TECHNICAL INFORMATION

CITIZEN QUARTZ

Cal. No. B51※

CITIZEN

Contents

§1. OUTLINE

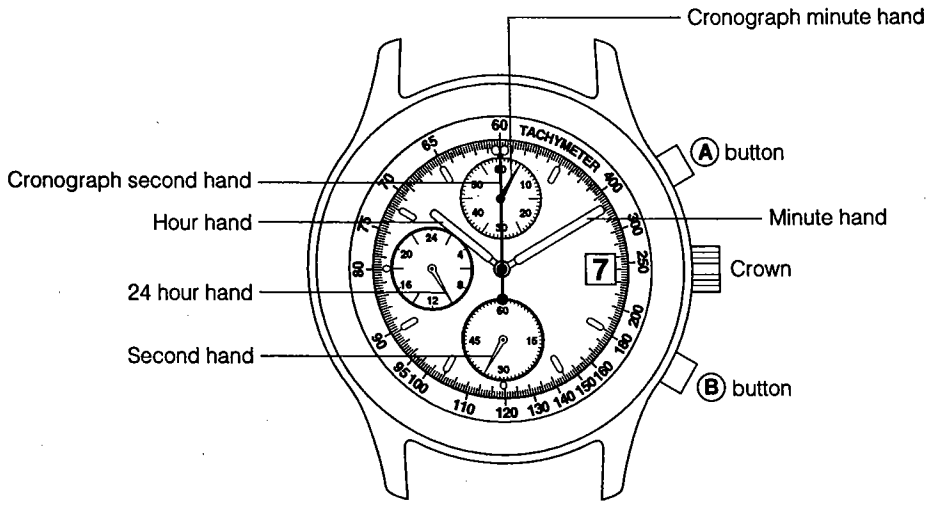
This analog quartz watch incorporates a solar cell in the watch face. In addition to being equipped with a photoelectric power generation function that converts light energy to electrical energy, it also is equipped with a self-winding power generation function that converts "movement of the watch" produced by swinging the watch while wearing on the wrist into electrical energy. Once full charged, the watch will continue to run for approximately 5 months without recharging. In addition, this watch is also provided with a chronograph function (60 minute clock) that allows measurement of time in 0.2 second (1/5 second) units.

This watch also uses a secondary battery for storing the electrical energy that is generated. This battery is completely free of mercury and other hazardous substances. Since this secondary battery is able to be repeatedly charged and discharged, **it is not required to be periodically replaced as in the case of ordinary watch batteries.**

§2. SPECIFICATIONS

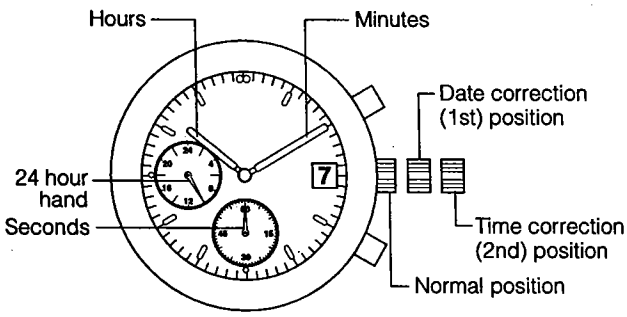
Caliber No.		**B510**
Type		Analog Solar Power Watch
Module size (mm)		ø30.8 x 6.5t
Time accuracy		±15 Sec/month (at 5°C/41°F ~ 35°C/95°F)
Watch operational temperature range		–10°C/14°F ~ +60°C/140°F
Time adjustment		Non
Measurement time		10 Seconds
Display functions		• Time .....Hour, Minute, Second and 24-Hour hands • Calendar .....Date • Chronograph.....Minute, Second, 0.2 (1/5) second hand
Additional functions		• Chronograph.....Measurement is taken in 0.2 seconds and for 60 minutes max. • Self-winding power generation function • Insufficient charging warning feature • Time setting warning feature
Continuous operation	From fully recharge to stop	Approx. 5 months
	From two second interval movement to stop	Approx. 1 day
Secondary battery	Part No.	295-40
	Remarks	Secondary battery block (With welded lead plate)

§3. NAME OF PARTS



§4. SETTING THE TIME AND DATE

* If the crown is of the screw-tightened type, set the time and date after first loosening the screw. Retighten the screw after the time and date have been set.



If the watch stops or the second hand moves at two second intervals when setting the time, charge the watch by referring to Section §6 entitled, "CHARGING PROCEDURE" to return the watch to the normal 1-second interval movement before attempting to set the time and date.

<Setting the Time>

(1) Pull the crown out to the time correction position (2nd position) so that the second hand stops at the 0 second position.

(2) Turn the crown to set the time.
* The date change at 12:00 AM. Set the time while being careful not to mistake AM and PM.

(3) Push the crown in to the normal position in synchronization with a telephone time service or other offical time service.

<Setting the Date>

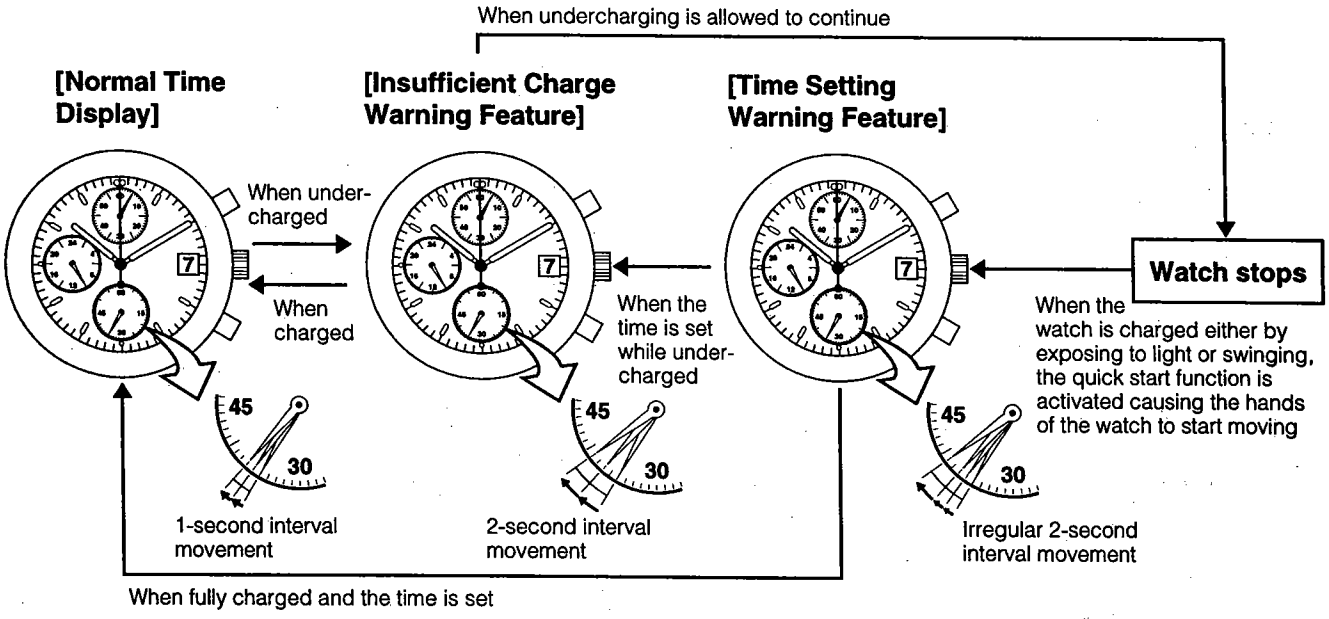
(1) Pull the crown out to the date correction position (1st position).

(2) Turn the crown to set the date.
Turning the crown towards you (counter-clockwise) advances the date by one day.
The date will not move if the crown is turned in the opposite direction (clockwise).

(3) Return the crown to the normal position.
* Do not attempt to set the date between the hours of 9:00 PM and 1:00 AM. Setting the date during this time may not result in the date changing on the following day.

§5. CHARACTERISTIC FUNCTIONS OF SOLAR-POWERED WATCHES

When the watch becomes undercharged, the warning feature illustrated below is activated and the display of the watch (movement of the second hand) changes.



§6. CHARGING PROCEDURE

If the second hand of the watch is moving in 2-second interval movement or has stopped due to undercharging, recharge the watch either by exposing the solar cell to light or by swinging.

A. Charging by Exposing the Solar Cell to Light

* Expose the surface of the solar cell to a fluorescent lamp, incandescent light or sunlight to recharge.
* If the watch is ordinarily concealed from the light as a result of wearing long sleeve shirts and so on, the watch will be susceptible to becoming undercharged as a result of not being exposed to light. Try to place the watch in as bright a location as possible when it is not worn.
* When there are few opportunities for exposing the watch to light, the watch can also be recharged by swining in the manner described below.

[Precautions When Charging by Exposing to Light]

* Avoid charging the watch at high temperatures (approx. 60°C/140°F and above) since allowing the watch to become overheated during charging can lead to a malfunction.

Examples:

* Charging in close proximity to an incandescent lamp or halogen lamp which can easily reach high temperatures.
* Charging in locations that can reach high temperatures such as on an automobile dash-board.

* When charging with an incandescent lamp, always make sure to keep the watch at least 50 cm (20 in.) away from the lamp to prevent the watch from overheating.

[General Reference for Charging Times]
(Case of Charging by Illuminating Solar Cell Only)

Charging times differ depending on the watch model (type of face, etc.). The charging times shown in the table below are meant to only serve as a rough indicator of required charging times.

* The charging time indicated refers to the duration of continuous illumination.

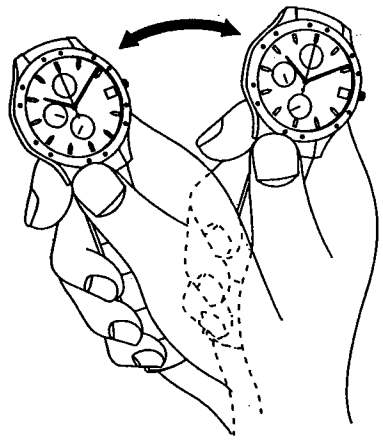
Illuminance (lux)	Environment	Time required		
		Charging time for 1 day of operation	Charging time from stop until 1-second interval movement	Full charging time
500	Typical office	2 hours	37 hours, 30 minutes	335 hours
1000	Under a fluorescent lamp (30W) at a distance of 60-70 cm (24-28 in.)	45 minutes	15 hours	143 hours
3000	Under a fluorescent lamp (30W) at a distance of 20 cm (8 in.)	15 minutes	5 hours	45 hours
10000	Cloudy day	4 minutes	1 hour, 30 minutes	13 hours
100000	Under direct sunlight on a summer day	2 minutes	30 minutes	2 hours, 30 minutes

Full charging time: Time from the state in which the watch is stopped until it is fully charged
Charging time for 1 day of operation: Time required for the watch to run for 1 day using the normal time display (1-second interval movement)

B. Charging by Swinging the Watch

When there are few opportunities for charging the watch by exposing to light, occasionally charge the watch by swinging. In addition, for those persons who only wear the watch for short periods of time (several days) or when there is little movement while wearing the watch, it is also recommended to charge the watch by swinging.

<How to Effectively Charge the Watch by Swinging>



Swing the watch back and forth over a distance of about 20–25 cm (8–10 in.) at the rate of about 2-2.5 strokes per second.

* Swing the watch for about 300–500 times (strokes) when it has stopped.
* Charging will not proceed efficiently if the watch is swung too fast or too slow.
* When swinging the watch, although the sound of the generator turning can be heard from inside, this is normal and does not indicate a malfunction.

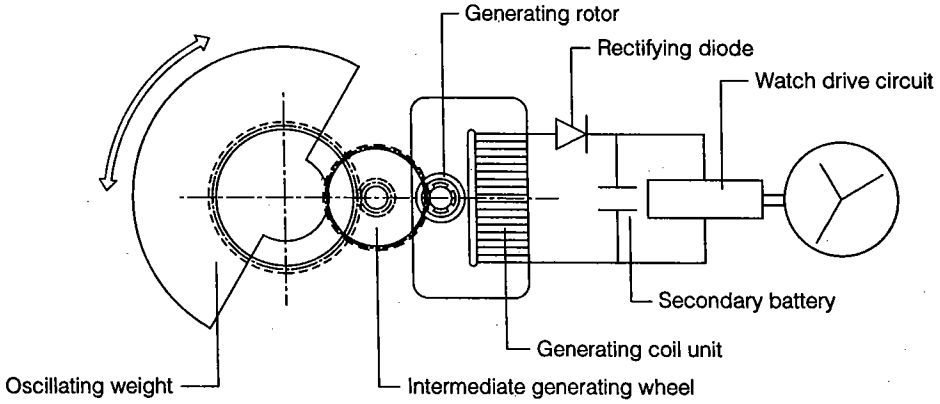
* The watch should be swung approximately 200–300 times to ensure 1 full day's worth of charging when running normally (1-second interval movement).
* Charging can be performed even more efficiently by combining charging by exposing the watch to light and charging by swinging.
* Since this watch is provided with an overcharging prevention feature, there is no risk of damage to the watch due to excess charging.

<Basic configuration of automatic generating system>

As the arm of the watch wearer swings, the oscillating weight revolves in either direction. Then, the generating rotor on which a bipolar permanent magnet is fixed is revolved at a high speed by the oscillating weight through the intermediate generating wheel.

Since the magnetic flux of the permanent magnet crossing the generating coil unit changes as time passes, a voltage is generated in the generating coil unit because of the principle of electromagnetic induction.

A current flows because of the generated voltage, and it is rectified by the rectifying diode and used to charge the secondary battery.

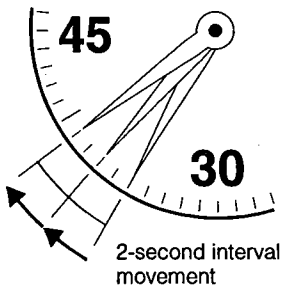


§7. WARNING FEATURES

When this watch becomes undercharged, a warning feature is activated and the display of the watch changes.

<Insufficient Charging Warning Feature>

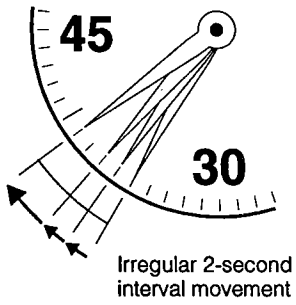
When the second hand is moving in 2 second intervals (moving once every 2 second), this means that the watch is undercharged. Although the watch will continue to run normally at this time, the watch will stop if 2-second interval movement is allowed to continue for roughly 1 day.



When this happens, charge the watch by referring to Section §6 entitled, "CHARGING PROCEDURE" so that it returns to normal 1-second interval movement. Furthermore, the chronograph function cannot be used when the insufficient charging warning feature has been activated (during 2-second interval movement).

* If charging is only performed until the watch returns to 1-second interval movement, it will again return to 2-second interval movement within a few minutes. It is therefore recommended to additionally charge the watch for at least one day's worth of charging by exposing to light or by swinging (200–300 times) to ensure continuous operation.

<Time Setting Warning Feature>

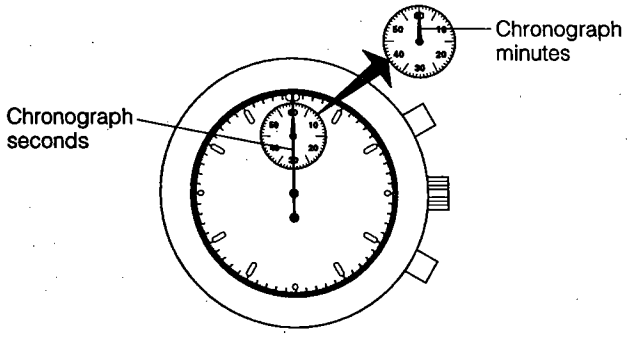


After the watch has been recharged after having stopped due to being undercharged, although the watch hands will being to move, the time will not be correct. The second hand will begin irregular 2-second interval movement (moving irregularly once every 2 seconds) at this time indicating that the time is incorrect. Reset the time after sufficiently charging the watch by referring to Section 6 entitled, "CHARGING PROCEDURE". When the time has been reset, the second hand will not longer movee irregularly in two second intervals, and return to either 1-second or 2-second interval movement. In the case of 2-second interval movement, the watch must be additionally charged.

§8. USING THE CHRONOGRAPH

This chronograph is able to measure and display time in 0.2 second (1/5 second) units up to a maximum of 59 minutes and 59 seconds. After completing measuring time for 60 minutes, it returns to the reset display and stops.

[Chronograph Reset Display]



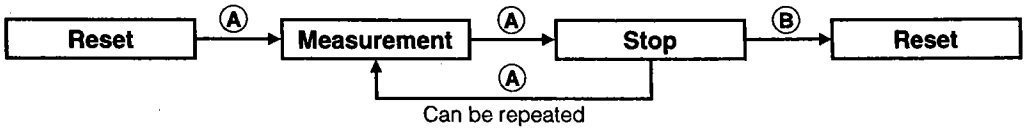
* If the chronograph second hand does not return to the zero second position when the chronograph has been reset, correct the second hand position by referring to Section 9 entitled, "ZEROING THE CHRONOGRAPH SECOND HAND'.

<Measuring Time with the Chronograph>

(1) Pressing button Ⓐ starts and stops the chronograph.

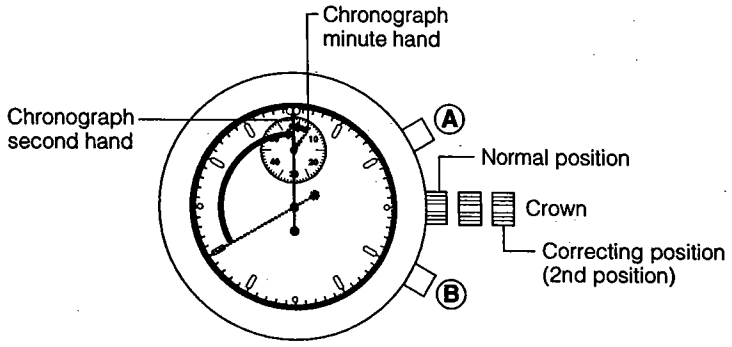
(2) Pressing button Ⓑ when the chronograph is stopped returns the chronograph to the reset display.

* If button Ⓑ is pressed by mistake during chronograph measurement, the chronograph will return to the reset display. Be careful not to accidentally press button Ⓑ during time measurement.



§9. ZEROING THE CHRONOGRAPH SECOND HAND

The zero position of the chronograph second hand may rarely shift out of position after replacing the battery or after the watch has been subjected to a strong shock. When the chronograph second hand does not return to the zero position when the chronograph has been reset, correct the hand position using the following procedure.



<Correcting Procedure>

(1) Pull the crown out to the correcting position (2nd position).

(2) Press button Ⓐ to set the chronograph second hand to the 0 position. Each time button Ⓐ is pressed causes the chronograph second hand to be corrected in the clockwise direction by 0.2 seconds (1/5 second) at a time. (Pressing button Ⓐ continuously causes the second hand to advance rapidly.)

(3) Return the crown to the normal position.

(4) Press button Ⓑ to confirm that the chronograph second and minute hands are reset to the 0 position.

* Although the chronogaph minute hand will also move when correcting the chronograph second hand. pressing button Ⓑ returns the chronograph minute hand to the zero position.
* Always make sure to reset the time after completing the zroing procedure.

§10. HELPFUL HINTS IN USING YOUR WATCH

Exposing this watch to light (1,000 lux or more) for at least 3 hours per day or wearing the watch for at least 12 hours per day will enable it to obtain the amount of charging required to power the watch for approximately 1 day. The amount of charging varies depending on the intensity of the light to which the watch is exposed, the manner in which the watch is worn and individual differences, however.

<When the Watch is Worn Daily>

If the watch is exposed to light daily or worn daily for at least 12 hours, the watch will be additionally charged each day. This will enable the watch to run continuously without intentionally charging. When the watch is used where there are low levels of light or when the amount of movement of the watch is low, such as during long periods of desk work, the watch should occasionally be charged by swinging.

<When the Watch is Worn for Short Periods (Several Days)>

When the amount of time the watch is not worn is longer than the time it is worn, there are few opportunities to expose the watch to light, or when the watch is not worn on the wrist, the watch should occasionally be charged by swinging. If the watch is only worn occasionally, it may stop before it is worn as a result of being undercharged. When this happens, it is necessary to recharge the watch by exposing to light or swinging and then reset the time prior to use.

§11. SECONDARY BATTERY

CAUTION: Handling of Secondary Battery

* Do not attempt to remove the secondary battery from the watch. If the secondary battery should happen to be removed, store it in a location out of the reach of small children to prevent it from being swallowed accidentally.
* If the secondary battery has been swallowed, consult a physician immediately and seek medical assistance.

CAUTION: Only Use the Specified Battery.

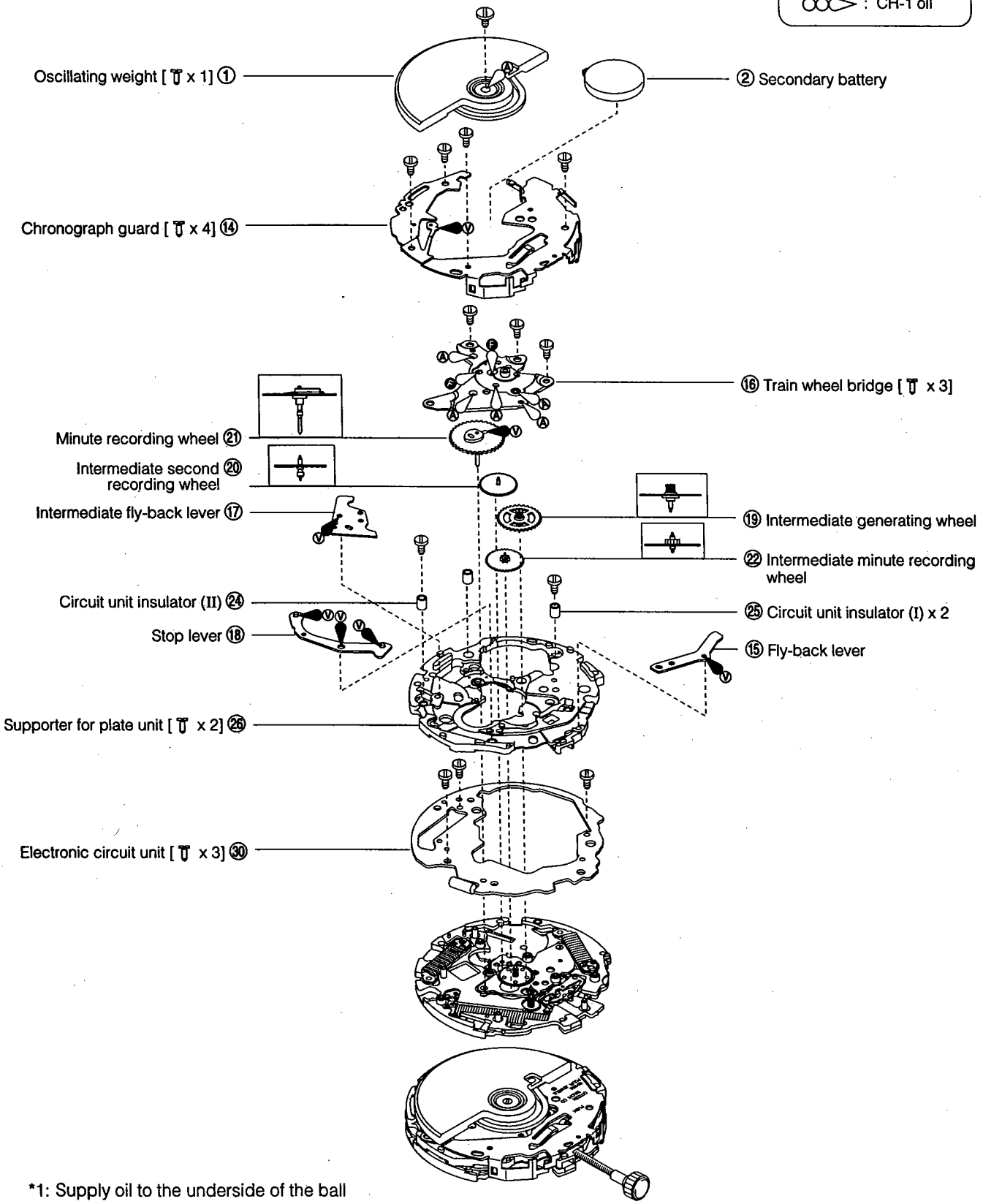
* Never attempt to use a battery other than the specified secondary battery in this watch. Although the watch is constructed to prevent the watch from operating if another type of battery is installed, if a silver battery or other type of battery is forcibly installed and the watch is recharged with that battery is use, the battery may become overcharged causing it to rupture and resulting in the risk of damage to the watch and injury to the wearer. When replacing, always make sure to only use the specified secondary battery.

§12. DISASSEMBLY AND ASSEMBLY OF MOVEMENT

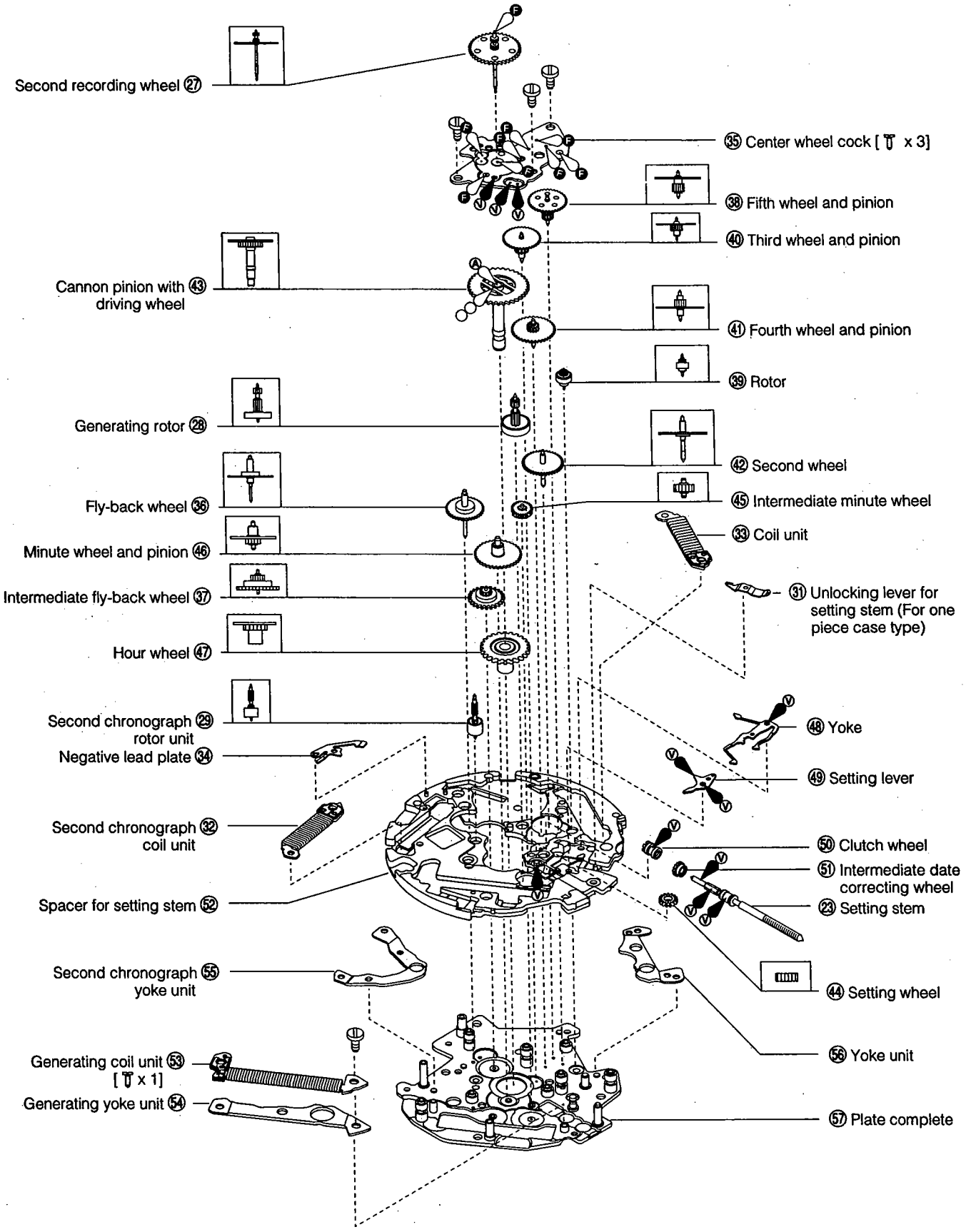
Disassembly procedure: ① → ⑰
Assembly procedure: ⑰ → ①

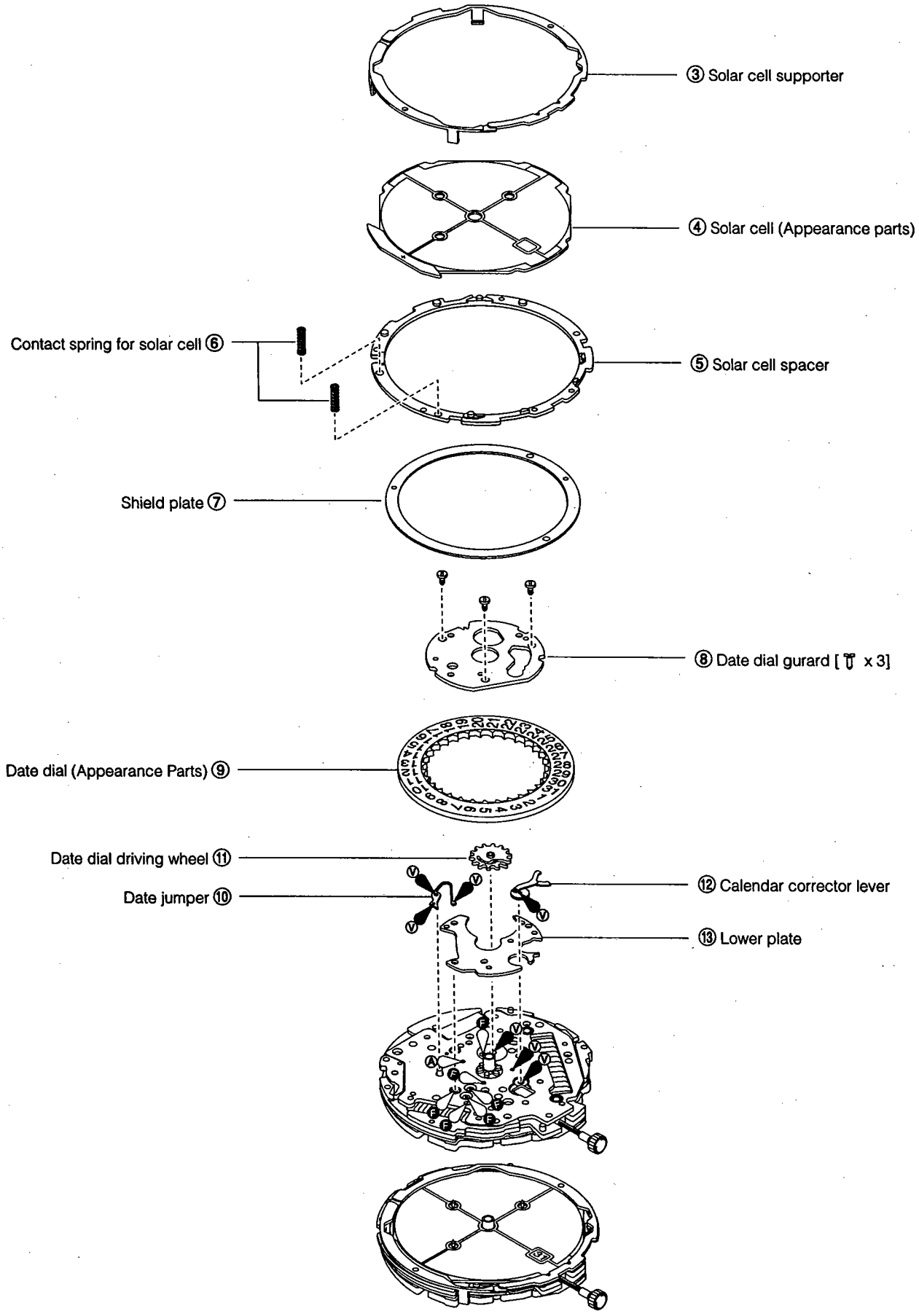
● Lubrication mark

Ⓐ : A-Lube oil
Ⓥ : V-Lube oil
Ⓕ : F-Lube oil
CH-1 oil

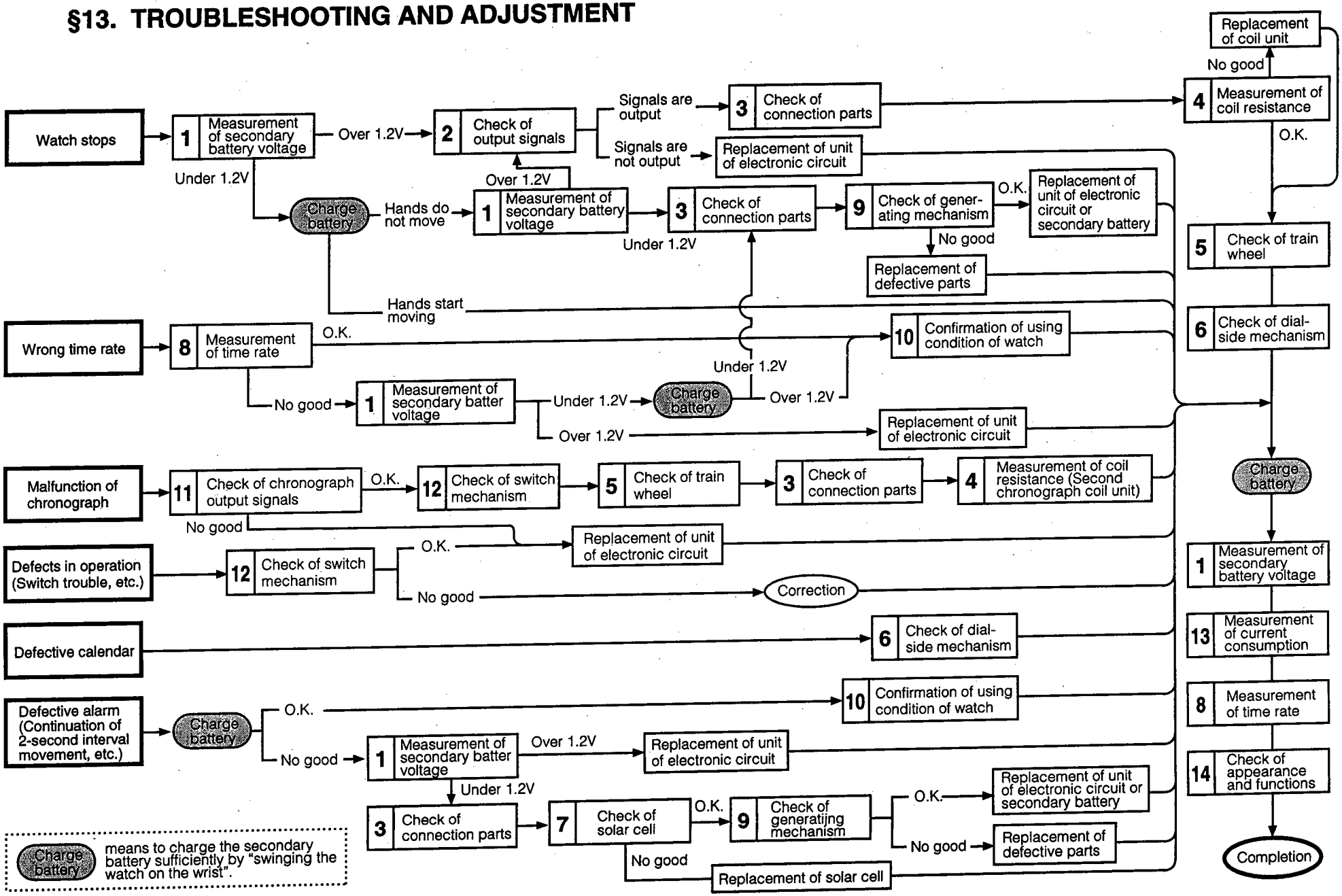


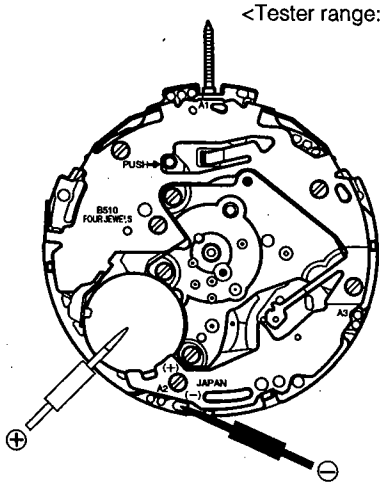
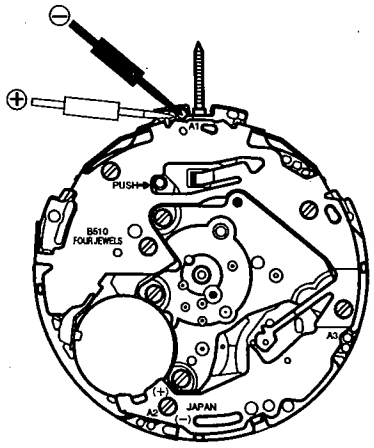
*1: Supply oil to the underside of the ball bearing of the oscillating weight.

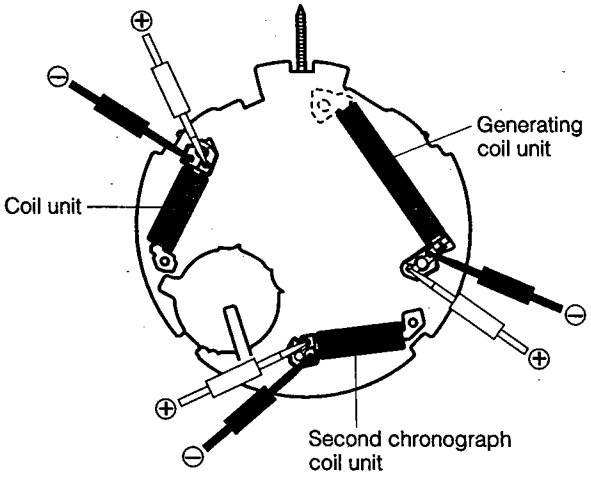

Second recording wheel ㉗
㉟ Center wheel cock [T x 3]
㊳ Fifth wheel and pinion
㊵ Third wheel and pinion
Cannon pinion with ㊸ driving wheel
㊶ Fourth wheel and pinion
㊴ Rotor
Generating rotor ㉘
㊷ Second wheel
Fly-back wheel ㊱
㊺ Intermediate minute wheel
㉝ Coil unit
Minute wheel and pinion ㊻
Intermediate fly-back wheel ㊲
㉛ Unlocking lever for setting stem (For one piece case type)
Hour wheel ㊼
Second chronograph ㉙ rotor unit
㊽ Yoke
Negative lead plate ㉞
㊾ Setting lever
Second chronograph ㉜ coil unit
㊿ Clutch wheel
(51) Intermediate date correcting wheel
Spacer for setting stem (52)
㉓ Setting stem
Second chronograph (55) yoke unit
㊹ Setting wheel
(56) Yoke unit
Generating coil unit (53) [T x 1]
Generating yoke unit (54)
(57) Plate complete


③ Solar cell supporter
④ Solar cell (Appearance parts)
Contact spring for solar cell ⑥
⑤ Solar cell spacer
Shield plate ⑦
⑧ Date dial gurard [x 3]
Date dial (Appearance Parts) ⑨
Date dial driving wheel ⑪
Date jumper ⑩
⑫ Calendar corrector lever
⑬ Lower plate

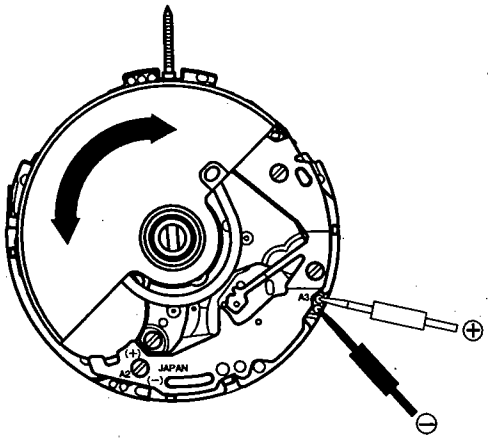
§13. TROUBLESHOOTING AND ADJUSTMENT

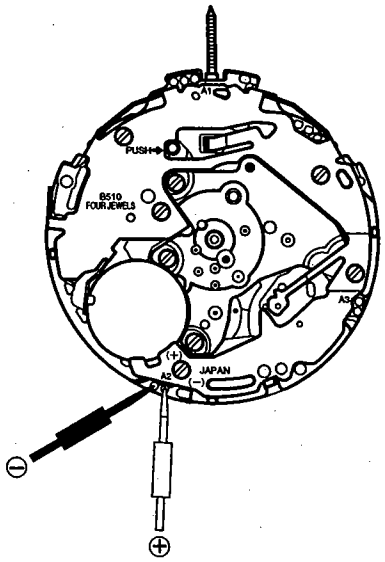


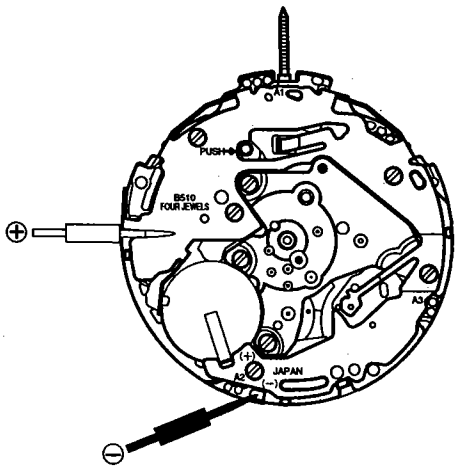
Check Items	How to Check	Result and Treatment
❶ Measurement of secondary battery voltage	**<Preparation for measurement>** • Before measuring the secondary battery voltage, remove the oscillating weight to prevent it from short-circuiting to the negative terminal. <Tester range: DC 3.0V>  **<Standard>** • **Under 1.2V:** 2-second interval movement • **1.2V - 2.4V:** 1-second interval movement **Caution:** When measuring, take care not to touch (short-circuit) the circuit unit supporter with the negative ⊖ lead pin.	
❷ Check of output signals	* Refer to Technical Manual, Basic Course: II-1-b. <Tester range: DC. 0.3V> This watch has the following three output signals. • A1: Output signal of time (Hour, minute, second, 24-hour system) • A2: Output signal of chronograph (1/5 second, minute) • A3: Output signal of generating function If the watch has stopped, check output signal A1. (The tester lead pins have no polarity)  • In the 1-second interval movement mode, the tester pointer swings in both directions at the interval of 1 second. • In the 2-second interval movement mode, the tester pointer swings in only one direction at the interval of 2 second.	• Tester pointer swings over 0V at interval of 1 second. → Normal • Tester pointer does not swing. → Check connections. ⇩ • Connections are normal. → Replace unit of electronic circuit.

Check Items	How to Check	Result and Treatment
❸ Check of connection parts	* Refer to Technical Manual, Basic Course: II-2-a. • Check the screws of the chronograph holder, coil unit, etc. for looseness. • Check the connection patterns of the coil and unit of electronic circuit for dirt and dust. • Check the lead plates of the secondary battery for removal of the welded parts and circuit patterns. Confirm that each part is connected correctly.	• A screw is loosened → Retighten screw. • Dirt or dust is sticking → Remove dirt or dust. • A welded part or a circuit pattern is removed → Replace the defective part.
❹ Measurement of coil resistance	* Refer to Technical Manual, Basic Course: II-1-c. • Remove the unit of electronic circuit, and measure the resistance of each coil unit.  (The tester lead pins have no polarity)	• Measured resistance of coil unit: 1.6 ~ 2.0kΩ → Normal Measured resistance of second chronograph coil unit: 1.9 ~ 2.2kΩ → Normal Measured resistance of generating coil unit: 460 ~ 550Ω → Normal • Out of above range → Replace coil unit.
❺ Check of train wheel	* Refer to Technical Manual, Basic Course: II-2-b. • Check the clearance and lubrication of each gear. • Check for dirt and dust.	• Improper clearance → Correct. • Insufficient oil → Supply oil again. • Dirt and dust → Remove dirt and dust.

Check Items	How to Check	Result and Treatment
❻ Check of dial-side mechanism	* Refer to Technical Manual, Basic Course: II-2-c. • Confirm that the hands can be turned normally. Check the quick setting function of the date, too. → If any trouble is found, check the parts of the dial-side train wheel such as the minute wheel and pinion, date dial driving wheel, etc. for deformation.	• Hand turning load is heavy → Supply CH1 to cannon pinion with driving wheel. • Parts are deformed → Replace parts.
❼ Check of solar cell	• Check the solar cell for breakage and dirt, and check the solar cell electrodes for dirt and removal. • Give light to the solar cell (disconnected) and check the voltage generated by the solar cell to see roughly if the solar cell functions. (1) While light is given to the solar cell, set the tester. (2) Check movement of the pointer of the tester. **<Caution>** When measuring, take care sufficiently not to damage the terminals of the solar cell.	• Solar cell is broken or electrode is removed. → Replace solar cell. • Dirt → Remove dirt. • Pointer of tester moves. → Solar cell is normal. • Pointer of tester does not move. → Replace solar cell.
❽ Check of time rate	* Refer to Technical Manual, Basic Course: II-2-d. (Measurement range: Analog 10 seconds) • The time rate cannot be adjusted. • The time rate may not be measured accurately in the 2-second interval movement mode. In this case, "charge the battery sufficiently by swinging the watch on the wrist" to set the watch in the 1-second interval movement mode, then measure the time rate.	• Watch loses or gains substantial time → Replace unit of electronic circuit.

Check Items	How to Check	Result and Treatment
❾ Check of generating mechanism	See if the generating mechanism is working normally. (Tester range: DC 0.3V) 1. Check of output (1) Set a tester..	
		• Tester pointer swings → Normal • Tester pointer does not swing → Go to ❾-2.
	(2) With the lead pins of the tester applied, turn the oscillating weight lightly to the right and left. At this time, take care not to apply a strong force to the oscillating weight. (3) Check movement of the tester pointer.	No troubles are found → Replace unit of electronic circuit.
	2. If the output is not detected (the tester pointer does not swing), perform the following inspection. • Measurement of resistance of generating coil unit Measure the resistance of the generating coil unit. (See Inspection item ❹.)	
	• Check of turn of oscillating weight Slant the movement to check that oscillating weight turns smoothly.	• Oscillating weight does not turn smoothly. → Check parts.
	• Check of parts Check the parts of the generating mechanism (oscillating weight generating rotor unit, intermediate generating wheel, generating yoke unit) for breakage, flaw and deformation.	
❿ Confirmation of using condition of watch	* Refer to Technical Manual, Basic Course: II-2-e. This watch has a solar generating function to converter solar energy into electrical energy and an automatic generating function to convert movement of the worn watch (made by swinging the arm) into the electrical energy. If the watch does not have sufficient chances to receive light or the user does not wear the water for a sufficiently long time every day or does not move sufficiently, the secondary battery must be charged by swinging the arm consciously.	

Check Items	How to Check	Result and Treatment
⓫ Check of chronograph output signals	* Refer to Technical Manual, Basic Course: II-1-b. <Tester range: DC 0.3V> • Check the output signal (A2) to drive the step motor for chronograph (1/5 second, minute). <Measuring method> • Press the Ⓑ button to start the chronograph, then check the output while the chronograph is in operation.  (The tester lead pins have no polarity)	• Tester pointer swings → Normal • Tester pointer does not swing → Check connections. ⇩ Connections are normal → Replace unit of electronic circuit.
⓬ Check of switch mechanism	* Refer to Technical Manual, Basic Course II-2-f. 1. Check of movement • Check the electronic circuit for removal of the pattern, and the switch spring of the chronograph holder for fatigue and deformation. • Check the space between the switch spring and electronic circuit for dirt and dust. • Check that the intermediate fly-back lever, stop lever and fly-back lever are installed correctly. 2. Check of push buttons • Check the push buttons for dirt and deformation. **<Caution>** Apply silicone oil to the packings of the push buttons without fail. It is necessary for maintenance of water resistance and smooth operation.	• Electronic circuit pattern is removed → Replace unit of electronic circuit. • Parts are fatigued or deformed → Replace defective parts. • Dust and dirt → Remove. • Push buttons are dirty or deformed → Remove dirt or replace parts.

Check Items	How to Check	Result and Treatment
⓭ Measurement of current consumption	* Refer to Technical Manual, Basic Course: II-1-f. • This watch uses a secondary battery, instead of a common silver battery. Accordingly, when measuring the current consumption, prepare a silver battery (1.55V), then perform the following procedure. (1) Remove the oscillating weight, battery strap, battery insulator and secondary battery. (2) Referring to Technical Manual, Basic Course, set the silver battery (1.55V) to the adapter of the tester correctly. (3) Pull out the crown. (4) Set the tester. (Tester range: DC 10μA)  (5) Return the crown to the ordinary position, then measure the current consumption of the module. • The tester indicates a high current. Wait until the tester pointer is stabilized, then measure the current. **Influence of light:** Avoid measuring current consumption under an incandescent lamp or the direct rays of the sun, because it may cause the current value to increase. A fluorescent lamp does not have any effect on the measurement of the current.	• Current consumption of movement **Under 1.0μA** → Normal **Over 1.0μA** → Check train wheel and dial-side mechanism. → Remove dust and dirt. ⇩ • Re-measured current consumption **Over 1.0μA** → Replace unit of electronic circuit.
⓮ Check of appearance and functions	* Refer to Technical Manual, Basic Course: II-2-f.	