SEIKO

CRYSTAL CHRONOMETER QC-951-II

REPAIR GUIDE

INTRODUCTION

Model QC-951-II Seiko Crystal Chronometer is an extremely outstanding timepiece whose design and manufacture are based on Seiko's traditional technique.

Featuring compact dimensions and light weight in addition to high accuracy and stability, this Chronometer has been highly evaluated both domestically and overseas. The Chronometer is widely used as a standard or master clock, displaying its intrinsic value.

This repair manual contains an explanation of the operating principle, instructions for disassembly, adjustment, and reassembly, parts list, and other data required in improving after-sales services which follow delivery of the worldwide popular Seiko Model QC-951-II Crystal Chronometers to the users.

The "Unit replacement method" described in this repair manual makes it possible for anyone to perform repairs, and the "Electronic circuit repair method" is for electronic or mechanical engineers.

We hope that this manual will assist our dealers in providing the maximum extent of after-sales services for Seiko customers.

CONTENTS

I. DESCRIPTION

1. SPECIFICATIONS

1.	Accuracy	: Mean daily rates: ±0.1 second per day (at 20°C) ±0.2 second per day (0 to +40°C) Mean variation of the daily rates: 0.05 second
2.	Temperature range	: Accuracy guaranteed range: 0 to +40°C Operation guaranteed range: -10°C to +50°C
3.	Dry cell life	: Approximately 12 months
4.	Dry cell used	: Two UM-1 (type D) dry cells in series (6AH, 9AH)
5.	Allowable voltage range	: 2.2 to 3.2V
6.	Current consumption	: 0.85mA (3V)
7.	Standard crystal oscillation	: 6269.388Hz
8.	Circuit system	: All silicon transistorized
9.	Oscillation dividing ratio	: 1/96
10.	Hand operation	: Continuous
11.	Shockproof	: Withstands continuous 2G
12.	Splash-resistant	: Passed water spray test registered in Japan
13.	Weight	: 2.6kg
14.	Hand adjustment	: Second-correction device--One push = ±0.2 sec. Hour and minute hands correcting device
15.	Dimensions (Width x Height x Depth)	: 160 x 200 x 40 to 70mm

2. OUTLINE

Seiko Model QC-951-II Crystal Chronometer uses meticulously selected natural crystal for the standard oscillation source, thus maintaining an extremely high accuracy over a long period of time.

This chronometer has been designed as a portable model. Although its dimensions, weight, and power consumption are minimized, its accuracy is equivalent to that of a large crystal chronometer. This is the first of its type unveiled to the world by Seiko's technical staff.

The all transistorized electronic circuits are highly reliable against temperature fluctuation, and with two dry cells, the chronometer continues to operate for one year.

The crystal oscillator circuit, frequency divider circuit, and motor circuit are independently contained in individual units permitting repair and adjustment to be made simply by replacing units as assemblies.

3. COMPOSITION

Construction of the Seiko Model QC-951-II Crystal Chronometer is shown in the following block diagram.

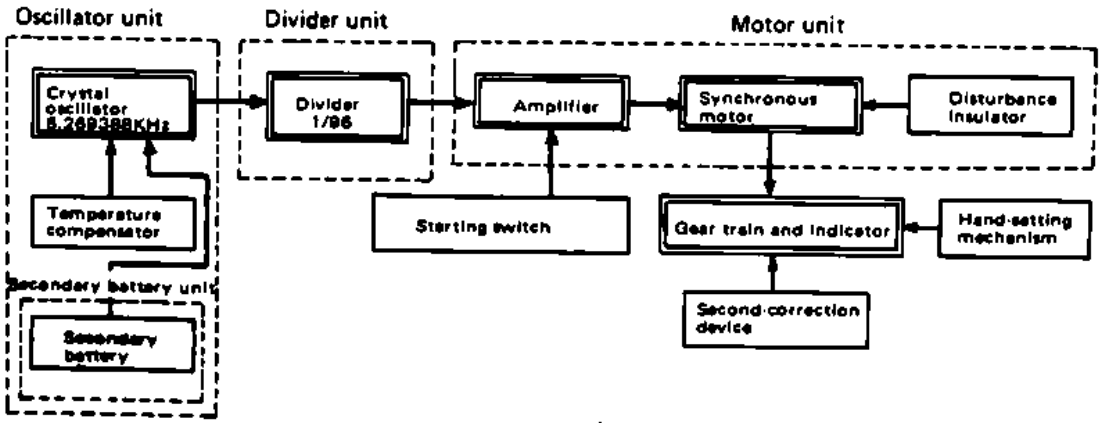


Fig. 1

3.1 Oscillator Unit

With two transistors, this circuit generates frequencies of 6269.388Hz. For fine tolerance of the crystal element due to temperature fluctuation, thermovariable condenser for temperature compensation is used, and such tolerance is compensated accurately over a temperature range from 0°C to 40°C. Specifically, the variable condenser is moved by utilizing motion of a bimetal which moves in response to temperature fluctuation, the constant of the electronic circuit is changed, and frequency is maintained at a constant level.

3.2 Divider Unit

This circuit is used to divide the frequency into four stages; 1/3 x 1/4 x 1/4 x 1/2 = 1/96 and 6269.388 x 1/96 = 65.30612Hz are obtained.

From the 1st to 3rd stages, blocking oscillation is effected by each transistor, and this oscillation is synchronized by a synchronizing signal from the preceding stage.

The 4th stage is a flip-flop circuit using two transistors, simultaneously effecting division and forming of the waveform.

3.3 Buffer Amplifier Circuit

This circuit, using one transistor, amplifies current in a manner that the divider is unaffected, sending a synchronizing signal to the motor in the subsequent stage.

3.4 Motor Unit

This circuit employs one transistor, and by employing a detector and driving coils in the motor coil, self-oscillation is performed. To prevent a speed rising beyond the rated speed, a filter circuit is used. When a synchronizing signal is applied from the preceding stage, the

motor continues complete synchronized rotation; thus, the motor operates as a synchronous motor.

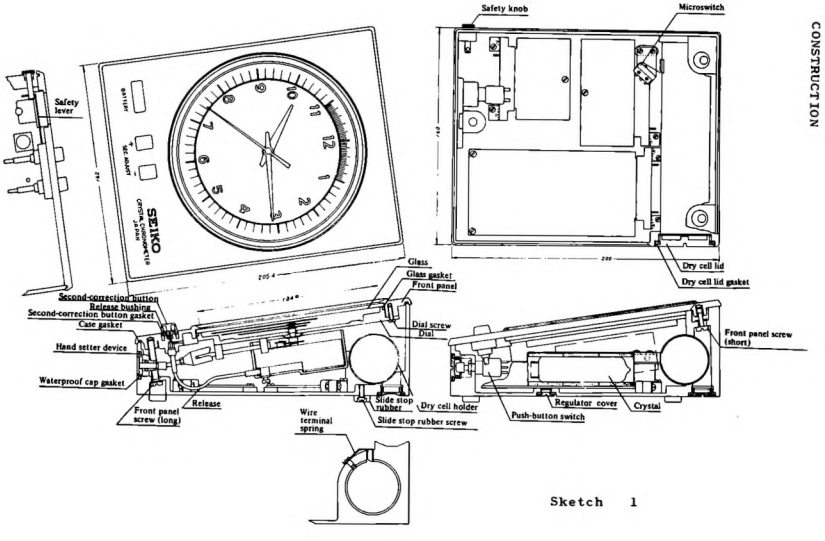
This motor is equipped with a inertia wheel which turns in a reverse direction to the rotor, and with this construction, unbalance of rotation due to vibration and external interference is completely prevented.

3.5 Gear Train and Indicator System

This unit is similar to an ordinary clock, the only difference being the second-correction device. An idler is used between the 4th wheel (second hand wheel) and 5th wheel. When the button is depressed once in the positive or negative direction, time can be corrected every 0.2 seconds by the coaxial claw wheel.

3.6 Power Source

This chronometer utilizes two UM-1 (type D) dry cells, providing the chronometer with 3.0 V; current consumption is approximately 850 microampere, indicated by the meter. This power consumption is equivalent to 1/250th of an ordinary small bulb, amazing proof that this Seiko Crystal Chronometer operates at extremely low power consumption. With two UM-1 (type D) dry cells, the chronometer functions for one year.


Safety knob
Microswitch
Safety lever
Glass
Glass gasket
Front panel
Dry cell lid
Dry cell lid gasket
Second-correction button
Release bushing
Second-correction button gasket
Case gasket
Dial screw
Dial
Front panel screw (short)
Hand setter device
Waterproof cap gasket
Release
Front panel screw (long)
Slide stop rubber
Slide stop rubber screw
Dry cell holder
Regulator cover
Crystal
Push-button switch
Wire terminal spring

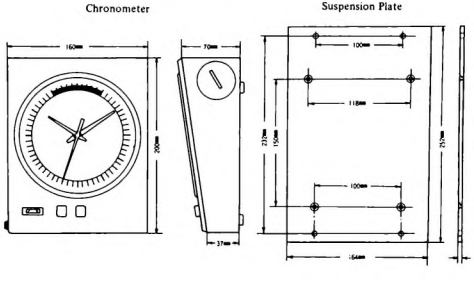
Sketch 1

5. EXTERNAL VIEW PHOTOGRAPHS

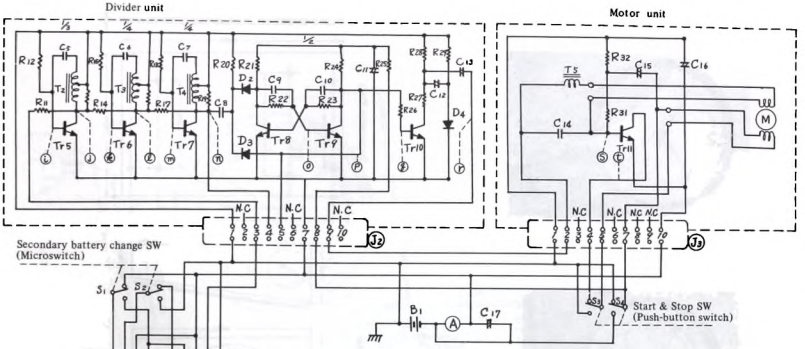
Standard type

Wall mount type

Dimensions



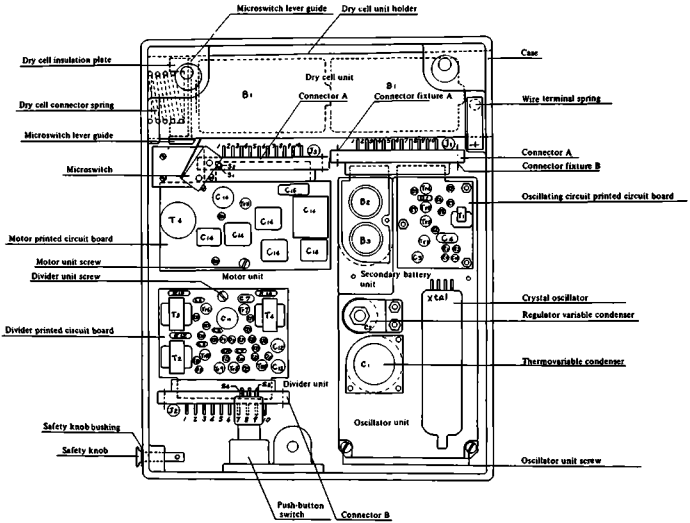
Sketch 2



Sketch 3

Standard Parts List

Tr1~10	2SC-318A3	SONY	C15	3.3μF	
D1~4	SD-34	NEC	C18	10PF	
Xtal	6.269388KHz	KSS	C17	2200μF	
R1.3.4.5	500KΩ		T1	75-C	
R2.6~9.11.14.17 22.23.31	100KΩ		T2~4	S-D	
R10.28	30KΩ		T5	SM-F	
R12.15.18	400~550KΩ				
R13.16.19.20.21.24	50KΩ		B1	3V	1.5x2
R25	3KΩ		B2~3	1.3V	Ni-Cd
R26.29.32	250KΩ		S1~2	S-5GL2	BATTERY CHANGE
R27	20KΩ		S3~4	SB-2061	START & STOP
			M		MOTOR
C1	30~60PF	THERMO VARI. CON.	A	1mA	BATTERY LIFE
C2	15~50PF	REGULATOR	J1~3	143-010-01	ANPHENOL
C3	0~50PF		Tr11	2SC-318A5	SONY
C4	0.05 μF				
C5.8.9.10	0.001μF				
C6	0.006μF				
C7	0.027μF				
C11.16	220 μF				
C12.13	33 μF				
C14	0.8~1.2μF				


Microswitch lever guide
Dry cell unit holder
Dry cell insulation plate
Case
Dry cell unit
B1
Connector A
B1
Connector fixture A
Dry cell connector spring
Wire terminal spring
Microswitch lever guide
Connector A
Connector fixture B
Microswitch
Oscillating circuit printed circuit board
Motor printed circuit board
Motor unit screw
Divider unit screw
Motor unit
Secondary battery unit
Crystal oscillator
Regulator variable condenser
Divider printed circuit board
Thermovariable condenser
Divider unit
Oscillator unit
Safety knob bushing
Safety knob
Oscillator unit screw
Push-button switch
Connector B

Sketch 4

8. OPERATING PRINCIPLE

Summary of the operating principle of the extremely low power consumption, high-accuracy Seiko Model QC-951-II Crystal Chronometer is described as follows:

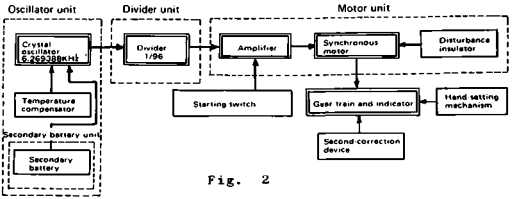


Fig. 2

The transistors used are all-silicon types, and the chronometer consists of a oscillator unit, divider unit, motor unit, gear train and indicator system, and power source.

8.1 Oscillator Unit and Temperature Compensation

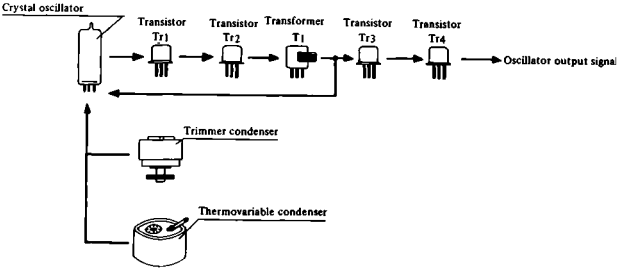


Fig. 3 Construction of oscillator unit

When power source is applied and current flows, the crystal oscillator vibrates finely. This fine oscillation is captured by the emitter follower transistor Tr1 having high input resistance, oscillation is applied to the subsequent amplifier transistor Tr2, and thus, a large voltage is generated on the output transformer T1. This voltage is applied to the crystal oscillator, the oscillator element highly oscillates, and this large oscillation is recaptured by the emitter follower transistor Tr1. These operations are repeated, the crystal element increases amplitude, and the amplitude settles down at the stability point determined by the circuit constant. When temperature is constant, a natural oscillation is stably maintained.

If the temperature changes, a slight change occurs in the natural oscillation of the substantial crystal element. To compensate this change at the electronic circuit, a thermovariable condenser is employed.

Each of the crystal oscillator has its own temperature characteristics. Characteristics of each crystal oscillator are previously examined, the variable condenser is suited to each crystal oscillator, and thus, natural temperature characteristics of the crystal elements are compensated.

Speed regulation of the chronometer is effected by moving the trimmer condenser shaft vertically. To maintain constant voltage, a charger is self-contained, preventing tolerance due to voltage fluctuation. Two stages of buffer amplifiers are used, improving output stability.

Fig. 4 shows the oscillograph waveforms of Tr2 and Tr4.

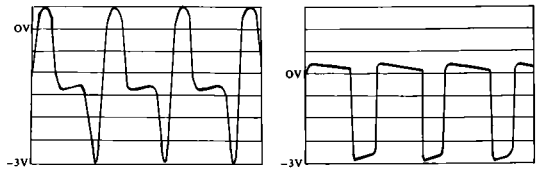


Fig. 4

8.2 Divider Unit (1st to 3rd stages)

Fig. 5 shows construction of divider unit which adopts circuit systems from the 1st stage to 3rd stage, and with a single-element transistor and transformer, a blocking oscillation circuit is formed.

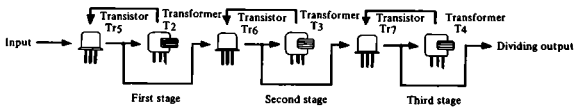


Fig. 5

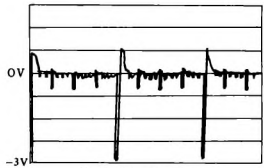
The difference between the individual stages is the time constant of the circuit. When a synchronizing signal is applied to this divider from the oscillator and the divider is operated, frequency is accurately divided by an integral number, obtaining the frequency divisions listed on page 12.

1st stage: 6269.388Hz x 1/3 = 2089.796Hz
2nd stage: 2089.796Hz x 1/4 = 522.449Hz
3rd stage: 522.499Hz x 1/4 = 130.612Hz

These signals are sent to the subsequent 4th divider stage.

Fig. 6 shows a waveform of the Tr7 oscillograph.

Fig. 6



Tr7(n) Collector waveform

8.3 Divider Unit (4th stage)

Fig. 7 shows the construction. With two transistor elements, a flip-flop circuit is formed. Whenever input signal is applied, transistors on both sides operate alternately, obtaining a signal of 1/2.

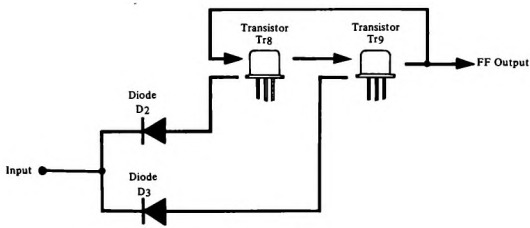


Fig. 7

The 4th stage obtains the following frequency:

130.612Hz x 1/2 = 65.306Hz

This output waveform differs from those of the 1st through 3rd stages. The square waveform shown in Fig. 8 is obtained, simultaneously effecting frequency division and forming of the waveform. Fig. 8 shows an oscillograph waveform of Tr9.

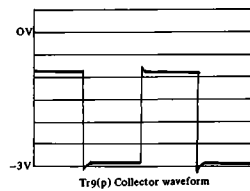


Fig. 8

8.4 Buffer Amplifier

With the construction shown in Fig. 9, this circuit functions as a buffer. Employing a high resistance, input is received, amplified, and the diode maintains a constant output level so that the above-mentioned divider unit is not affected. Thus, a synchronizing signal is sent to the subsequent motor unit.

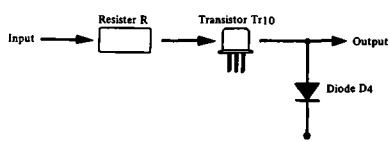
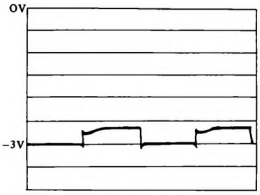


Fig. 9

Fig. 10 shows an oscillograph waveform of the Tr10 collector measured at the output point.

Fig. 10



Tr10(r) Collector waveform

8.5 Motor Unit

Fig. 11 shows construction of the motor unit. The motor uses a detector coil and a driving coil. When the motor rotor is started, power is generated on the detector coil by the rotor magnet. This current flows through the filter, enters the transistor, is amplified, current flows to the driving coil, the rotor is accelerated, speed increases, and motor speed increases as power generated by the detector coil increases.

The upper limit of this speed is adjusted by adjusting capacity of the filter condenser. When an input signal is applied, the motor functions as a synchronous motor, and under a constant speed, the motor operates the subsequent gear train system.

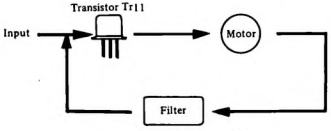
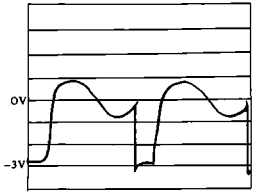


Fig. 11

Fig. 12 shows an oscillograph waveform of the Tr11.



Tr11(t) Collector waveform

Fig. 12

8.6 Gear Train System and Indicator System

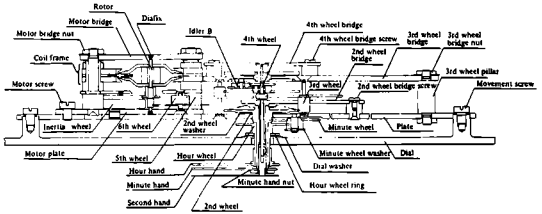


Fig. 13

This system is very similar to an ordinary clock; however, driving power is supplied by the motor. The gear train system is equipped with a inertia wheel which turns in reverse direction to the rotor, preventing any influence due to external interference.

The motor is started by operating the START/ STOP push button.

Small and large idler wheels are positioned between the 4th and 5th wheels of the second-correction device, a small idler wheel is installed eccentrically on the claw wheel washer which is coaxial with the 4th wheel, and this wheel turns the 4th wheel as the claw wheel turns.

With this system, seconds can be corrected without stopping the second hand quantitatively for both loss and gain.

II. REPAIR

1. HANDLING METHOD

1.1 Starting

(1) By using an exclusive tool to remove the START/STOP button lid located on the front of the timepiece, the START/STOP button is disclosed.

(2) The clock will start by depressing (in this condition, the clock is still stopped) and releasing the START/STOP button.

1.2 Setting the Hour and Minute Hands

Set the hands by turning the hour/minute hand setting button while depressing it with the exclusive tool.

Right turn ... Minute hand turns counter-clockwise

Left turn .... Minute hand turns clock-wise

1.3 Setting the Second Hand

(1) Pull out the safety release button.

(2) Set the second hand by depressing the second-hand-correction button.

When the clock gains...Depress the minus (-) button--One depression represents -0.2 second correction.

When the clock loses...Depress the plus (+) button--One depression represents +0.2 second correction.

1.4 Replacing Dry Cells

Replace dry cells when the pointer of the dry cell meter reaches the boundary line between red and blue.

(1) Use the exclusive tool to open the dry cell lid located on the right side of the timepiece.

(2) Pull out the dry cell unit and replace the dry cells with new ones. When electrolyte has leaked out and corroded the corrector, also replace the dry cell case.

(3) After replacing the dry cells, insert the dry cell unit in the timepiece and close the dry cell lid.

Even though the dry cell unit is pulled out, the clock will continue to operate precisely for approximately 24 hours through action of a built-in secondary battery.

1.5 Overhauling

Life of the clock can be prolonged by performing periodic overhauling. Disassemble, clean, and adjust during periodic overhauling every two years.

2. TOOLS FOR REPAIR

Screwdriver

Screwdriver

Nut tightener

Exclusive tool

Pliers

Tweezers

Magnetproof tweezers

Screwdriver

Screwdriver

Eye glass

Seiko watch oil S-4

Synta-visco-lube (Moebius V)

Note) Always use designated "SEIKO watch oil S-4" or "SYNTA-VISCO-LUBE (MOEBIUS V)."

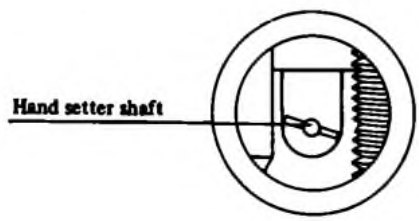
3. ADJUSTING METHOD OF HAND SETTER DEVICE

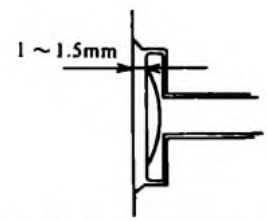
Inserting method of hand setter device

Insert the hand setter fixture in the hand setter shaft while observing the hand setter device hole, then tighten the hand setter cap.

Check

1. While turning the hand setter knob without depressing it with the exclusive tool, the hour and minute hands should not rotate.
2. By turning the hand setter knob while pressing it 1.0 - 1.5mm with the exclusive tool, the hour and minute hands will rotate smoothly.





When depressing the hand setter knob with the exclusive tool, distance should be 1 - 1.5mm.

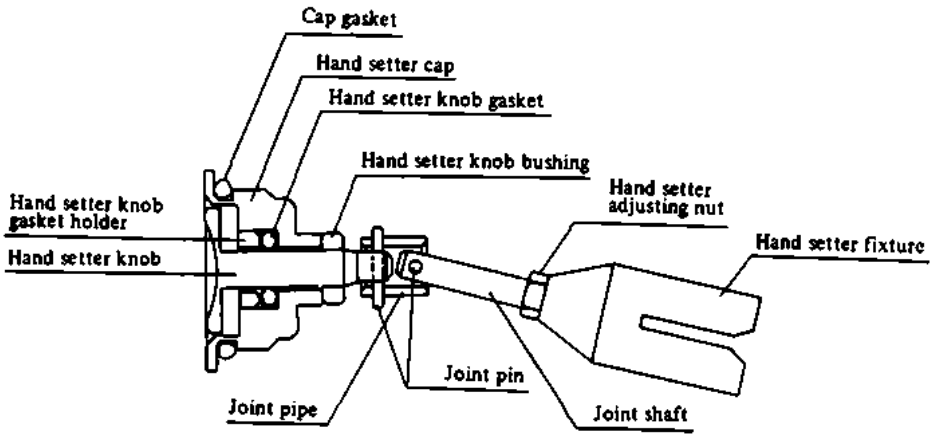


Fig. 14

Adjusting method of hand setter device

1. The hour and minute hands will rotate when turning the hand setter knob without pressing it.
   Adjust the hand setter fixture and hand setter adjusting nut by moving them in the direction of the hand setter knob.
2. The hour and minute hands do not move, even when rotating the hand setter knob while pressing it.
   Adjust the hand setter fixture and hand setter adjusting nut by moving them in the direction of the hand setter shaft.
3. The hand setter knob does not rotate smoothly.
   Check the hand setter device, hand setter shaft, and gear train.

(Note)
Sufficiently tighten the hand setter fixture and the hand setter adjusting nut. If they are not fully tightened, they will further loosen during the hand setting operation. Secure them with a bonding agent to prevent loosening.

4. REPAIR METHOD BY REPLACING EACH UNIT

1. The clock interior components are independently separated according to their respective functions such as the oscillator unit, divider unit, motor unit, secondary battery unit, and dry cell unit, making it possible for anyone to perform repair simply by replacing individual units. Also, disassembling and reassembling the motor and movement are possible.

   Those persons who are familiar with special testing apparatus (tester, oscilloscope, frequency counter, and so on) can repair the clock without using the unit-repair method. The methods of repairing the electronic circuit are described on page 46.

2. Each replacement unit is shipped after being completely adjusted, factory-assuring perfect repair and adjustment merely by replacing each unit according to the malfunction.

3. Unit replacing method

   Replace each unit according to the condition of malfunction.

   Refer to the GUIDE TO AFTER-SALES SERVICE, page 45, for judgment and procedures on replacing units.

Dry cell unit

Disassembling procedures

1) Remove the dry cell lid with the exclusive tools.
2) Pull out the dry cell unit.
3) Remove the dry cells.

Note)
When electrolyte has leaked out of a dry cell, confirm whether or not the dry cell connector is corroded. If corroded, replace the dry cell case with a new one.

Assembling procedures

1) Set the dry cell unit in the clock after confirming its (+) and (-) sides.

2) Close the dry cell lid.

Oscillator unit

Disassembling procedures

1) Remove the two oscillator unit screws.

2) Remove the washers.

3) Remove the oscillator unit from the connector.

Note)
Remove the unit slowly. The secondary battery unit is secured to the oscillator unit with screws.

Assembling procedures

1) Insert the oscillator unit in the connector.

2) Set the washers.

3) Tighten the two oscillator unit screws.

Secondary battery unit

Disassembling procedures

1) Remove the oscillator unit.

2) Turn the oscillator unit upside down.

3) Remove the two secondary battery unit screws.

Note)
The secondary battery unit is secured to the oscillator unit with two screws.

Assembling procedures

1) Turn the oscillator unit upside down.

2) Secure the secondary battery unit.

3) Tighten the two secondary battery unit screws.

Divider unit

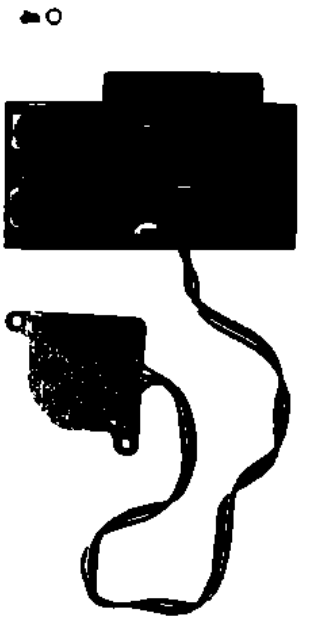
Disassembling procedures

1) Remove the divider unit screw.
2) Remove the washer.
3) Remove the divider unit from the connector.

Assembling procedures

1) Insert the divider unit in the connector.
2) Set the washer.
3) Tighten the divider unit screw.

Motor unit



Disassembling procedures

1) Remove the motor unit screw.
2) Remove the washer.
3) Remove the motor unit from the connector.
4) Remove the two motor screws.
5) Remove the washer.
6) Remove the motor from the movement.

Note)
Detach the dustproof case before removing the motor screw.

Assembling procedures

1) Set the motor on the movement.
2) Set the washer.
3) Tighten the two motor screws.
4) Insert the motor unit in the connector.
5) Set the washer.
6) Tighten the motor unit screw.

5. METHOD OF INSPECTING CLOCK ACCURACY

The clock repaired through unit replacement will pass SEIKO CRYSTAL CHRONOMETER STANDARDS; however, always confirm clock accuracy by measuring the daily rates for 5 - 10 days.

(Method of confirmation)

Measure the daily rates for 5 - 10 days by utilizing time signals on the radio, television, telephone, standard radio wave (JJY), and so on. If the integrated error is within 1.0 - 2.0 seconds, SEIKO CRYSTAL CHRONOMETER STANDARDS have been passed.

"SEIKO CRYSTAL CHRONOMETER STANDARDS"

- o Mean daily rates: ±0.1 (sec) at 20°C
- o Mean variation of daily rates : 0.05 (sec)
- o Temperature characteristic : ±0.2 (sec)/day

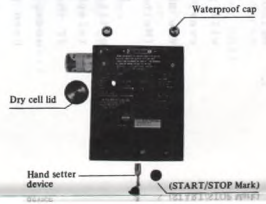
Note)

When the chronometer is left over a long period (more than one month) without connecting the dry cells (or voltage drops to less than 2V), the inner secondary battery will discharge.
When new dry cells are connected to the chronometer in which the inner secondary battery has discharged, set the time after 24 hours have elapsed, then measure the daily rates.

6. DISASSEMBLING AND ASSEMBLING THE CRYSTAL CHRONOMETER QC-951-II

Disassembling, assembling, and inspecting the case and front panel

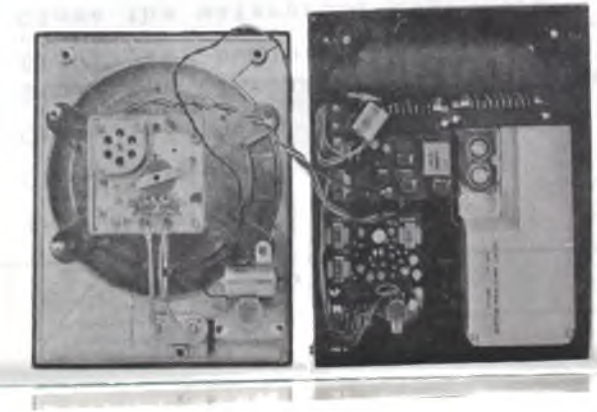
Disassembly

		1	Cap
Disassembling procedures		1) Remove the waterproof caps (3 pcs) with the exclusive tool. 2) Remove the dry cell lid with the exclusive tool. 3) Pull out the dry cell unit. 4) Remove the hand setter cap by using the exclusive tool provided.	
Remarks		o Turn the exclusive tool after securely pressing the hand setter cap. o Use damper material under the front panel to prevent it from scratching.	
Photos			

Assembly		4 Inspection	3 Cap
	Assembling procedures	1) Does the clock move when depressing the START/STOP button? 2) Does the clock continue to move even when removing the dry cell lid? 3) Is the hand setting condition satisfactory? 4) Is pulling out condition of the safety knob satisfactory? 5) Is correcting condition of the second hand satisfactory? Is second correction performed when pulling out the safety knob? Is second correction performed when depressing the safety knob?	1) Insert the dry cell unit. 2) Close the dry cell lid. 3) Close the hand setter cap. 4) Start the clock by depressing the START/STOP button. 5) Close the waterproof caps (3).
	Remarks		o Insert the dry cell unit in the arrow direction. o Regarding the hand setter cap, tighten the screw after inserting the hand setter fixture in the hand setter shaft while observing the interior, placing the clock front side upward. o When depressing the START/STOP button, the clock comes to a halt. If the switch is released quickly the clock will start. o Refer to "ADJUSTING METHOD OF HAND SETTER DEVICE" (p. 21) regarding the adjusting method of hand setter device.

Disassembling, assembling, and inspecting the case and front panel

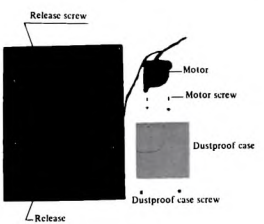
Disassembly

	2 Front panel screws	3 Removing the front panel
Disassembling peocedures	1) Loosen the two front panel screws (short). 2) Remove the front panel screw (long).	1) Place the clock with the dial upward. 2) Remove the front panel.
Remarks	o Before removing the front panel screw, memorize or note the assembled position of the case and the front panel. o The two front panel screws (short) cannot be taken out.	o Raise the front panel approximately 3cm directly upward and place it on the side of the case.
Photos		

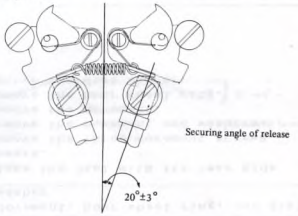
Assembly

	2 Front panel screws	1 Installing the front panel
Assembling procedures	1) Turn the clock rear side upward. 2) Loosely tighten the two front panel screws (short). 3) Loosely tighten the front panel screw (long). 4) Set the case and the front panel to the assembling position memorized or noted during disassembling. 5) Securely tighten all three front panel screws.	1) Place the front panel on the case. 2) Insert the safety lever in the safety knob hole.
Remarks	o When tightening the front panel screws, the case and the front panel must be positioned symmetrically. o Always tighten screws from directly above, not on a slant.	o When combining the front panel and the case, insert the lead wire between the divider unit and the motor unit board to prevent the lead wire and dial from meshing. o Face the safety knob hole upward.

Disassembling, assembling, and inspecting the dial and gear train

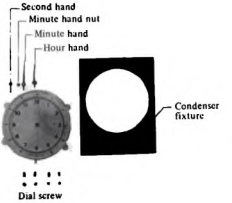
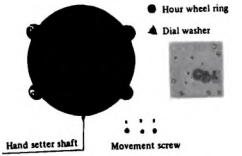
Disassembly			1 Dial rear side
	Disassembling procedures		1) Loosen the two release screws. 2) Remove the release. 3) Remove the two dustproof case screws. 4) Remove the dustproof case. 5) Remove the two motor screws. 6) Remove the washers. 7) Remove the motor.
	Remarks		o Loosen the two release screws by turning them twice. o Remove the motor lightly and diagonally upward, never applying strength.
	Photos		

Assembly

	8 Inspection	7 Dial rear side
Assembling procedures	1) Check assembly according to Item 4 and Item 6. Shake amount of each wheel: 5/100 - 10/100mm. When revolving the 5th wheel, it must turn and stop smoothly. 2) Check with Item 7. When starting the motor, the hands must move. When operating the second hand correction button, the second hand must be corrected by 0.2 second either way.	1) Set the motor. 2) Set the washers. 3) Tighten the two motor screws. 4) Set the dustproof case. 5) Tighten the two dustproof case screws. 6) Set the release. 7) Tighten the two release screws.
Remarks	o (When a synchroscope is provided) Must be synchronized by observing the motor waveform.	o When setting the motor, perform from diagonally and upward, never applying strength. 

Disassembling, assembling, and inspecting the dial and gear train

Disassembly

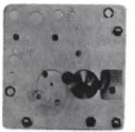
	2 Second, minute, and hour hands	3 Movement, hour wheel ring, and dial washer
Disassembling procedures	1) Remove the four dial screws. 2) Remove the washers. 3) Put the dial on the dustproof case with its front surface upward. 4) Remove the second hand. 5) Remove the minute hand nut. 6) Remove the minute hand. 7) Remove the hour hand.	1) Place the dial with its rear side upward. 2) Remove the three movement screws. 3) Remove the movement and washers. 4) Remove the movement. 5) Remove the hour wheel ring. 6) Remove the dial washer.
Remarks	o Pull out the second and hour hands directly upward. o When removing the minute hand nut, cover it with a cloth and turn it counter-clockwise with radio pliers. Hold the hour and minute hands with the finger tips to prevent revolving them.	o Do not touch the dial surface with the bare hands.
Photos		

Assembly

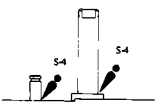
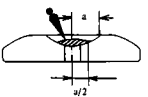
	6 Second, minute, and hour hands	5 Movement, hour wheel ring, and dial washer
Assembling procedures	1) Place the dial with its front surface upward. 2) Set the hour hand. 3) Set the minute hand. 4) Tighten the minute hand nut. 5) Set the second hand. 6) Set the dial on the front panel. 7) Set the washers. 8) Tighten the four front panel screws.	1) Place the dial with its rear side upward. 2) Set the dial washer. 3) Set the hour wheel ring. 4) Set the movement. 5) Set the washers. 6) Tighten the three movement screws.
Remarks	o Install the hour, minute, and second hands parallel with the dial. o Do not forcibly push in the second hand. o Completely remove dust accumulated on the dial.	o Bending the dial washer. 

Disassembling, assembling, and inspecting the dial and gear train

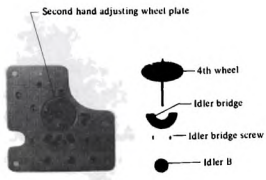
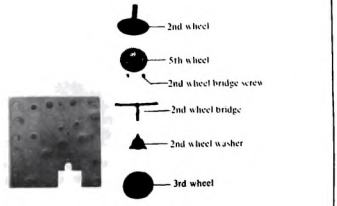
Disassembly

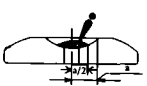
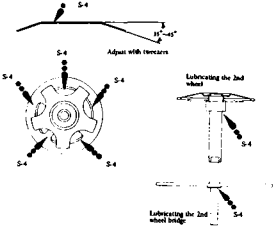
	4 Hour wheel and minute wheel	5 4th wheel bridge and 3rd wheel bridge
Disassembling procedures	1) Remove the minute wheel washer. 2) Remove the hour wheel. 3) Remove the minute wheel.	1) Remove the two 4th wheel bridge screws. 2) Remove the 4th wheel bridge. 3) Remove the three 3rd wheel bridge nuts. 4) Remove the washers. 5) Remove the 3rd wheel bridge.
Remarks		o Remove the 3rd wheel bridge directly above. o Since a bonding agent was used on the 3rd wheel bridge, wash it with benzine and a brush.
Photos		 

Assembly

	4 Hour wheel and minute wheel	3 4th wheel bridge and 3rd wheel bridge
Assembling procedures	1) Lubricate the 2nd wheel arbor. 2) Lubricate the minute wheel pin. 3) Set the minute wheel. 4) Set the hour wheel. 5) Set the minute wheel washer. 6) Lubricate the pawl lever.	1) Set the plate assembly and the 3rd wheel bridge assembly. 2) Set the washers. 3) Tighten the three 3rd wheel bridge nuts. 4) Set the 4th wheel bridge. 5) Tighten the two 4th wheel bridge screws. 6) Lubricate the upper and lower hole jewels of the 3rd wheel, 4th wheel, and 5th wheel.
Remarks	o Lubricating the 2nd wheel arbor and minute wheel pin  o Lubricating the pawl lever  	o When setting the plate and the 3rd wheel bridge, confirm that the pivots of the right and left wheels are fitted in the hole jewels. MOEBIUS V  Lubricating the upper and lower hole jewels of the 3rd wheel, 4th wheel, and 5th wheel. Oil amount 1/2 - 1/3 of the hole jewel diameter.

Disassembly

	6 4th wheel, idler bridge, and idler	7 5th wheel, 3rd wheel, 2nd wheel bridge, and 2nd wheel
Disassembling procedures	1) Remove the 4th wheel. 2) Remove the two idler bridge screws. 3) Remove the idler bridge. 4) Remove the idler.	1) Remove the 5th wheel. 2) Remove the 3rd wheel. 3) Remove the two 2nd wheel bridge screws. 4) Remove the 2nd wheel bridge. 5) Remove the 2nd wheel. 6) Remove the 2nd wheel washer.
Remarks	o Pull out the 4th wheel diagonally. o Do not remove the pawl, pawl wheel, and second hand adjusting wheel plate.	
Photos		

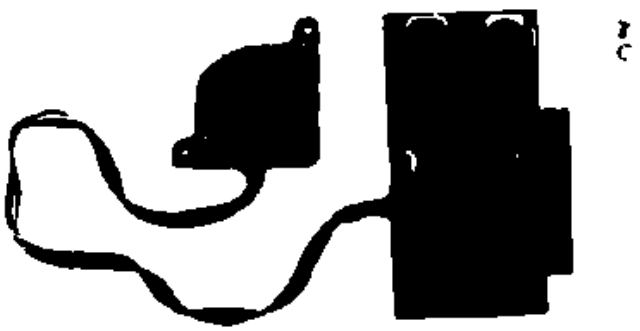
	2 4th wheel, idler, and idler bridge	1 5th wheel, 3rd wheel, 2nd wheel bridge, and 2nd wheel
Assembling procedures	1) Set the 3rd wheel bridge. 2) Lubricate the idler hole jewel (second hand adjusting wheel plate side). 3) Set the idler. 4) Set the idler bridge. 5) Tighten the two idler bridge screws. 6) Lubricate the idler hole jewel (idler bridge side). 7) Set the 4th wheel.	1) Check the bending amount of the 2nd wheel washer and lubricate it. 2) Lubricate the 2nd wheel. 3) Lubricate the 2nd wheel bridge. 4) Tighten the two 2nd wheel bridge screws. 5) Set the 3rd wheel. 6) Set the 5th wheel.
Remarks	o Lubricating the idler upper and lower hole jewels (second hand adjusting wheel plate side and idler bridge side). o Lubricating the 4th wheel   Oil amount is 1/2 - 1/3 of the hole jewel diameter.	o Bending and lubricating the 2nd wheel washer 

Disassembling, assembling, and inspecting th

Disassembly			
Photos	Remarks	Disassembling procedures	

1	Motor unit

1) Remove the motor unit screw.
2) Remove the washer.
3) Detach the motor unit from the connector.
4) Remove the two motor screws.
5) Remove the washers.
   Unfasten the motor binding wire.



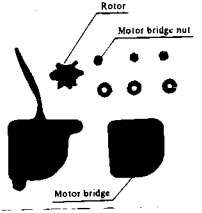
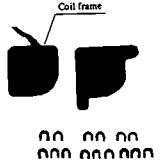
Assembly		6	Inspection
	Assembling procedures		1) Check according to Item 4, Assembly Shake amount of the rotor, inertia wheel, and 6th wheel: 5/100 - 8/100mm. Gap between the rotor blade and coil: The coil must be positioned in the middle of the rotor blade. When this position has slipped, adjust the shake adjusting washer. 2) Iron powder must not be allowed to adhere to the rotor. 3) The motor must start smoothly when depressing the START/STOP button. (When a synchroscope is provided) Must be synchronized by observing the motor waveform.
	Remarks		

	5	Motor unit

1) Set the motor on the movement.
2) Set the washers.
3) Tighten the two motor screws.
4) Insert the motor unit in the connector.
5) Set the washer.
6) Tighten the motor unit screw.
7) Tie the motor binding wire.

Disassembling, assembling, and inspecting the motor

Disassembly

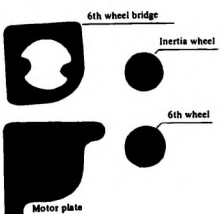
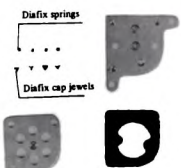
	2 Motor bridge and rotor	3 Coil frame
Disassembling procedures	1) Remove three motor bridge nuts. 2) Remove the washers (There are clocks without washers). 3) Remove the motor bridge. 4) Remove the rotor. (Use magnetproof tweezers).	1) Remove the shake adjusting washers. 2) Remove the coil frame.
Remarks	o Pull out the rotor from the coil interior, being careful not to contact the coil to prevent it from breaking. o Since the rotor is a magnet, place the rotor on a clean surface to prevent adhesion of metallic particles such as iron powder.	o Note the type, number, and position of the shake adjusting washers. o Note the position of the coil frame.
Photos		

Assembly

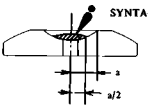
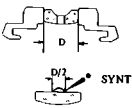
	4 Motor bridges and rotor	3 Coil frame
Assembling procedures	1) Set the rotor. (Use magnetproof tweezers) 2) Set the motor bridge. 3) Set the washers. 4) Tighten three motor bridge nuts. 5) Lubricate the 6th wheel lower hole jewel, (plate side).	1) Set the shake adjusting washers. 2) Set the coil frame. 3) Set the shake adjusting washers.
Remarks	o Check the rotor shaft and the rotor blade for iron powder etc. adhered to them. Remove any metallic particles with adhesive tape. o Setting the rotor through the coil without touching the coil. o Lubricating the 6th wheel SYNTA-VISCO-LUBE 	o Assembling direction and position of the coil frame, and the number of shake adjusting washers, should be the same as before assembling. (Place the coil frame with the motor stop lever upward.) o Be very careful not to break the coil when handing the coil frame.

Disassembling, assembling, and inspecting the motor

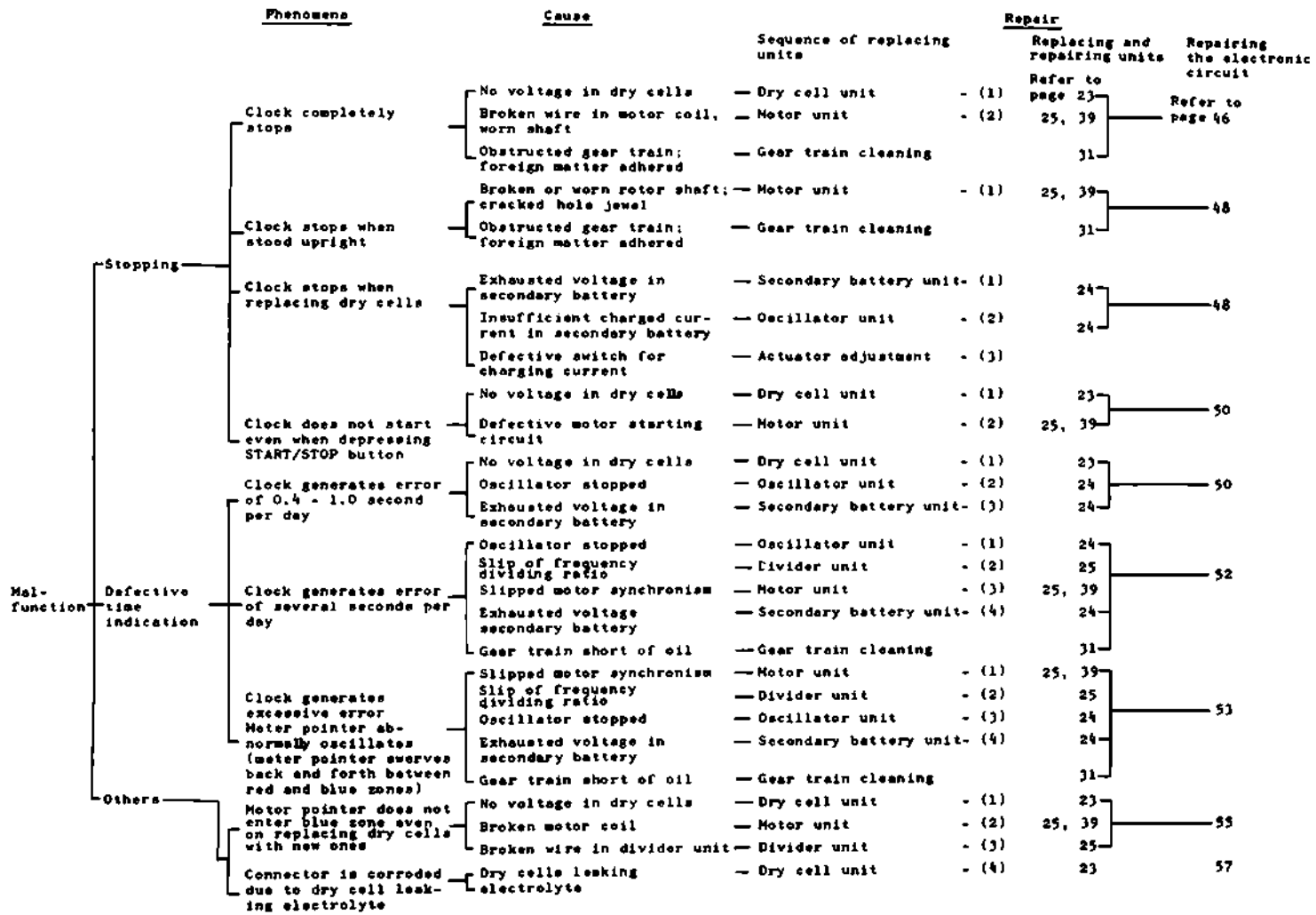
Disassembly

	4 6th wheel bridge, inertia wheel, 6th wheel, and motor plate	5 Diafix
Disassembling procedures	1) Remove the 6th wheel bridge. 2) Remove the inertia wheel. 3) Remove the 6th wheel.	1) Remove the four diafix springs. 2) Remove the four diafix cap jewels.
Remarks		
Photos		

Assembly

	2 6th wheel bridge, inertia wheel, 6th wheel, and motor plate	1 Diafix
Assembling procedures	1) Set the 6th wheel on the motor plate. 2) Set the inertia wheel. 3) Set the 6th wheel bridge. 4) Lubricate the 6th wheel upper hole jewel. (motor bridge side).	1) Insert the diafix cap jewels with flat surface upward. 2) Lubricate the cap jewels. 3) Set cap jewels on the frame. 4) Set the diafix springs.
Remarks	o Lubricating the 6th wheel upper hole jewel. 	o Lubricating the diafix  Oil amount is 1/2 - 1/3 of hole jewel diameter; lubricate after setting the diafix.

7. GUIDE TO AFTER-SALES SERVICE



8. ELECTRONIC CIRCUITS REPAIR METHOD

Since special gauges (oscilloscope, tester, and so forth) are employed for repairing the electronic circuits, have the clock repaired in a factory where these facilities are available and by a qualified electrician with sufficient electric knowledge.

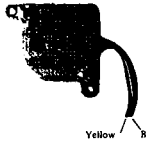
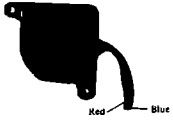
These repairing methods can be conducted without depending on the unit replacing process; however, when repairing operation is impossible, we recommend replacing the defective units.

Utilize the guide to After-sales Service on page 45 to ascertain the phenomena of malfunctions and their causes.

Precise adjustments of oscillator unit and divider unit are explained in the following items, precise adjustment of the electronic circuit on page 58, and the voltage waveform of each section on page 61.

(1) When the clock stops

Unit nomenclature	Investigation of cause	Standard of new parts	Measuring apparatus	Corrective action
Dry cell unit	1. Checking the dry cell voltage 	More than 2.2V	Tester (voltmeter)	Replace dry cells with new ones.

Unit nomenclature					
	Motor unit	2. Defective contact of dry cell connector (Measure dry cell case by same method as that of checking dry cell voltage)	More than 2.2V	Tester (voltmeter)	Replace the dry cell case.
		1. Broken wire in motor coil. Detector coil (between black and yellow lead wires). 	Approx. 200Ω	Tester	Soldering the lead wire connection. Replace parts.
		Driving coil (between red and blue lead wires) 	Approx. 1KΩ	Tester	Soldering the lead wire connection. Replace parts.
		2. broken or worn rotor shaft.	No shaft broken or worn	Eye glass	Replace parts.
		3. Broken or worn inertia wheel shaft.	"	"	"

Unit nomenclature					
	Gear train	4. Cracked hole jewel.	No hole jewel cracks	Eye glass	Replace parts.
		5. No shakes on each wheel.	5/100 - 8/100mm	"	Adjust shakes.
		1. Obstructed gear train. Foreign matter adhered to wheels.	No foreign matter	Eye glass	1. Remove foreign matter. 2. Cleaning
	Outer case	1. Obstructed hands. Contact between hand and hand, or hand and dial.	No hand obstructed	Eye glass	Correct contacted portions.

(2) The clock stops when stood upright

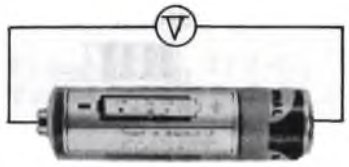
	Motor unit	1. Broken or worn rotor shaft.	Shaft not broken or worn	Eye glass	Replace parts.
		2. Broken or worn inertia wheel shaft.	"	"	"
		3. Cracked hole jewel.	No hole jewel cracks	"	"
	Gear train	1. Obstructed gear train. Foreign matter adhered to wheels.	No foreign matter	Eye glass	1. Remove foreign matter. 2. Cleaning

(3) Clock stops when replacing dry cells

	Secondary battery unit	1. Checking secondary battery voltage  (1)(2)(3)(4)			1. Replace secondary battery unit. 2. Recharge secondai battery (5mA char ing, 10 hours)

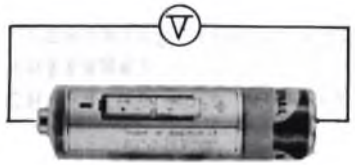
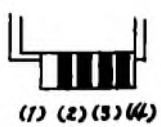
Unit nomenclature					
	Oscillator unit	(1) - (2)	More than 1.1V	Tester (voltmeter)	
		(3) - (4)	"	"	
		1. Checking the charging circuit			1. Check the charging circuit. 2. Replace parts.
		 (6)(7)(8)(9)(10)			
		(10)(+) - (6)(-)	100KΩ ± 30%	Tester	
		(10)(+) - (7)(-)	30KΩ ± 30%	"	
	Battery charging switch	1. Check ON and OFF operations of SW1 and SW2. Check the operation			1. Replace the switch.
		C-NO	Infinity	Tester	
		C-NC	0Ω	"	
		Switch operation			
		C-NO	0Ω	"	
		C-NC	Infinity	"	
		2. Check whether or not actuator switch operates when pulling out dry cell unit.	Switch operates	Observe with naked eye	2. Actuator bends until switch is operated.

(4) Clock does not move even on depressing START/STOP button

Unit nomenclature					
	Dry cell unit	1. Checking the dry cell voltage 	More than 2.2V	Tester (voltmeter)	Replace dry cells with new ones.
		2. Defective contact of dry cell connector (Measure dry cell case by same method as that of checking dry cell voltage).	More than 2.2V	"	Replace dry cell case.
	Motor unit	1. Transistor Tr11-B, Transistor Tr11-C Observing the waveform (Terminal 4 or 5 of motor unit connector) Slipped motor synchronism	Refer to voltage waveform of each section (11), page 64 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts. 3. Check and clean the motor.

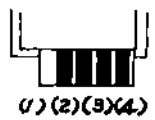
(5) Clock generates error of 0.4 - 1.0 second per day

	Dry cell unit	1. Checking the dry cell voltage	More than 2.2V	Tester (voltmeter)	Replace dry cells with new ones.

Unit nomenclature					
Secondary battery unit	Oscillator unit				
					
		2. Defective contact of dry cell connector (Measure dry cell case by same method as that of checking dry cell voltage).	More than 2.2V	Tester (voltmeter)	Replace dry cell case.
		1. Transistor Tr4-B) Transistor Tr4-C Observing the waveform (Terminal 9 of oscillator unit connector)	Refer to voltage waveform of each section (4), page 62 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts.
		1. Checking the secondary battery voltage			1. Replace secondary battery unit. 2. Recharge secondary battery (5mA charging, 10 hours)
		 (1) (2) (3) (4)			
		(1) - (2)	More than 1.1V	Tester (voltmeter)	
		(3) - (4)	"	"	

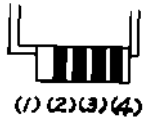
(6) Clock generates error of several seconds per day

Unit nomenclature					
Oscillator unit		1. Transistor Tr4-B) Transistor Tr4-C) Observing the waveform (Terminal 9 of oscillator unit connector)	Refer to voltage waveform of each section (4), page 62 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts.
Divider unit		1. Transistor Tr7-C) Transistor Tr7-B) Observing the waveform (Terminal 4 of divider unit connector)	Refer to voltage waveform of each section (7), page 63 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts.
		2. Transistor Tr9-C) Transistor Tr9-B) Observing the waveform (Terminal 5 of divider unit connector) FF stopping	Refer to voltage waveform of each section (9), page 63 .	"	"
		3. Transistor Tr10-C) Transistor Tr10-B) Observing the waveform	Refer to voltage waveform of each section (10), page 64 .	"	"
Motor unit		1. Transistor Tr11-C) Transistor Tr11-B) Observing the waveform (Terminal 4 or 5 of motor unit connector) Slipped motor synchronism.	Refer to voltage waveform of each section (11), page 64 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts.
		1. Checking the secondary battery voltage			1. Replace secondary battery unit. 2. Recharge secondary battery. (5mA charging, 10 hours)

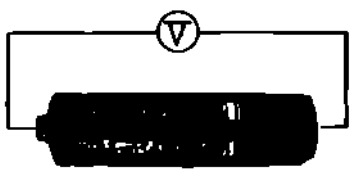
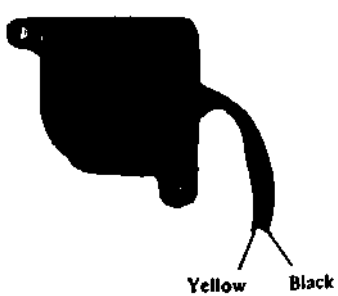
Unit nomenclature					
Secondary battery unit					
	(1) - (2)	More than 1.1V	Tester (voltmeter)	
	(3) - (4)	"	"	
Gear train	1. Short of oil. 2. Cracked jewel. 3. Heavy gear train revolution.	5th wheel smoothly revolves without obstructions in each section.	Eye glass	1. Replace parts. 2. Cleaning

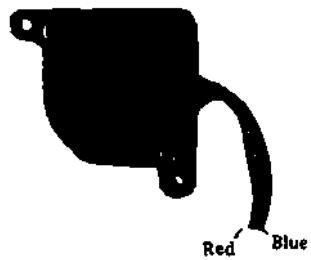
(7) Clock generates wide errors, and meter pointer abnormally fluctuates between red and blue ranges

Motor unit	1. Transistor Tr11-B, Transistor Tr11-C Observing the waveform (Terminal 4 or 5 of motor unit connector) Slipped motor synchronism.	Refer to voltage waveform of each section (11), page 64 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts. 3. Check and clean the motor.
Divider unit	1. Transistor Tr7-C, Transistor Tr7-B Observing the waveform (Terminal 4 of divider unit connector)	Refer to voltage waveform of each section (7), page 63 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts.

Unit nomenclature					
	Oscillator unit	2. Transistor Tr9-C) Transistor Tr9-B) Observing the waveform (Terminal 5 of divider unit connector) FF stopping	Refer to voltage waveform of each section (9), page 63.	Oscilloscope	1. Check the electronic circuit. 2. Replace parts.
		3. Transistor Tr10-C) Transistor Tr10-B) Observing the waveform	Refer to voltage waveform of each section (10), page 63.	"	"
		1. Transistor Tr4-B) Transistor Tr4-C) Observing the waveform (Terminal 9 of oscillator unit connector)	Refer to voltage waveform of each section (4), page 62.	"	1. Check the electronic circuit. 2. Replace parts.
	Secondary battery unit	1. Checking secondary battery voltage  (1)(2)(3)(4)			1. Replace secondary battery unit. 2. Recharge secondary battery. (5mA charging, 10 hours)
		(1) - (2)	More than 1.1V	Tester (voltmeter)	
		(3) - (4)	"	"	
	Gear train	1. Short of oil. 2. Cracked jewel. 3. Heavy gear train.	5th wheel smoothly revolves without obstructions in each section.		

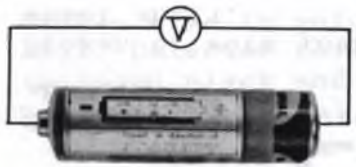
(8) Meter pointer does not enter the blue range even on inserting new dry cells

Unit nomenclature					
Dry cell unit	1. Checking the dry cell voltage 	More than 2.2V	Tester (voltmeter)	Replace dry cells with new ones.
	2. Defective contact of dry cell connector. (Measure by same method as checking dry cell voltage)	"	"	Replace the dry cell case.
Motor unit	1. Broken wire in motor coil. Detector coil (between black and yellow lead wires). 	Approx. 200Ω	Tester	Soldering the lead wire connection. Replace parts.

Unit nomenclature					
		Driving coil (between red and blue lead wires)  	Approx. 1KΩ	Tester	Soldering the lead wire connection. Replace parts.
		2. Broken or worn rotor shaft.	No shaft broken or worn	Eye glass	Replace parts.
		3. Broken or worn inertia wheel shaft.	"	"	"
		4. Cracked hole jewel.	No hole jewel cracks	"	"
		5. No shakes on each wheel.	5/100 - 8/100mm	"	Adjust shakes.
		6. Transistor Tr11-B) Transistor Tr11-C Observing the waveform (Terminal 4 or 5 of motor unit connector) Slipped motor synchronism	Refer to voltage waveform of each section (11), page 64 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts. 3. Check and clean the motor.
	Divider unit	1. Transistor Tr7-C) Transistor Tr7-B Observing the waveform (Terminal 4 of divider unit connector)	Refer to voltage waveform of each section (7), page 63 .	Oscilloscope	1. Check the electronic circuit. 2. Replace parts.

		2. Transistor Tr9-C) Transistor Tr9-B) Observing the waveform (Terminal 5 of divider unit connector) FF stopping	Refer to voltage waveform of each section (9), page 63.	Oscilloscope	"
		3. Transistor Tr10-C) Transistor Tr10-B) Observing the waveform	Refer to voltage waveform of each section (10), page 64 .	"	"

(9) Connector is corroded by leaking dry cell electrolyte

Unit nomenclature	Dry cell unit	1. Checking the dry cell voltage 	More than 2.2V	Tester (voltmeter)	Replace dry cells with new ones.
		2. Defective contact of dry cell connector. (Measure by same method as checking dry cell voltage)	"	"	Replace the dry cell case.

9. PRECISE ADJUSTMENT OF THE ELECTRONIC CIRCUIT

9.1 Measuring the Crystal Oscillator Frequency

Since the frequency of crystal oscillator directly affects clock accuracy, it is necessary to adjust the frequency correctly.

In general, while adjusting the REGULATOR located on the rear side of the clock, actually measure the daily rates and set the frequency of the crystal oscillator.

Use a frequency counter to adjust the frequency of the crystal oscillator correctly in a short time.

Frequency counter

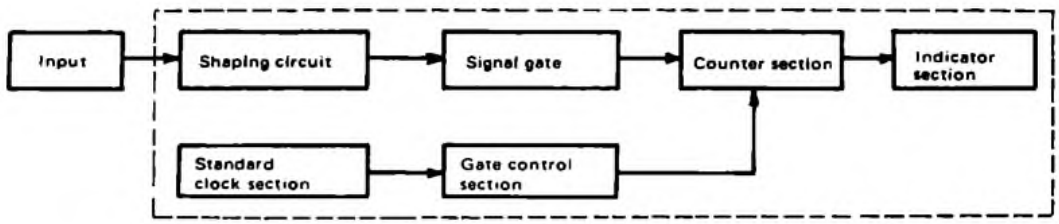
Signals of 1MHz are transmitted from the standard clock section, and these signals enter the counter section through the gate control section. On the other hand, oscillated signals from the clock to be adjusted enter shaping circuit from the input, then go to the signal gate.

As mentioned above, when measuring frequency through the frequency counter (measured at the oscillator unit connector (9)), it becomes $\frac{1}{6269388} \fallingdotseq 1595052\mu s$, and its measuring time is approximately 1.6 seconds.

The value of 1595052 indicates 0 second at the daily rates. When the last digit slips 1, an error of approx. 0.05 second will be generated, converting into the daily rates. When this digit slips

to plus (+), the clock loses; when it slips to minus (-), the clock gains.

When the measuring input impedance does not exceed 1MΩ, sometimes the circuit becomes erroneous, causing impossible measurement.



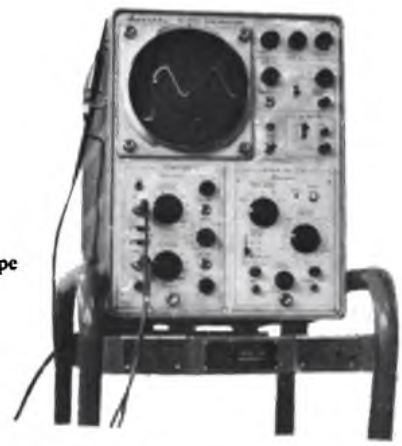
Frequency counter

Fig. 15

9.2 Measurement with an Oscilloscope

An oscilloscope or synchroscope is used when measuring the voltage waveform of each electronic circuit. In this case, if there is a type available capable of DC measurement, it is very convenient to measure the electric potential and the waveform simultaneously.

When the measuring input impedance does not exceed 1MΩ, sometimes the circuit becomes erroneous, causing impossible measurement.



Oscilloscope

9.3 Frequency Dividing Resistance Precise Adjustment

When measuring the divider unit connector (4) through the oscilloscope, if the waveform is the same as the voltage waveform of each section (7) on page 63 , the resistance is normal. If the frequency dividing ratio is not 1/3 x 1/4 x 1/4, adjust the resistance value.

1st stage - when 1/3 divider has slipped
... Adjust R12

2nd stage - when 1/4 divider has slipped
... Adjust R15

3rd stage - when 1/4 divider has slipped
... Adjust R18

When decreasing the resistance value → Frequency dividing ratio becomes small

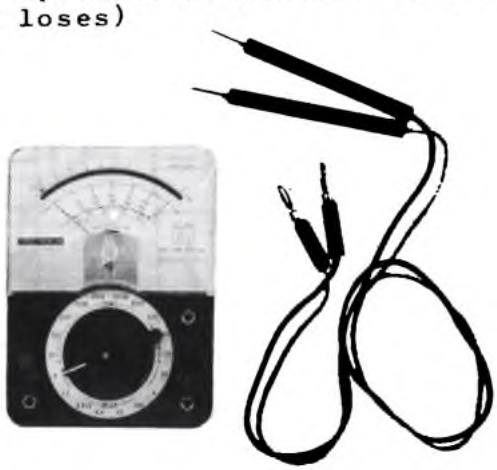
When increasing the resistance value → Frequency dividing ratio becomes large

9.4 Motor Condenser Precise Adjustment

When measuring the motor unit connector (4) through the oscilloscope, if the waveform is the same as the voltage waveform of each section (11) mentioned on page 64 , the condenser is normal. If the waveform has slipped, this is caused by slipped motor synchronism; thus, adjust C14.

When motor speed is fast...Increase C14
(The clock gains)

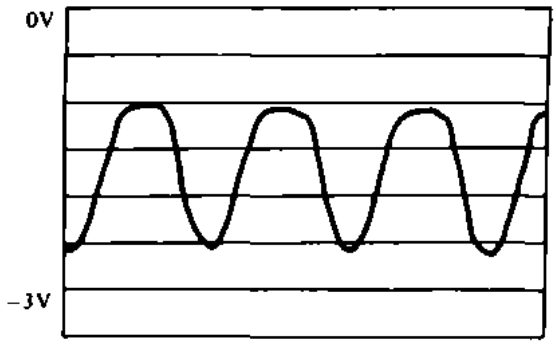
When motor speed is slow....Decrease C14
(The clock loses)



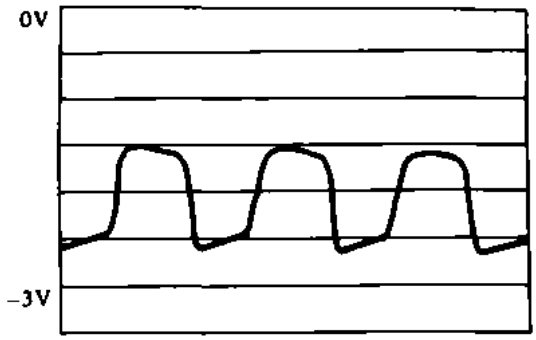
10. VOLTAGE WAVEFORM OF EACH SECTION

Waveforms of collector (C), emitter (E), and base (B) for each transistor Trl - Trll are indicated.

(1)



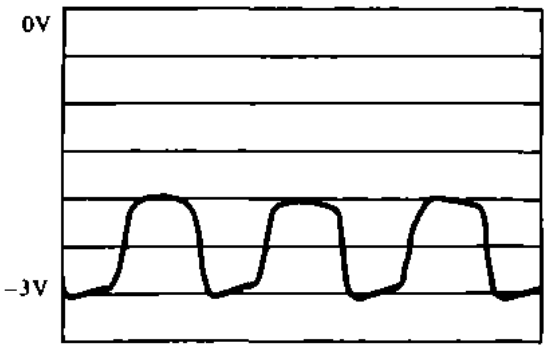
Tr_1-B(a)



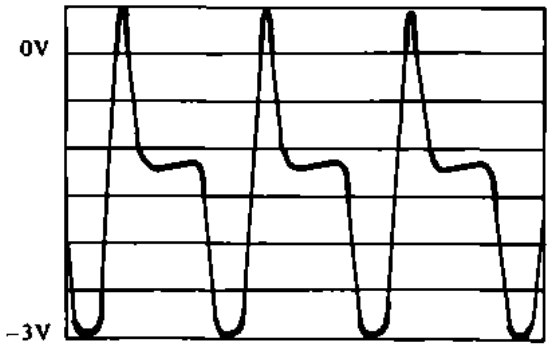
Tr_1-E(b)

Fig. 16 6269.388Hz Oscillating waveform

(2)



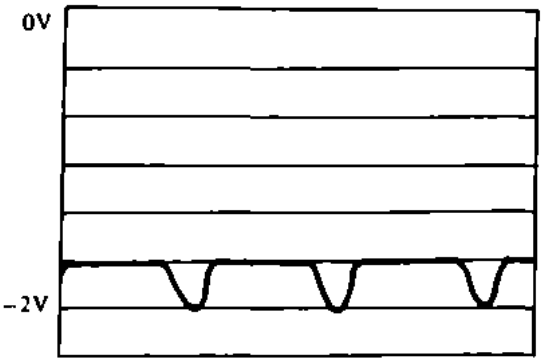
Tr_2-B(c)



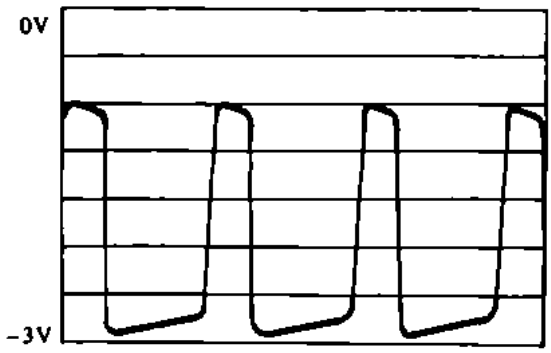
Tr_2-C(d)

Fig. 17 6269.388Hz Oscillating waveform

(3)



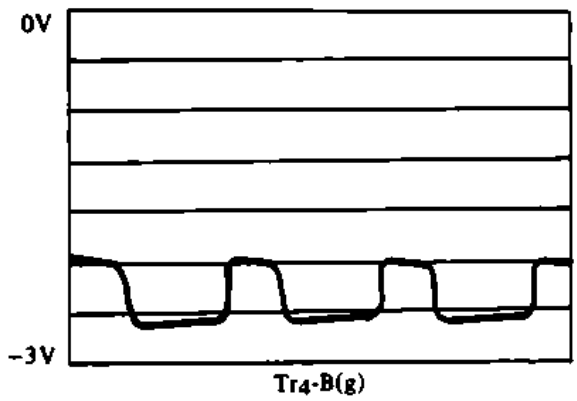
Tr_3-B(e)



Tr_3-C(f)

Fig. 18 6269.388Hz Oscillating amplifier waveform

(4)



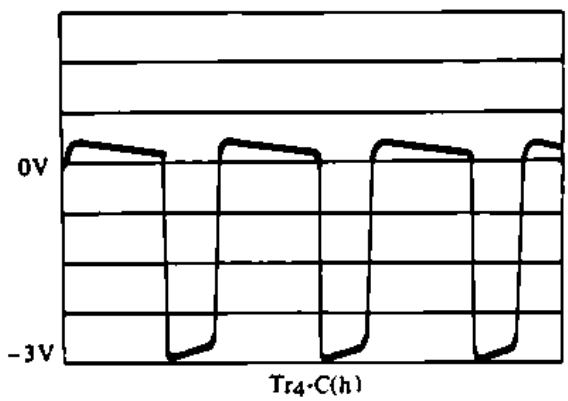
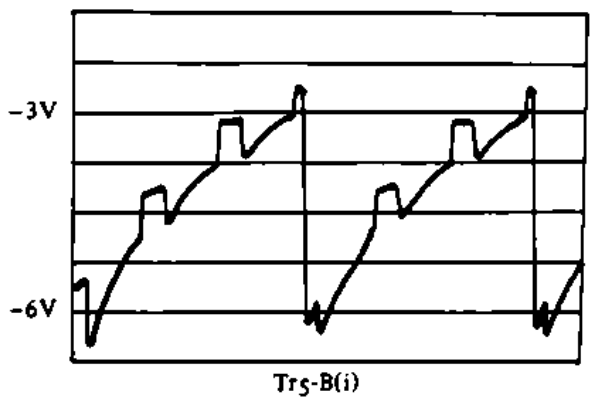


Fig. 19 6269.388Hz

Oscillating amplifier waveform

(5)



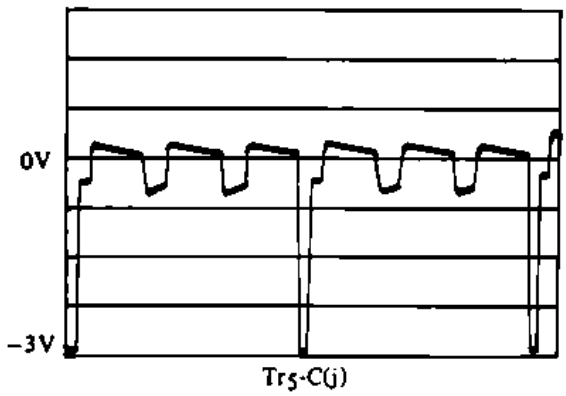
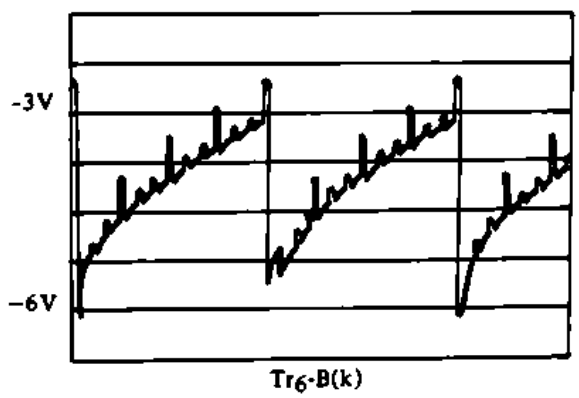


Fig. 20 2089.796Hz

Divider 1st stage, 1/3 waveform
(Blocking divider)

(6)



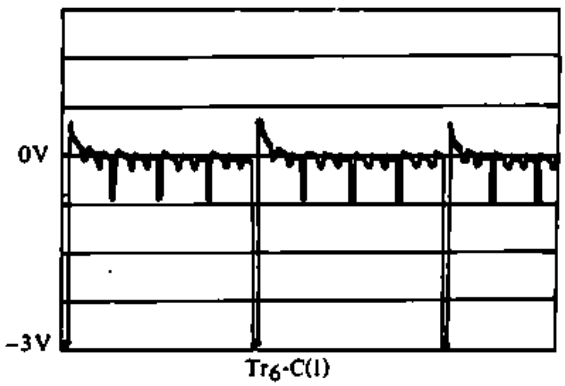
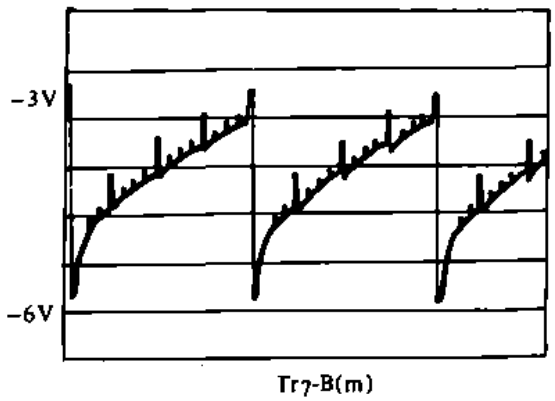


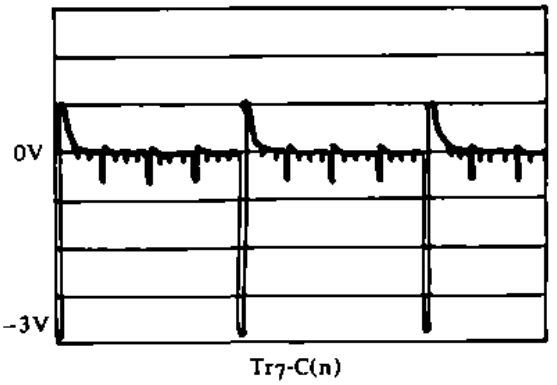
Fig. 21 522.449Hz

Divider 2nd stage, 1/4 waveform
(Blocking divider)

(7)



Tr7-B(m)

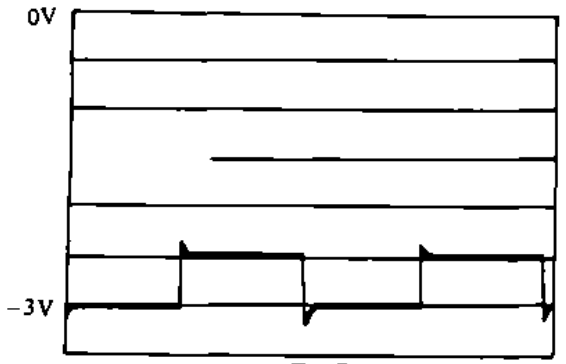


Tr7-C(n)

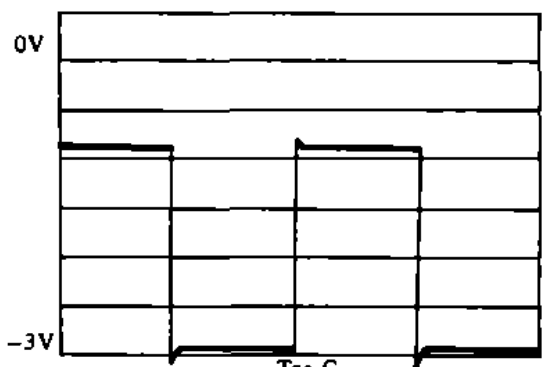
Fig. 22 130.612Hz

Divider 3rd stage, 1/4 waveform
(Blocking divider)

(8)



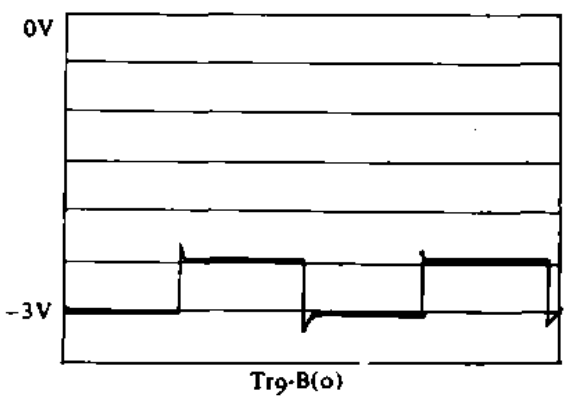
Tr8-B



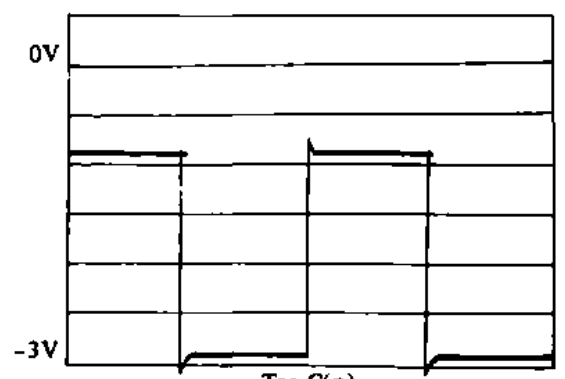
Tr8-C

Fig. 23 65.306Hz

(9)



Tr9-B(o)

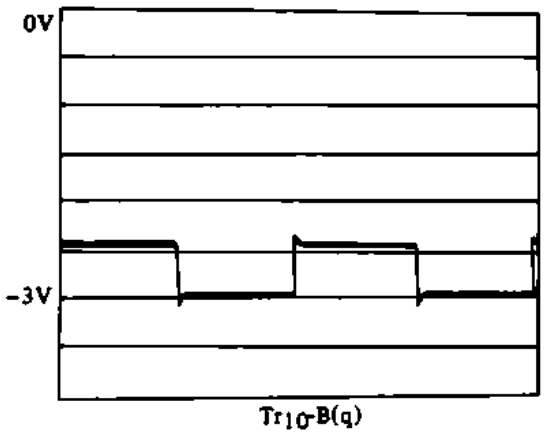


Tr9-C(p)

Fig. 24 65.306Hz

Divider 4th stage, 1/2 waveform
(Flip-flop divider)

(10)



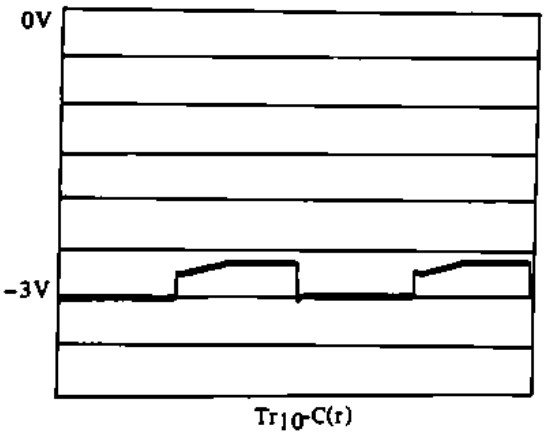
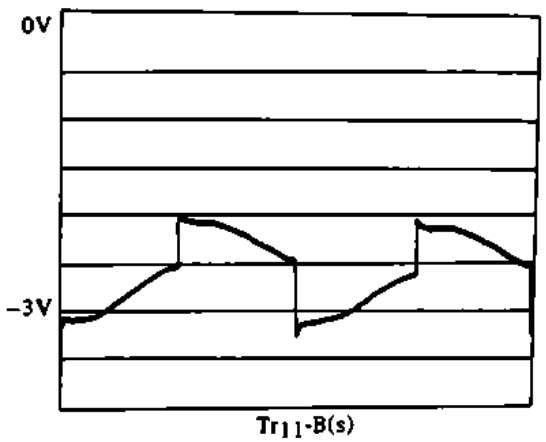


Fig. 25 65.306Hz Buffer amplifier waveform

(11)



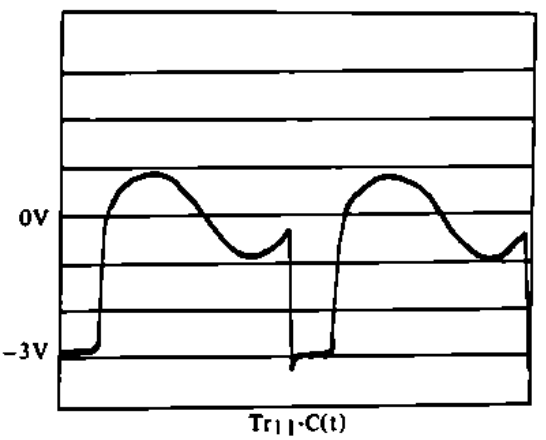


Fig. 26 65.306Hz Motor waveform

III. PARTS

1. CRYSTAL CHRONOMETER QC-951-II PARTS LIST

Division	Parts No.	Sub Division		Quan.	Rating & remarks
		Complete parts	Component parts		
Outer case	951S2018	Front panel			
			Front panel unit	1	
	951S2036		Release	2	
	951S2035		Second hand correction button	2	
	951S2106		Second handcorrection button gasket	2	
	951S2039		Release bushing	2	
	951S2020	Case			
			Case body	1	
			Safety knob bushing	1	
			Safety knob gasket	1	
	951S2095		Handling instruction plate	1	
	951S2096		Machine number plate	1	
	951S2069		Dry cell unit holder	1	
	951S2070		Dry cell unit holder cover	1	
	951S2021	Dial		1	
	951S2022	Glass		1	
	951S2023	Dry cell lid		1	
	951S2041	Safety knob		1	
	951S2024	Waterproof cap		1	With START & STOP marks
	951S2118	Waterproof cap		2	Without START & STOP marks
	951S2015	Hand setter device			

			Hand setter cap	1	
			Hand setter knob	1	
			Hand setter fixture	1	
			Hand setter knob bushing	1	
			Joint pipe	1	
			Hand setter knob gasket holder	1	
			Hand setter knob gasket	1	
			Joint pin	2	
			Hand setter adjusting nut	1	
			Joint shaft	1	
	951S2051	Hand setter shaft spring		1	
	951S2054	Hand setter shaft			
			Hand setter shaft	1	
			Hand setter pinion	1	
	951S2052	Hand setter knob pin		1	
	951S2025	Regulator cover		1	
	951S2027	Wire terminal spring			
			Wire terminal spring	1	
			Wire terminal pin	1	
	951S2040	Safety lever		1	
	951S2043	Safety lever guide pin		2	

Division	Parts No.	Sub Division		Quan.	Rating & remarks
		Complete parts	Component parts		
Outer case	951S 264	Dry cell meter		1	
	951S2029	Dry cell meter holder		1	
	951S2030	Meter ring		1	
	951S2046	Hour hand		1	
	951S2045	Minute hand		1	
	951S2049	Minute hand nut		1	
	951S2047	Second hand		1	
	951S2071	Dry cell insulation plate		1	
	951S2074	Dry cell connector spring		1	
	951S2072	Microswitch lever		1	
	951S2076	Microswitch lever guide		1	
	951S2119	Connector fixture - A		3	
	951S2120	Connector fixture - B		3	
	951S2091	Condenser setting fixture		1	
	951S2093	Dustproof case		1	
	951S2115	Connector - A		2	Without cut
	951S2116	Connector - B		1	With cut
	951S2102	Slide stop rubber		4	
	951S2103	Dry cell lid gasket		1	

	951S2104	Waterproof cap gasket		4	Waterproof cap x 3 Hand setter device x 1
	951S2107	Front panel screw gasket		3	
	951S2108	Regulator cover gasket		1	
	951S2109	Case gasket		1	
	951S2110	Glass gasket		1	
	951S2111	Meter gasket		1	
Switch	951S 266	Push-button switch		1	NKK SB-2061
	951S 267	Microswitch		1	2 SAL-F
Dry cell unit	951S2065	Dry cell case			
			Dry cell case body	1	
			Dry cell removing handle	1	
			Dry cell case detent	1	
			Dry cell case detent	1	
			Dry cell connector		
	951S2122	Dry cell		2	UM-1 "D" type
Secondary battery unit	951S 261	Secondary battery unit		1	6AH or 9AH
Oscillator unit	951S 262	Oscillator unit			
			Oscillating circuit shielded case	1	
			Oscillating circuit plate	1	
			Oscillating circuit bushing	3	

Division	Parts No.	Sub Division		Quan.	Rating & remarks
		Complete parts	Component parts		
Oscil-lator unit			Oscillating circuit insulation plate	1	
			Thermovariable condenser set	1	
			Trimmer condenser set	1	
			Regulator variable condenser setting plate Type L	1	
			Thermovariable condenser plate	1	
			Crystal damper	2	
			Oscillating circuit plate	1	
			O-ring	1	
			Film condenser	1	DEP KO.01μF 50WV
			Resistor	1	Type PLS RF1/16ZK 30KΩ
			Resistor	5	Type PLS RF1/16ZK 100KΩ
			Resistor	4	Type PLS RF1/16ZK 500KΩ
			Transistor	4	SONY 2SC-318A3
			Diode	1	NEC SD34
			Crystal oscillator	1	6269.388Hz

Divider unit	9515 263	Divider unit	Oscillating circuit printed circuit board	1	
			Lug plate	1	
			Transformer	1	Type 75 C
			Styrol condenser	1	CQ09S-2B10R00-M03
			Divider printed circuit board	1	
			Electrolysis condenser	2	6VASN-30
			" "	1	6VBSN-200
			" "	1	6TA-1000
			Film condenser	4	DEPK0.001μF 50WV
			Mylar condenser	1	0.027μF 50V
			Mylar condenser	1	0.006μF 50V
			Resistor	1	Type PLS RF1/16 ZK 3KΩ
			Resistor	1	Type PLS RF1/16 ZK 20KΩ
			Resistor	1	Type PLS RF1/16 ZK 30KΩ
			Resistor	6	Type PLS RF1/16 ZK 50KΩ
			Resistor	5	Type PLS RF1/16ZK 100KΩ
			Resistor	2	Type PLS RF1/16ZK 250KΩ
			Transistor	6	SONY 2SC-318A3
			Transformer	3	S-D

Division	Parts No.	Sub Division		Quan.	Rating & remarks
		Complete parts	Component parts		
Motor unit	951 265	Motor unit			
			Motor printed circuit board	1	
			Electrolysis condenser	1	6VBSN-200
			" "	1	25T H-3
			Resistor	1	Type RLS RF1/16ZK 250KΩ
			Transistor	1	SONY 2SC-318A5
			Transformer	1	S-MM) New M-F
			Transformer	1	S-MC
			Polyester film condenser	1	PLM-068-50
			Resistor	1	Type PLS RF1/16ZK 100KΩ
	951 266	(Motor set)			
	951 211		Motor plate (with pillar)	1	
	011 309		6th wheel lower hole jewel	1	
	952 2312		D.F rotor lower hole jewel with frame	1	
	952 2311		D.F inertia wheel lower hole jewel with frame	1	
	011 219		D.F cap jewel	2	
	952 232		D.F spring	2	
	951 212		Motor bridge	1	
	952 2312		D.F rotor upper hole jewel with frame	1	

	011 219		D.F cap jewel	1	
	952 232		D.F spring	1	
	951 213		6th wheel bridge	1	
	011 309		6th wheel upper hole jewel	1	
	952 2311		D.F inertia wheel upper hole jewel with frame	1	
	011 219		D.F cap jewel	1	
	952 232		D.F spring	1	
	951 215		Rotor	1	
	951 218		Inertia wheel	1	
	951 226		6th wheel	1	
	951 224		Coil frame	1	
	951 235		Motor pillar ring	3	
	951 2331		Shake adjusting washer A		t=0.03mm
	951 2332		Shake adjusting washer B		t=0.1mm
Movement	951 121	Plate (with minute wheel pin, 2nd wheel pillar, motor guide pin)		1	
	011 309		3rd wheel lower hole jewel	1	
	011 309		5th wheel lower hole jewel	1	
	951 122	2nd wheel bridge (with center pipe)		1	

Division	Parts No.	Sub Division		Quan.	Rating & remarks
		Complete parts	Component parts		
Movement	951 123	3rd wheel bridge (Pawl lever (left/right), second hand adjusting wheel, second hand adjusting wheel washer, pawl wheel, release fix pin, 4th wheel pillar, dustproof case pillar)		1	
	011 309		3rd wheel upper hole jewel	1	
	011 309		5th wheel upper hole jewel	1	
	011 309		Idler B lower hole jewel	1	
	951 124	4th wheel bridge		1	
	011 316		4th wheel upper hole jewel	1	
	951 125	2nd wheel		1	
	951 126	3rd wheel		1	
	951 127	4th wheel (with idler A)		1	
	951 132	5th wheel		1	
	951 133	Minute wheel		1	
	951 134	Hour wheel		1	
	951 1462	Idler bridge		1	
	011 309		Idler B upper hole jewel	1	

	951 131	Idler B		1	
	951 148	Pawl lever spring		1	
	951 151	Minute wheel washer		1	
	951 153	Dial washer		1	
	951 177	Hour wheel ring		1	
	951 153	2nd wheel washer		1	
	951 162	3rd wheel pillar		3	
Screw	022 351	Idler bridge screw		2	
	951 172	2nd wheel bridge screw		2	
	951 172	4th wheel bridge screw		2	
	951 174	Release screw		2	
	951S2201	Oscillating circuit board screw		3	
	951S2201	Regulator variable condenser screw		2	
	951S2202	Thermovariable condenser screw		3	
	951S2204	Microswitch lever screw		2	
	951S2205	Oscillating circuit shielded case screw		2	
	951S2205	Secondary battery unit screw		2	
	951S2206	Connector fixture screw		1	(Flat-head screw)

Division	Parts No.	Sub Division		Quan.	Rating & remarks
		Complete parts	Component parts		
Screw	951S2208	Dustproof case screw		2	
	951S2209	Divider unit screw		1	
	951S2209	Motor unit screw		1	
	951S2209	Movement screw		3	
	951S2209	Motor screw		2	
	951S2209	Microswitch lever guide screw		2	
	951S2210	Oscillator unit screw		2	
	951S2211	Meter screw (short)		1	
	951S2211	Connector fixture screw		5	(Cylinder-head screw)
	951S2212	Dial screw		4	
	951S2213	Meter screw (long)		1	
	951S2213	Connector screw		6	
	951S2214	Slide stop rubber screw		4	
	951S2215	Front panel screw (long)		1	
	951S2031	Front panel screw (short)		2	
Washer	951 176	3rd wheel bridge nut washer		3	
	951 176	Motor bridge nut washer		3	

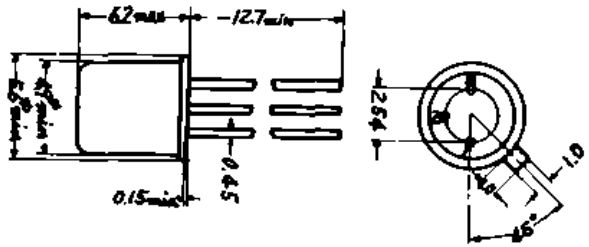
	951S2230	Microswitch screw washer	(Spring washer)	2	
	951S2232	Connector screw washer		11	
	951S2232	Meter screw washer		2	
	951S2233	Front panel screw washer	(Spring washer)	3	
	951S2234	Microswitch screw washer		2	
	951S2235	Front panel screw washer		3	
	951S2236	Hand setter shaft washer		2	
	951S2237	Divider unit screw washer		1	
	951S2237	Motor unit screw washer		1	
	951S2237	Oscillator unit screw washer		2	
	951S2237	Motor screw washer		2	
	951S2231	Movement screw washer		3	
	951S2232	Dial screw washer		4	
Nut	951 176	3rd wheel bridge nut		6	
	951 176	Motor bridge nut		3	
	951S2221	Connector nut		6	
	951S2220	Thermovariable condenser setting nut		2	

Division	Parts No.	Sub Division		Quan.	Rating & remarks
		Complete parts	Component parts		
Nut	951S2220	Oscillating circuit printed circuit board nut		3	

Remarks: 1. Parts whose Nos. are not indicated are unavailable.
2. When placing an order for parts, always state Parts No. and Parts Name.

2. TRANSISTOR STANDARDS

(SONY 2SC318)



1. Emitter
2. Base
3. Collector

Absolute maximum ratings T = 25°C

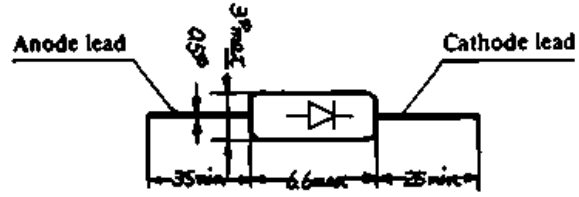
Collector to base voltage	V_{CBO}	50	V
Collector to emitter voltage	V_{CEO}	30	V
Emitter to base voltage	V_{EBO}	5	V
Collector current	I_C	100	mA
Collector loss	P_C	300	mW
Junction temperature	T_I	175	°C
Storage temperature		-65 - 200	°C

Standards

T = 25°C

Item	Symbol	Test condition	Minimum value	Typical value	Maximum value	Unit
Collector cut-off current	I_{CBO}	V_{CB}=25V, I_E=0			0.2	μA
Collector to emitter voltage	V_{CEO}	I_C=2mA	30			V
Emitter cut-off current	I_{EBO}	V_{EB}=5V, I_C=0			0.2	μA
DC current gain	$h_{FE}1$	I_C=0.1mA, V_{CE}=3V		50		
DC current gain	$h_{FE}2$	I_C=1mA, V_{CE}=3V	42	90	272	
DC current gain	$h_{FE}3$	I_C=10mA, V_{CE}=3V		140		
DC current gain	$h_{FE}4$	I_C=50mA, V_{CE}=3V		115		
Collector to emitter saturation voltage	$V_{CE(SAT)}$	I_C=50mA, I_B=10mA		0.15	0.30	V
Base to emitter voltage	V_{BE}	I_C=50mA, I_B=10mA		0.88	1.00	V
Small signal current gain	$\|h_{fo}\|$	I_E=-2mA, V_{CE}=6V, f=100MC	1.5	4.5		dB
Collector output capacitance	C_{ob}	V_{CB}=6V, I_E=0, f=1MC		3.0	4.5	PF
$C_c \cdot \gamma_{bb'}$	$C_c \cdot \gamma_{bb'}$	I_E=-2mA, V_{CB}=6V, f=1.59MC		100	250	PS

3. DIODE STANDARDS (SD 34)



Absolute maximum ratings (T = 25°C)

Item	Symbol	SD 34	Unit
Surge reverse voltage	V_{RM}	75	V
DC reverse voltage	V_R	60	V
Surge current (1 sec)	I_{surge}	350	mA
Surge forward current	I_{FM}	90	mA
Mean rectification current	I_o	30	mA
Storage temperature	T_{stg}	-65 - +90	°C

Electrical characteristics (T_a = 25°C)

Item	Symbol	Test conditions	SD 34	Unit
Forward current (min.)	I_F	V_F=1V	5	mA
Reverse current (max.)	I_R	V_R=3V		μA
		V_R=10V	20	μA
		V_R=30V		μA
		V_R=50V	350	μA
		V_R=100V		μA
Rectification ratio (min.)	η	f=40MHz, V_{sig}=2V, C_L=20PF, R_L=5KΩ		%
Application			General