

BULOVA WATCH COMPANY, INC.



**GENERAL SERVICE
MANUAL FOR ANALOG
QUARTZ (SMQ[®]) WATCHES**

 **ACCUTRON[®]
BULOVA[®]
CARAVELLE[®]
QUARTZ **

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INTRODUCTION

Most Stepping Motor Quartz (SMQ) movements in the field today are similar in design and relatively simple to service. Differences are mainly in the quality and location of the components. Understanding how an SMQ functions reduces the anxiety one may have which would prevent an attempt at service.

BASIC THEORY OF A STEPPING MOTOR QUARTZ (SMQ) WATCH

The SMQ movement receives its driving force from a battery.

Energy (current) from the battery flows to the oscillator control of the electronic circuit and then to the Quartz Crystal, causing it to vibrate.

Most Quartz watch crystals in use today vibrate at a frequency of 32,768 Hz (vibrations per second). The accuracy of the watch is dependent on the accuracy of the crystal.

The 32,768 Hz vibrations must then be reduced to a workable number of timing signals.

By feeding the frequency signals into the frequency divider circuit, the signals are reduced until the required number is obtained.

The final signal is then fed into the motor driver circuit which causes a switch to open and close at specific intervals, allowing current from the battery to activate the coil winding.

The coil winding converts these current pulses into alternating north and south magnetic fields.

The rotor, complete with magnet, is positioned next to the coil and receives the alternating magnetic signals from the coil.

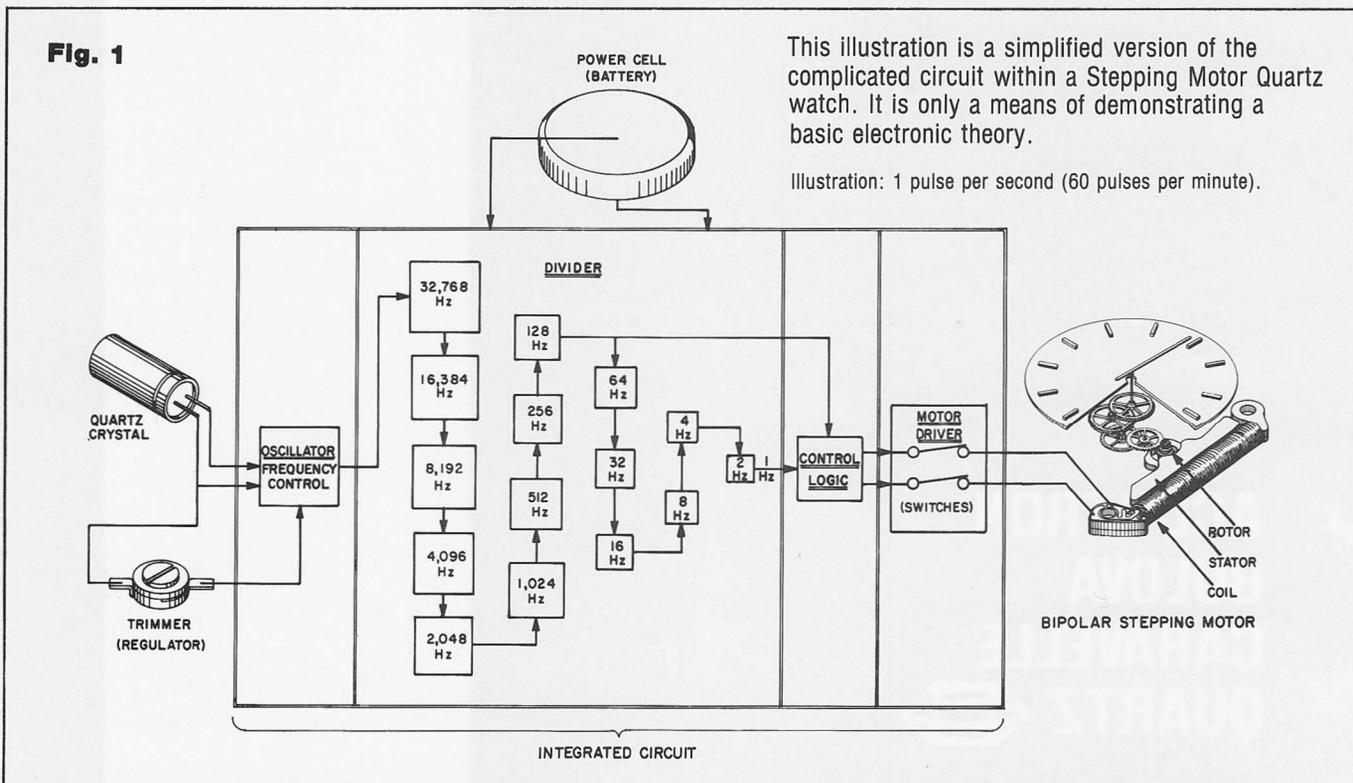
This magnetic field attracts and repels the magnet on the rotor, causing the rotor to rotate at specific intervals and direction.

The rotor, in turn, drives the gear train, dial train, calendar train and hands.

To summarize:

- 1) The battery current causes the Quartz Crystal to vibrate.
- 2) The vibrations are converted into timing signals, which are then reduced by the electronic circuit.
- 3) The electronic circuit alerts the battery to furnish current to the motor.
- 4) The motor turns, driving the mechanical portion of the watch.

Note: Electronic circuit is also referred to as a P.C. (Printed Circuit) Board.



RELATION OF STEPPING MOTOR QUARTZ TO MECHANICAL WATCH

<u>STEPPING MOTOR QUARTZ</u>	<u>MECHANICAL</u>
POWER CELL (BATTERY) Provides Power (Energy)	MAINSRING Provides Power (Energy)
QUARTZ CRYSTAL Source of Accuracy	BALANCE WHEEL Source of Accuracy
TRIMMER Means of Adjusting Rate	REGULATOR Means of Adjusting Rate
ELECTRONIC CIRCUIT Converts Quartz Vibrations into Electronic Signals and reduces signals to a workable number	ESCAPEMENT Transmits balance accuracy to gear train & releases energy to drive the balance
MOTOR DRIVER CIRCUIT Activates switch, releasing energy to coil winding	PALLET SLOT Transmits energy to drive balance wheel
COIL WINDING Releases energy on command (Magnetic field)	PALLET STONES Releases energy on command
ROTOR Drives the gear and dial trains	ESCAPE WHEEL Releases mainspring power to drive the balance wheel
GEAR AND DIAL TRAINS Turns the hands	GEAR AND DIAL TRAINS Turns the hands

There is one basic difference: The flow of energy (power) in a mechanical watch starts at the mainspring and is transmitted to the gear train, escapement and balance wheel.

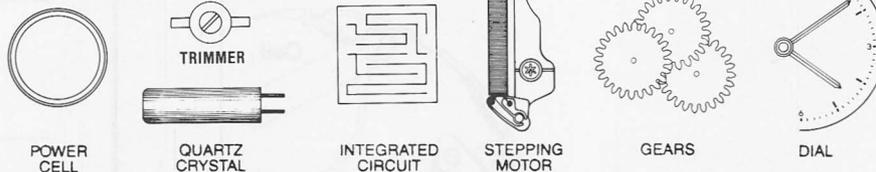
The flow of power in an SMQ starts at the battery, then flows through the electronic circuit to the crystal, divider, motor and coil circuits, causing

the rotor to turn and drive the train wheels.

This difference in the flow of energy and the lack of mainspring pressure substantially reduces the torque or driving power of an SMQ. It is, therefore, imperative that an SMQ watch be free of excess drag or bind. (See cleaning and lubrication on page 7.)

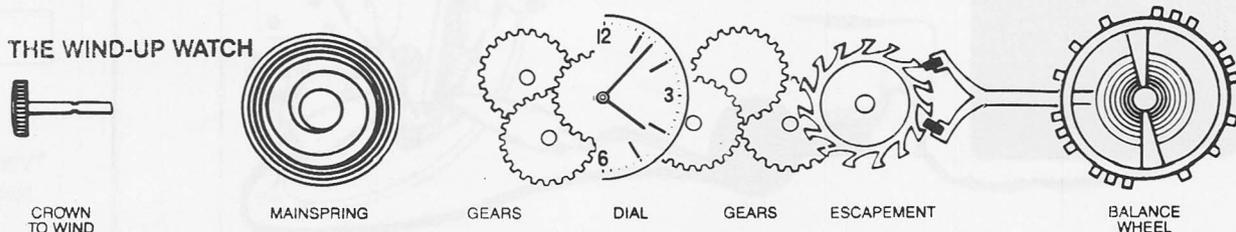
Fig. 2

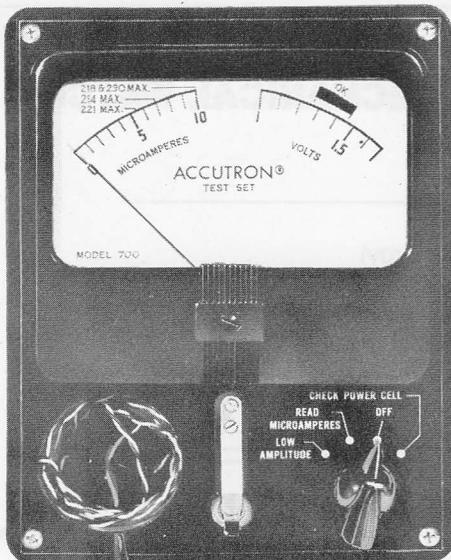
THE QUARTZ ELECTRONIC



POWER FLOW: Note the distance of the gear train from the power source between a mechanical and SMQ watch.

THE WIND-UP WATCH

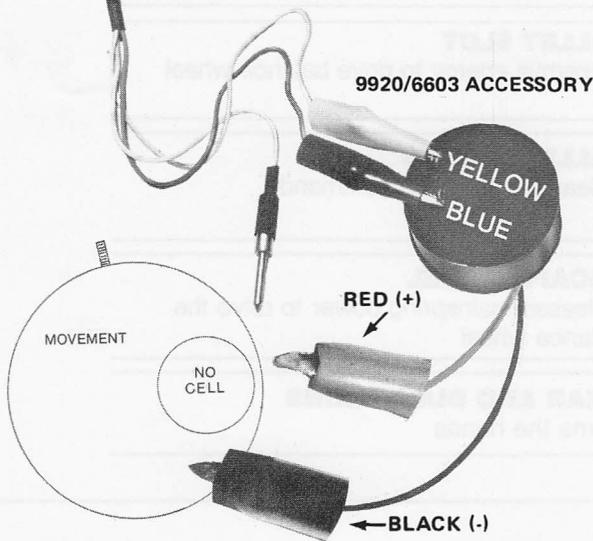




**BULOVA
NO. 700 METER**

Note:
photographs
of units are not
to actual size.

Fig. 3



9920/6603 ACCESSORY

CONNECTING METER TO MOVEMENT

1. Attach yellow Meter clip to yellow marked loop on Accessory 9920-6603.
2. Attach blue Meter clip to blue marked loop on Accessory.
3. Connect Red (+) Accessory clip to (+) connection of movement (see individual caliber manual).
4. Connect Black (-) Accessory clip to movement (see individual caliber manual).

METER HINTS

It is necessary to wait approximately 5 seconds for the meter attachment #9920 to lower its stored voltage before making a low amplitude test.

After the meter leads are attached to the movement, the meter pointer may remain stationary at approximately 1 to 3 microamps and not indicate a pulse fluctuation. This can be caused by a loose contact screw, a faulty P.C. Board, or a bad coil. Check accordingly. (If Accuset model, wait 30 seconds for sweep hand to start).

A watch which indicates a good frequency and meter pulse, but the hands do not move, indicates a mechanical problem.

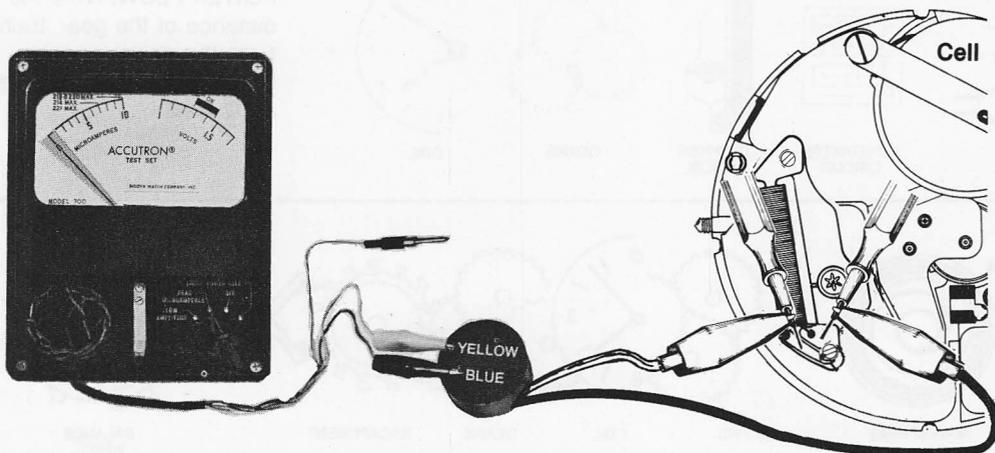
Check for metal slivers on magnet.

Check gear, dial and date wheels for blockage, binding, or excessive lubrication.

Fig. 4

Clamp accessory clips to screwdrivers or wire oilers as probes. Place probes on coil wire terminals.

This illustration indicates where to apply the probes. Positions may vary with caliber. If necessary remove magnetic shield to determine particular caliber contact position.



BASIC TEST

Step 1

CHECK POWER (

Step 2

CHECK FREQUENCY

Step 3

ELECTRONIC CIRCUIT

Step 4

COIL WINDING CH

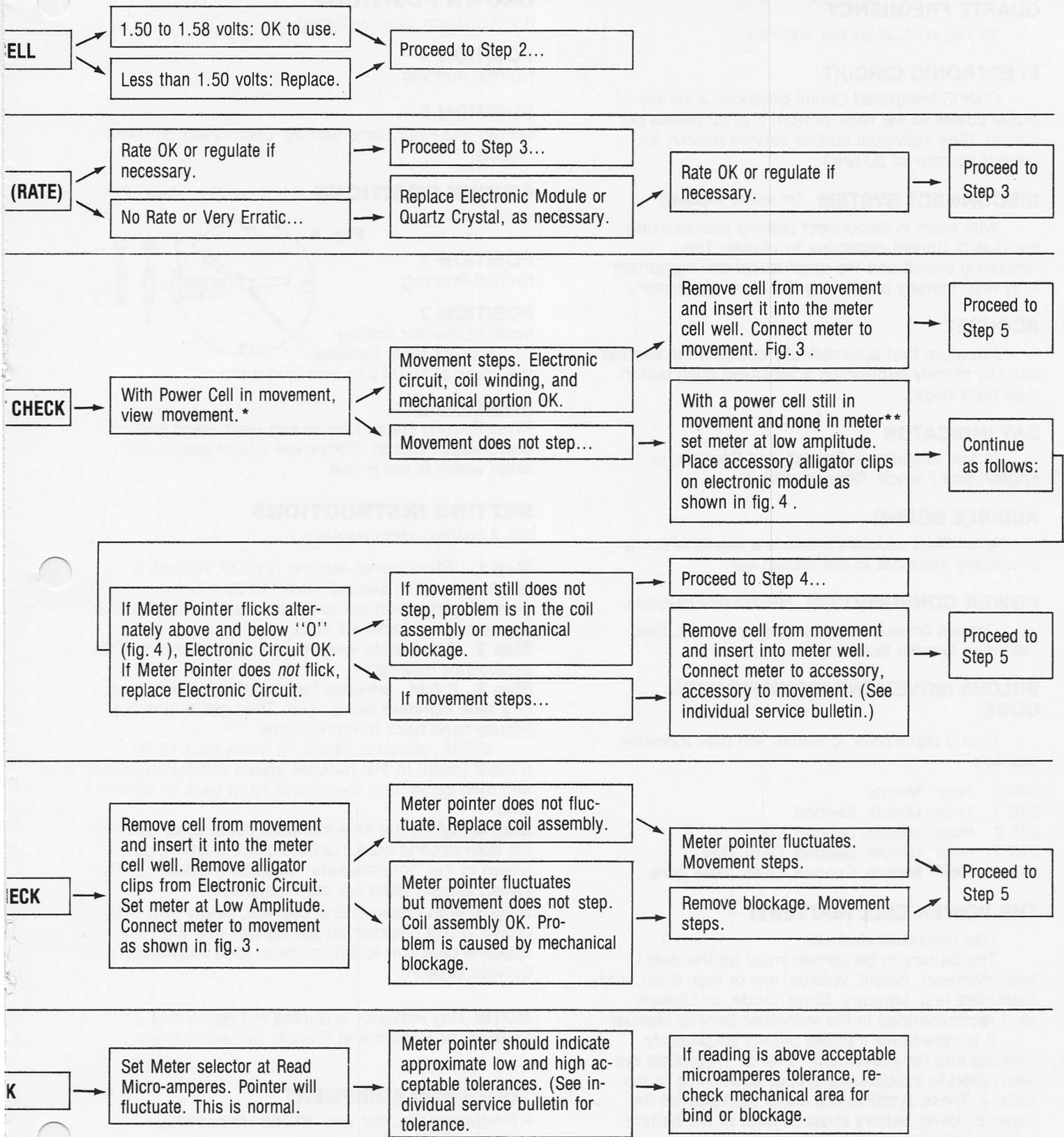
Step 5

CURRENT CHEC

*View rotor, wheel adja
sweep hand to determ

PROCEDURE FOR S.M.Q. WATCHES

NOTE: It is imperative that the basic "step-by-step" procedure be strictly adhered to beginning with Step 1 and continuing through Step 5.



cent to rotor, minute or
line if movement is stepping.

**IMPORTANT: The meter cell well clip must make firm contact with the well contact button. If necessary, slip a metal disc between the spring and contact button.

TECHNICAL INFORMATION

Most Bulova SMQ watches contain the following similarities, functions, or displays.

QUARTZ FREQUENCY

32,768 Hz (Cycles per second).

ELECTRONIC CIRCUIT

C-MOS Integrated Circuit produces a variety of signal pulses to the rotor of from 2 to 60 pulses per minute. (See individual caliber service bulletin for correct number of pulses.)

DISCONNECT SYSTEM (In some models)

With stem in disconnect (setting position) only the Quartz Crystal continues to vibrate. The remaining circuit and the mechanical driving portion is at rest, thereby preserving the life of the battery.

ACCUSET

A feature that automatically corrects the second hand by merely depressing a recessed push button. (See back page).

DAY INDICATOR

In two languages: English and Spanish, or English and French. Set accordingly.

AUDIBLE SOUND

Most SMQ watches produce a sound which is practically inaudible to the human ear.

POWER CONSUMPTION (Microampere drain)

Current consumed in running operation. (See individual Service Bulletin.)

BULOVA MOVEMENT IDENTIFICATION CODE

First 3 digits refer to Series. 4th digit indicates displays.

245 0	Hour, Minute
245 1	Hour, Minute, Second
245 2	Hour, Minute, Second, Date
245 3	Hour, Minute, Second, Date, Day
245 6	Hour, Minute, Second, Date, Time Zone

THE POWER CELL (BATTERY)

Use recommended cell.

The battery to be correct must be the exact type, diameter, height, voltage, low or high drain, and electrolyte (e.g. Mercury, Silver Oxide, or Lithium, etc.) recommended in the individual Service Manual.

It is imperative that the battery be properly inserted into the movement. + and - symbols are often used to indicate the proper positioning of the battery. These symbols are either stamped on the upper or lower battery straps, inside of the battery well, or imprinted in the case back.

If the cell is not replaced before it is exhausted, the watch will simply stop. The movement should not be harmed in any manner.

However, when it becomes exhausted, it should

be replaced at the earliest opportunity to diminish the possibility of leakage. NEVER STORE A WATCH WITH AN EXHAUSTED POWER CELL IN IT.

CROWN POSITIONS

(for 2 position stem watches).

POSITION 1

Normal Running.

POSITION 2

Minute and Hour Hand Setting. Disconnect on some models.

CROWN POSITIONS (for 3 position stem watches)

POSITION 1

Normal Running.

POSITION 2

Instant Calendar Setting.

(Do not reset between the hours of 10:00 p.m. and 2:00 a.m.).

POSITION 3

Stops Second Hand. Minute and Hour Hand Setting. Disconnect Position: Conserves Life of power cell when watch is not in use.

SETTING INSTRUCTIONS

(for 3 position stem watches.)

Step 1. When sweep second hand of the watch reaches the 60th second mark (12:00 o'clock marker), pull crown out to Position 3 (see Fig. 5). The sweep second hand will stop.

Step 2. Turn hands forward until date changes. (This establishes midnight.)

Step 3. If A.M., advance hands five minutes ahead of a time standard being used. Then gently turn the minute hand back to correct time.

If P.M., advance hands 12 hours past 12:00 o'clock (noon) to five minutes ahead of time standard and then gently turn the minute hand back to correct time.

Step 4. When the time standard being used reaches the 60th second mark (12:00 o'clock marker), push crown to the "intermediate" position (Position 2). The sweep second hand will start instantly.

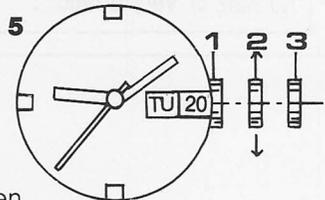
Step 5. With crown in 2nd position, slowly turn the crown in one direction to set the day and the opposite direction to set the date. (See Individual Service bulletin).

NOTE: Day indicator is printed in English and Spanish, or English and French. Set accordingly.

TOOLS AND EQUIPMENT

- Frequency Counter with 32,768 Hz capacity
- Bulova Service Meter #700
- Bulova Accessory #9920/6603
- Non-magnetic tweezers
- Watchmaker's Hand Tools
- Watchmaker's Loupe

Fig. 5



SERVICE

Knowledge of the procedure listed below will reduce service time.

1. Establish customer's reason for return of watch.
2. Visually inspect watch for damage.
3. Check the battery for correct voltage, position (+ or -) and number.

CLEANING

It is not necessary to clean an SMQ movement periodically. Clean only those areas that require cleaning.

The following components should not be subject to heat or harsh cleaning solvents: The Electronic Circuit, Coil Winding, Stepping Rotor, Quartz Crystal cannister, stator or any of the plastic parts.

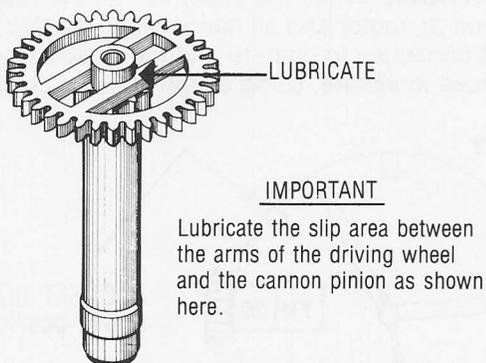
The proper cleaning solutions and method of cleaning will be indicated within the individual service manual. The rotor pivots and pinion can be cleaned with "One Dip", soft pith wood, or "One Touch". DO NOT PUT IT IN CLEANING SOLUTIONS (some magnets are cemented to an arbor and may separate if subjected to strong solution).

LUBRICATION

Unlike mainspring driven watches which exert extreme pressure on the wheel pivots and bearings, subjecting them to a high degree of wear, the SMQ design is such that it reduces wear drastically. The wheels of an SMQ are "Free Floating", with a minimum of pressure.

It is, therefore, extremely important that the correct lubricant, and amount of lubrication used, be carefully controlled. Avoid heavy lubricants and excess application in the gear and dial train area!!! Do not lubricate unless recommended in individual Service Bulletin.

Fig. 6



Either lack of lubrication or foreign matter between the cannon pinion and the center wheel post, or the cannon pinion and the driver wheel, can cause the pinion to bind, creating damage to the minute wheel, hour wheel, and minute post. Check the Service Bulletin for proper lubrication.

CHECKING THE FREQUENCY (RATE)

Place the watch on a frequency counter pick-up. The crystal frequency should be "0" + or - 0.4 seconds a day. Trimmer allows watch to be regulated accordingly.

ADJUSTING THE FREQUENCY (RATE)

Use a metal blade, imbedded in a non-conductive material, to turn the trimmer in the appropriate direction (+ or -). On the average, the maximum rate change is approximately 8 seconds per day. Avoid excessive downward pressure on the trimmer.

A frequency reading that will not change drastically when the trimmer is turned 360° indicates a faulty trimmer. Replace trimmer if possible, P.C. Board if necessary.

A frequency reading that cannot be regulated to within tolerance (trimmer OK) indicates a faulty Quartz and must be replaced. Replace Quartz Crystal if possible, P.C. Board if necessary.

A Quartz Crystal that is vibrating and produces a reading on the frequency counter does not indicate that the complete electronic unit is functioning. There are basically 2 halves to a P.C. Board. One half drives the Quartz. The other half contains the circuit which reduces the Quartz vibration from 32,768 Hz per second down to 60, 30, 20, 6, 2, etc., pulse signals per minute to the rotor (motor). Therefore:

- 1) No frequency reading indicates possible faulty Quartz, electronic circuit, or dead battery.
- 2) Good frequency reading but no impulse signal on meter indicates possible loose contact screw, open coil, or faulty P.C. Board. (See pages 4 and 5.)

HELPFUL HINTS

ELECTRONIC CIRCUIT

Use a tweezer to grip the Printed Circuit Board not covered by the printed pattern. Do not touch circuit board with fingers, or scratch the printed circuit.

Note: Check before removing P.C. Board. Some P.C. Boards have the coil attached and both the board and coil retaining screws must be removed before disassembling P.C. Board.

COIL ASSEMBLY

Use a tweezer to grasp the coil core at the bare hole end and not the end containing the connections to the printed circuit.

STEPPING ROTOR

Handle rotor by its pinion and not the magnet. Do not put in cleaning solutions other than those recommended in service manual. (Some magnets are cemented to arbor and may separate if subjected to strong solutions.)

TO OPEN CASE:

Use a piece of plastic sheet placed between the case opener and case to prevent damage to the case.

REMOVING HANDS:

On some models, the cannon pinion may lift during hand removal. Make certain the cannon pinion is lowered before advancing to the next operation. If the cannon pinion is not lowered, damage may occur to the dial train during attempts at setting the watch.

REMOVING THE STEM (ASSORTED TYPES)

- A) Screwdriver (set lever screw)
- B) Pointed tool (set lever pin)
- C) 1 mm wide blade (set lever pin)
- D) Downward pressure lever (set lever release)
- E) Swivel type (set lever release)

(See individual service manual)

DIALING

Calendar Mechanism: Turn hands clockwise until DATE changes (disregard Day Indicator). Push crown "in" (Position 1). Assemble Minute and Hour Hands at the 12:00 o'clock position.

Second Hand: When redialing, wait until motor has indexed a few times, then pull crown to the "out" (hack) position (Position 3). While holding in position, align the sweep hand with the 12:00 o'clock marker, and press hand into place.

The second hand is counterpoised. If replacement is necessary, use only genuine parts.

CHECKING HAND MOVEMENTS

After casing, visually check that the sweep second hand, (on some models) or the minute hand advances. This movement of the sweep hand is readily noticeable, but the minute hand is barely visible, short in length and occurs only once in 5, 10, 20 or 30 second intervals. The hand advancing indicates that the transmission of power to the dial is occurring. No advancement indicates a problem.

CHECKING THE TRAIN WHEELS

Remove Cell from movement. The rotor, held in place by its magnetic field, does not allow the train to turn freely. The freedom of the train wheels can be checked by moving each wheel up and down.

CHECK THE FOLLOWING POINTS:

1. Hand adjustment: hands level, not touching dial markers, each other, or rubbing on underside of crystal.
2. Calendar mechanism is free.
3. Setting mechanism is free, but not excessively free which would indicate a worn center wheel/cannon pinion assembly.
4. Hack stop lever must not be bent or distorted.

ACCUSET® FEATURE

Some models are equipped with the Accuset feature.

In addition to the divider and other circuits, there are two independent counter ACCUSET control

logic circuits. These logic circuits perform the resetting function for the ACCUSET feature.

ACCUSET SETTING INSTRUCTIONS

After programming Step 1 of setting instructions (Page 6), press and release ACCUSET button. (ACCUSET circuit is now synchronized with position of second hand.) Continue with Step 2 Setting Instructions.

Once the ACCUSET circuit has been set, there is no need to reset it unless after:

- A) Installing a Power Cell
- B) Servicing the movement
- C) Interruption of current
(e.g. loose contact screw)

CHECKING THE ACCUSET FUNCTION

After programming the ACCUSET feature, check as follows:

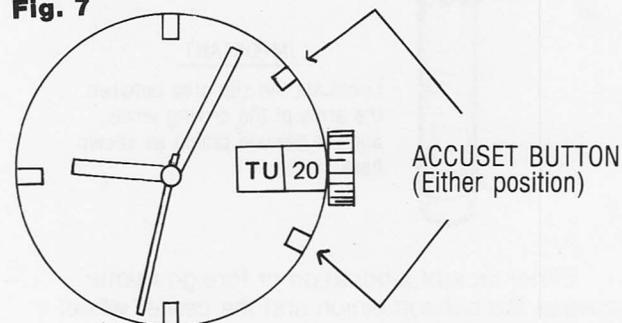
- 1) Press and release ACCUSET button, (Fig. 7) when the watch's second hand reaches the 15 second marker. The second hand should stop for 15 seconds.
- 2) Press and release ACCUSET button when the time standard being used, reaches the 60th second marker. The second hand should then advance twice as fast until the correct second is reached.

USING THE ACCUSET CORRECTOR

Once the ACCUSET feature has been programmed and after a period of time, if the watch is no longer accurate to the exact second, press and release the ACCUSET button the instant the time standard used reaches the 60th second (12:00 o'clock) marker. (Maximum correction is + or - 30 seconds.) The sweep second hand of the watch will temporarily stop if it is fast, or accelerate if it is slow until it is in synchronization with the time standard.

IMPORTANT: When the crown is "all the way out" (Position 3), motor and all hands stop. The ACCUSET circuit continues to operate and the Quartz Crystal continues to vibrate, using extremely little current.

Fig. 7



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