division, with operation being the same as in a radio signal controlled correction function watch of the past. If the condition in which light does not strike the solar cell 81 continues, the power generation signal S125 is not generated, and it is not possible for the charging circuit 82 to supply the charging signal S126 to the secondary cell 83. When the voltage detecting circuit 90 detects that the power supply signal S127 has fallen to below the watch stopping voltage of 1.3 volts, the voltage detection signal S128 changes from low level to high level, and the watch stops. In this condition, by the change of the voltage detection signal S128 from low level to high level, the frequency-dividing circuit 2 stops, the hour/minute hand position determining circuit 134 sends the hour/minute hand position information to the hand position storage circuit 14 as storage signal S108, and the hand position storage circuit 14 stores the storage signal S108. Even if any one of the HT switch position 71a, the LT switch position 72a, and the KT switch position 73a is ON, the hour/minute hand position information is stored in the hand position storage circuit 14. Because the voltage detection signal S128 is at the high level, the output of the NOR gate 121a, which is part of the automatic receiving condition setting means 121, becomes low level. At this time, with the automatic receiving signal S140, which is the output of the NOR gate 121c at low level, since the time data signal S132 is also at the low level, the signal S151 is held at the low level.

Next, when light strikes the solar cell 81, the power generation signal S125 is generated, and the charging circuit 82 outputs the charging signal S126 to the secondary cell 83. By doing this, the secondary cell 83 is charged, and the power supply voltage increases. As a result, when the voltage detecting circuit 90 detects that the power supply signal S127 is above the watch stopping voltage of 1.3 V, the voltage detection signal S128 changes from high level to low level, and the automatic receiving condition is enabled. In the automatic receiving condition, by the change from high level to low level of the voltage detection signal S128, the frequency-dividing circuit 2 starts operating, and the hour/minute hand position determining circuit 134 inputs the storage data of the hand position storage circuit 14 as the storage signal S109, the hour/minute hand position information at that time being used for the display with this timing.

Because the voltage detection signal S128 is at the low level, the signal S151 of the automatic receiving condition setting means 121 is at the low level, so that the

output of the NOR gate 121c, which is the automatic receiving signal S140, is high, the receiving enable signal S143 output of the OR gate 123 which serves as the automatic receiving enabling means changing to high level. As a result, even if any one of the HT switch position 71a, LT switch position 72a, and KT switch position 73a is set to ON, the time code receiving means 113 goes into the operating condition and receiving starts. The time code generating circuit 143 generates a time code from the demodulated signal S131 which is output from the receiving circuit 42, and when this is completed the time data signal S132 is generated approximately simultaneously with the time when the time code generating operation has been completed. The time data signal S132 corrects the time data of the hour/minute counter 32, the hour/minute hands 36 of the display means 4 indicating the time data after correction and the second count data of the second counter 52 being cleared to zero. When this is done, the high-level time data signal S132 is input to the NOR gate 121b, the automatic receiving signal S140 output from the automatic receiving condition setting means 121 changes to low level, and the OR gate 123, which is the automatic receiving enabling means, makes the receiving enable signal S143 low level. As a result, the time code generating means 113 ends the operating condition. Then the watch display mode is in accordance with the condition of switches in the switching means 10. That is, regardless of the mode of the watch, automatic receiving is always performed, and when automatic receiving is completed, the display is made in the selected mode. Thereafter, periodic receiving at an established time is performed only in the home time display mode.

Next, the fourth example of a radio signal controlled correction function watch according to the present invention will be described, with reference being made to FIG. 5.

While in the above-described first to third examples of the present invention, the description was presented for the case in which the time code generating means 9 operated only in the time display mode, the present invention is not limited in this way, it also being possible, when the time code generating means 9 operation starts, to prohibit the display of function modes other than time. That is, in the basic technical configuration of the present invention, in a radio signal controlled correction function watch which also uses a chronograph function in combination therewith, the timing at which it is possible to receive the correction radio signal at the time code receiving means is limited to the case in which the above-noted display contents selection means selects the time measuring mode, this including the case in which when the above-noted display contents selection means is selecting information of the time-measuring means, the processing operations of function modes, including the chronograph function, are substantially or temporarily stopped, and the case in which even when information of the time-measuring means in-

formation is being displayed, the processing operations of the function modes, including the chronograph function, are not interrupted, the function mode operating display only being blanked.

In this example of the present invention, the configuration, which is shown in FIG. 5, is an implementation of the second case noted above, this having approximately the same circuit configuration as shown in FIG. 1, the differences with FIG. 1, however, being that a display stopping means 114, formed by an inverter 16 that inverts the receiving operating signal S26 and an AND gate 15, can be provided. In a radio signal controlled correction function watch having the above-noted configuration, with the switch 51a in the ON condition, even if the selection circuit 7 selects the information of the function mode operating means 6, when the receiving operating signal S26 is output from the hour/minute counter 21, the switching signal S31 from the switch 51a becomes low level, and as a result the information of the function mode operating means 6 is not displayed, switching being done to the time-measuring means 5 information.

As described above, in a radio signal controlled correction function watch according to the present invention, since a function other than a time measuring function, such as for example, a chronographic function, and a receiving means are not operated simultaneously, it is possible that the receiving means can operate in a stable, noise-free environment.

Further, even if the radio signal controlled correction function watch in an embodiment of the present invention is implemented using a microcomputer program, it is possible that above-mentioned both functions which are required to have high-speed operation, respectively, can be mounted on one watch.

Moreover, in the present invention, when the radio signal controlled correction function watch is stopped due to the power supply voltage being lowered below a predetermined voltage level and thereafter when the power supply voltage is restored to the operating voltage level, the watch of the present invention can be controlled so that the receiving operation is started regardless the function mode of the watch and thus it is possible to eliminate the need for the user to set the time.

Therefore, the radio signal controlled correction function watch of the present invention will show a remarkable advantage when a power supply source thereof is composed of a electrical power generating means such as a solar cell.

Claims

1. A radio signal controlled correction function watch comprising:

a power supply;
an oscillation means;

a means for frequency-dividing an oscillation signal from said oscillation means to generate a frequency-divided signal;
 a time-measuring means to keep time based on said frequency-divided signal;
 a functional mode operating means for performing operation of a function other than time-measuring;
 a display contents selection means for selecting information from either said time-measuring means or said functional mode operating means;
 a display means for displaying the information selected by said display contents selection means;
 a switching means for operating said functional mode operating means and said display contents selection means;
 a time code receiving means for receiving a standard radio signal and sending time data to said time-measuring means; and
 a reception enabling means for causing said time code receiving means to operate only when said display contents selection means is selecting the information from said time-measuring means.

2. A radio signal controlled correction function watch according to claim 1, further comprising a function mode change prohibiting means which, when said time code receiving means is operating, prohibits operating of said function mode operating means.
3. A radio signal controlled correction function watch comprising:

a power supply;
 an oscillation means;
 a means for frequency-dividing an oscillation signal from said oscillation means to generate a frequency-divided signal;
 a time-measuring means to keep time based on said frequency-divided signal;
 a functional mode operating means for performing operation of a function other than time-measuring;
 a display contents selection means for selecting information from either said time-measuring means or said functional mode operating means;
 a display means for displaying the information selected by said display contents selection means;
 a switching means for operating said functional mode operating means and said display contents selection means;
 a time code receiving means for receiving a standard radio signal and sending time data to

said time-measuring means; and
 a display stopping means which, when said display contents selection means is selecting the information from said function mode operating means and said time code receiving means begins to operate, stops said display means.

4. A radio signal controlled correction function watch according to any of the preceding claims, wherein said function mode operating means is a chronograph operating means which performs operation of a chronograph function.
5. A radio signal controlled correction function watch according to claim 4, wherein said chronograph operating means performs a display for less than one second.
6. A radio signal controlled correction function watch according to any of the preceding claims, further comprising a voltage detecting means which detects the voltage of said power supply, and wherein when, after the power supply voltage drops below a prescribed value, the power supply voltage is restored, said time code receiving means operates regardless of the information selected by said display contents selection means.
7. A radio signal controlled correction function watch according to any of claims 1 to 5, further comprising a voltage detecting means which detects the voltage of said power supply, and an automatic receiving condition setting means whereby, when, after the power supply voltage drops below a prescribed value, the power supply voltage is restored, said time code receiving means is caused to operate.
8. A radio signal controlled correction function watch according to any of the preceding claims, wherein said power supply is an electrical power generating means.
9. A radio signal controlled correction function watch according to claim 8, wherein said electric power generating means is a solar cell.
10. A radio signal controlled correction function watch according to any of the preceding claims, wherein said display contents selection means selects a display in accordance with the condition of said switching means after completion of receiving operation by said time code receiving means.
11. A radio signal controlled correction function watch according to any of the preceding claims, wherein said function mode is a time difference display mode which displays times separately by regions.

FIG. 1

(a)

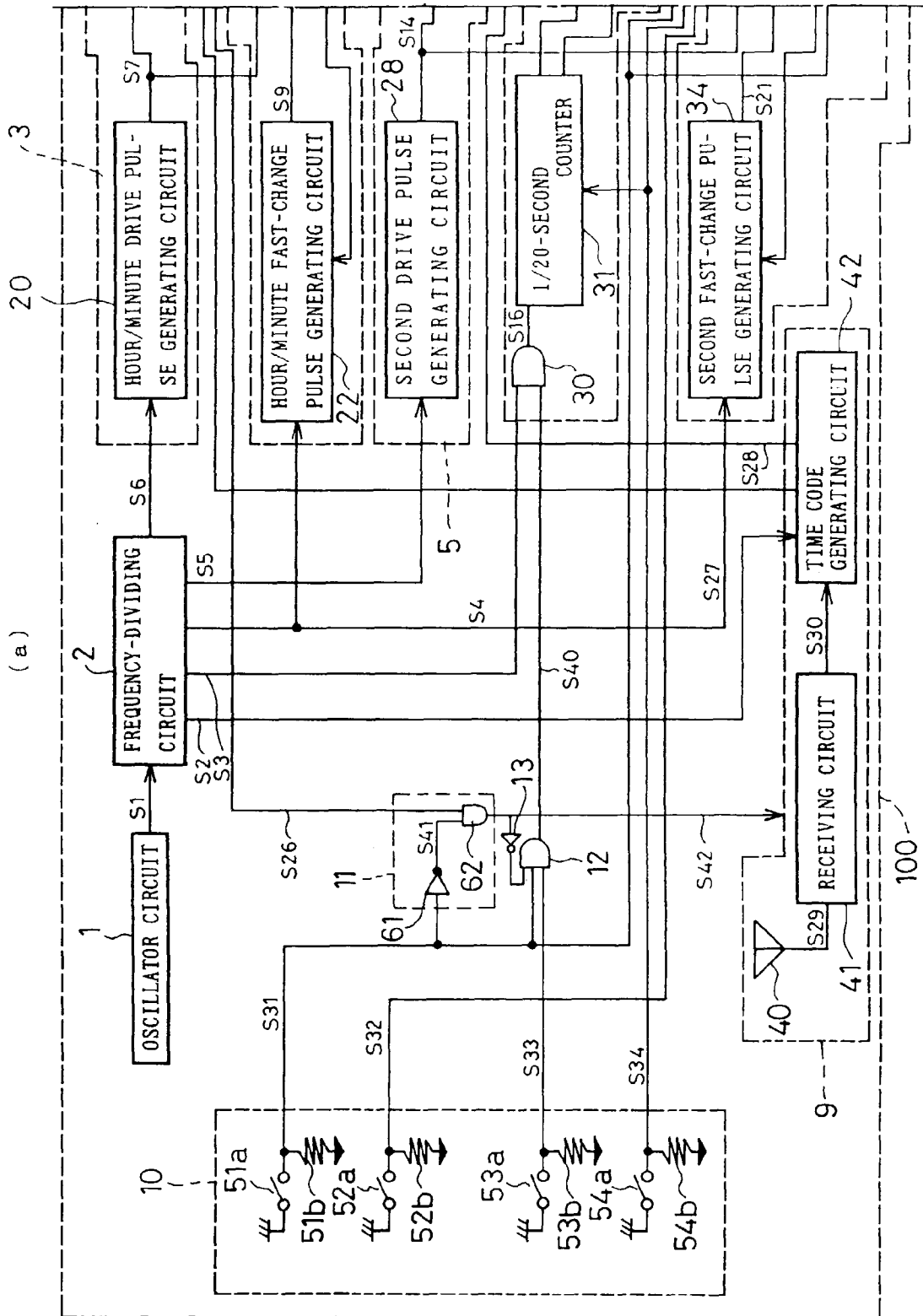


FIG. 2

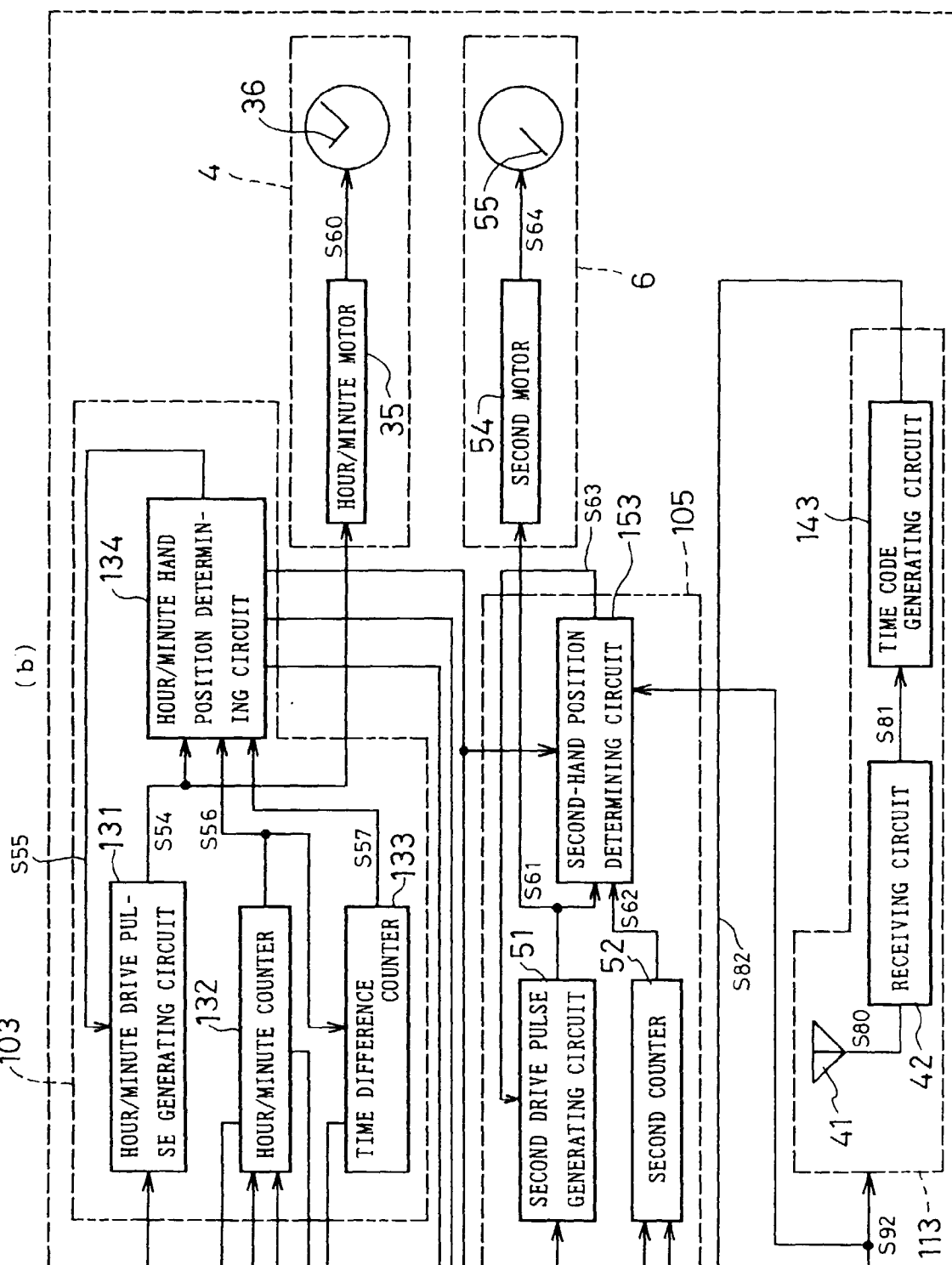


FIG. 3

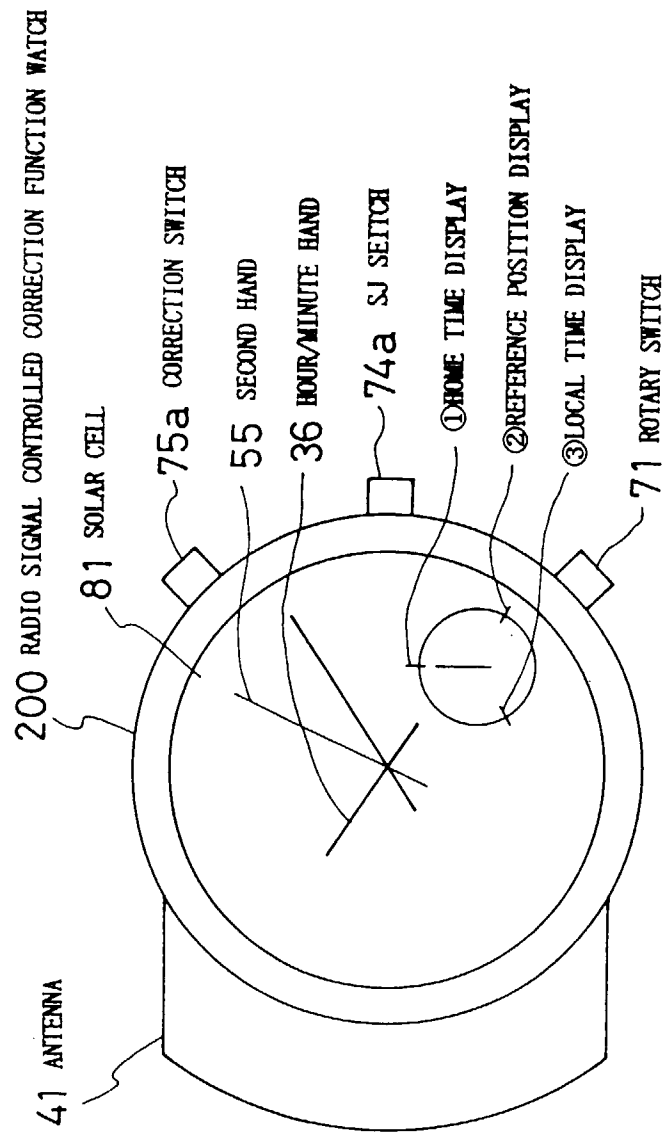


FIG. 4
(a)

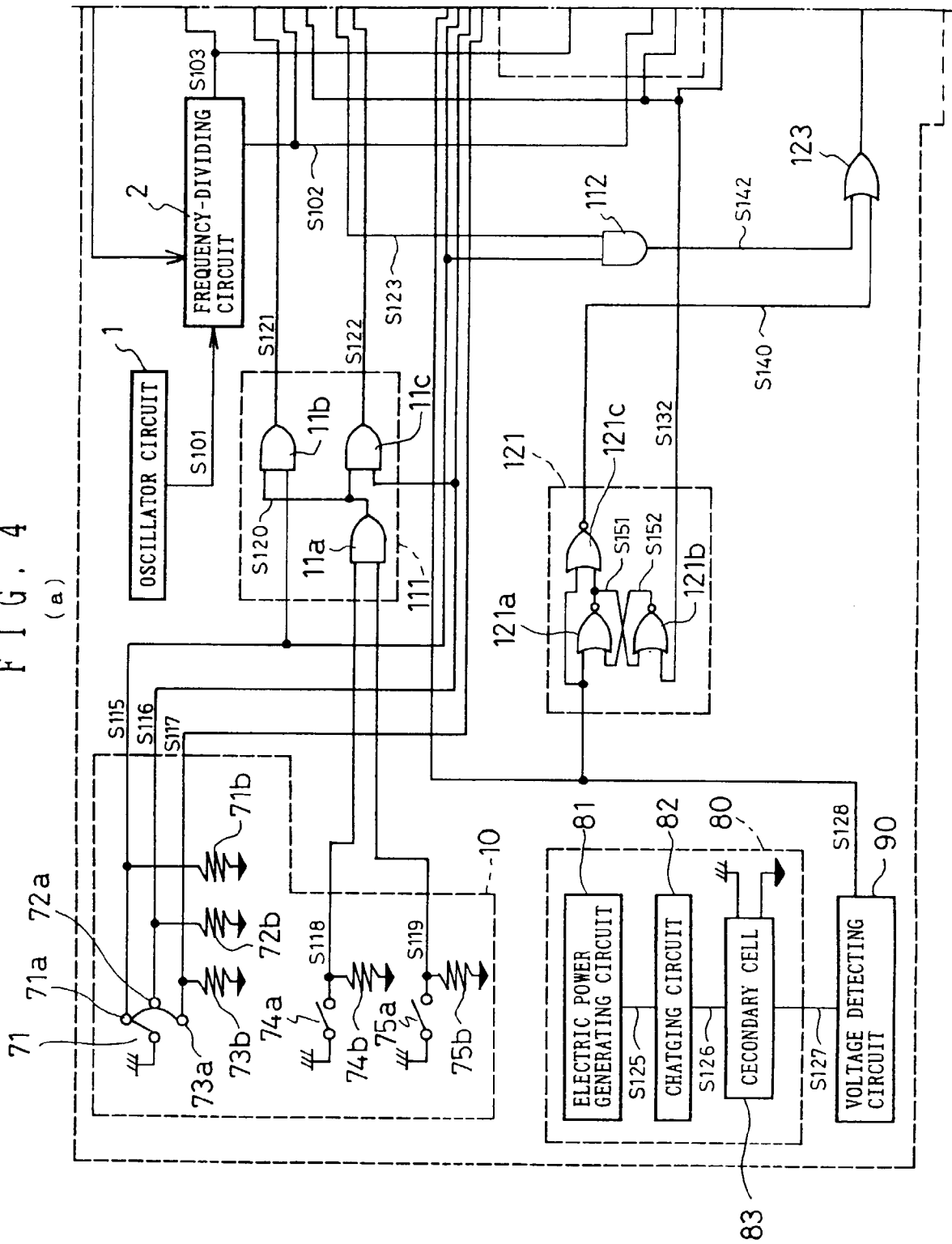


FIG. 5
(a)

