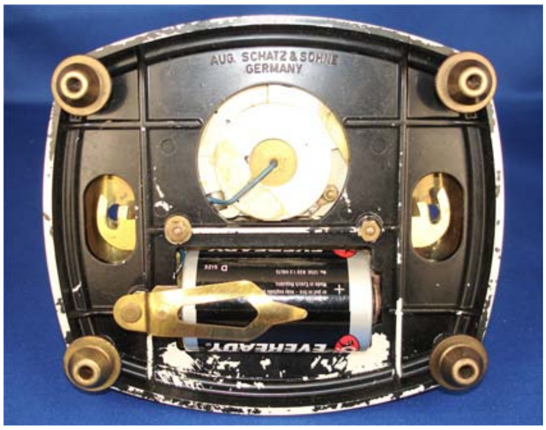
Jahresuhrenfabrik A. Schatz & Söhne Lectronic TSM Transistorized Anniversary Clock

This clock marked the transition from spring driven and solenoid driven mechanical movements to transistorized movements. Until then pendulums had been powered by mechanisms. This model uses a battery system beneath the base to swing the pendulum, and the fork near the suspension moves the pivot arm from side to side. This action rotates the gears in the clock which turn the hands. Unlike later quartz clocks, the pendulum length still controls the timekeeping.

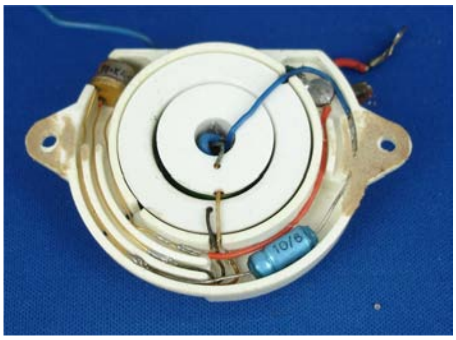
The repair of these clocks requires two quite different skills. The movement is of conventional design, needing conventional clockmaking skills to service and repair. The electronic device beneath the base requires knowledge of basic electronics and soldering, and this document will address the latter in the hope that it will assist clockmakers.

In order to identify if a problem lies with the mechanism or the module, first remove the suspension and replace it with the fork pointing to the rear. This will eliminate mechanical problems, with the exception of the suspension unit. The battery in this clock is large but the force of each pulse is fairly weak. The pendulum must hang in the printed circle on the base when stopped, and the suspension block at the top must be adjusted to ensure the clock is in beat. Just like any mechanical clock, if it is not in beat it will stop.



If everything mechanical has been adjusted correctly and the clock fails to run, check the battery. Modern 1.5v cells have a smaller positive cap at the top and these do not locate well in the original holder. Make sure both contacts are clean and that the battery is making contact with the holder terminals before assuming that an electronic fault exists. A multimeter should be used to check the voltage on the battery holder connectors.

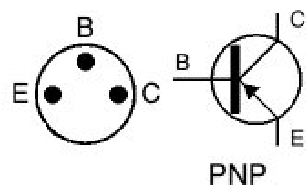
The two most common faults are with the coils and with the transistor. To identify the cause of the fault, you will need to remove the base, and remove the plastic housing containing the coils etc. The cardboard gasket is vital, as it acts as an insulation between the wiring and the brass body, which is grounded.



Identifying the fault
To properly identify the fault you will need to desolder some connections and test the individual components with a test meter. The transistor is vulnerable to heat damage, so always use a heat sink on the leads.

Transistors can be tested with a test meter.

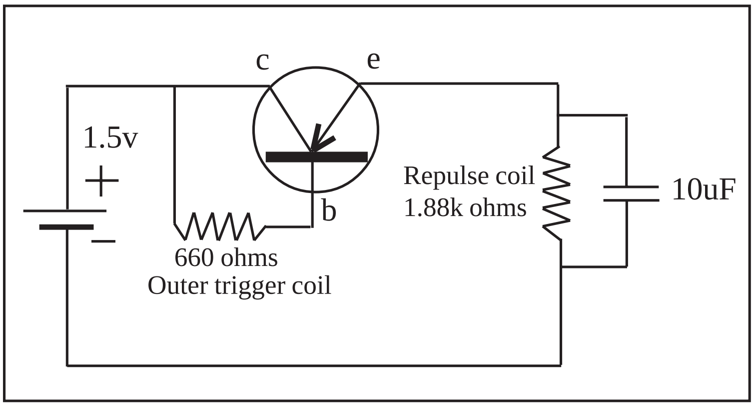
- Base to emitter is like a diode and should conduct in only one direction
- Base to collector is like a diode and should conduct in only one direction
- Collector to emitter should not conduct in either direction.



Most suitable PNP transistors will have this case layout.
The original transistors were of this style.
B = Base C = Collector E = Emitter

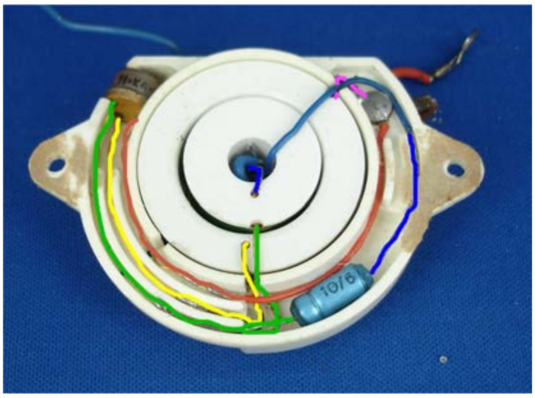
The coils can go open-circuit.
Desolder the coils and check both with a resistance meter.

Theory of Operation
The pendulum has a permanent magnet in its base. As the magnet passes over the outer 'Trigger' coil it induces a current at the base of the transistor. This current turns the PNP transistor on momentarily, allowing current to pass through the transistor, energising the centrally located repulse coil. The repulse coil gives the magnet an electromagnetic 'push' or repulse. The capacitor across this coil is also charged by the momentary current from the transistor. It acts as a small reservoir of energy which increases the duration of the push while it discharges.



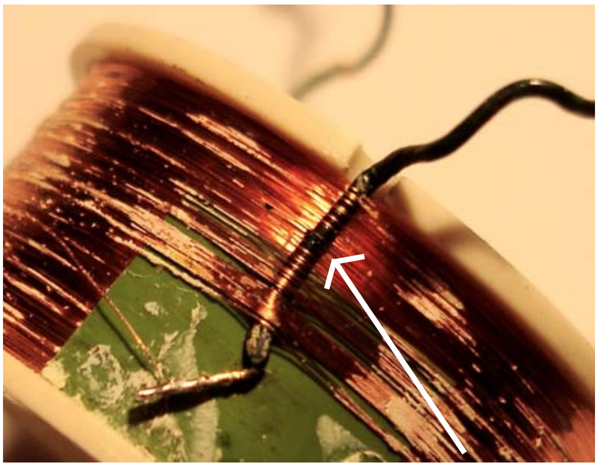
Dealing with the most common faults:

Open-circuit coils.
Desolder the coils and check both with a resistance meter. The resistance seems to vary between examples, possibly due to the age of the insulation, but expect the inner coil to be around 660 ohms and the outer coil 1,880 ohms.



The module with the leads coloured to show the layout.

If a coil is open circuit, it may still be repairable. Gently remove the adhesive tape around the coil in question. The fly lead will be soldered to the fine copper wire. The fly lead will be held in position by the last 20 or so turns of copper wire, and an adverse reaction between the insulation and the copper wire can cause a break, especially at the point the fly lead exits the coil, as this may have been exposed to the atmosphere.



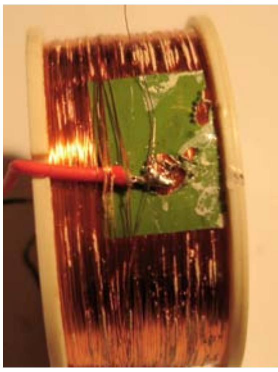
Copper wire attacked by the insulation

Carefully desolder the lead from the fine wire and unwind the wire until the old fly lead can be removed. You may find the fine wire will be broken or corroded somewhere during this process.

Locate the new end, remove some of the lacquer insulation and test for resistance. A serrated kitchen knife is excellent for scraping off the lacquer. If still open circuit, the coil is broken or it is corroded at the inner end.

If the reading is correct, unwind several more turns of wire. Prepare a new fly lead, tin the ends and place in position on the original pad. Rewind the wire and recreate the original arrangement. Apply new tape as before.

The new fly lead held in place with a few turns of wire and soldered. Check for continuity and apply insulation tape over the coils



If the break is not at the outer end, the coil can be re-wound with care. Using a sewing machine's bobbin winding facility, make yourself a bobbin big enough to hold all the wire. You might be able to do this by sticking circles of card to a normal cotton bobbin. Very slowly transfer the wire from the coil to the bobbin. If you find a break, stop and effect a repair. Solder the ends, lacquer them and when dry, rewind. If you reach the end, prepare a new inner fly lead, and rewind. You may need to rewind by hand. Insert a handle of some sort in the hole and wind evenly.

Transistor deterioration

Germanium transistors are prone to deterioration as a result of 'whiskers' growing on the tin inside. This is a shelf-life problem and as Germanium transistors are no longer manufactured, even unused replacement transistors can suffer from the same problem. A suitable Germanium replacement is the AC125, normally still available from specialist component dealers, but many other PNP switching transistors will work. Replacement with an equivalent Silicon transistor will not work because it triggers at a higher voltage, beyond the capabilities of the trigger coil. Additional circuitry would be required, but space is limited.

Reassembly requires some considerable dexterity, as the original components were probably soldered in a jig before installation, and you may find you need a bench type holder such as the 'Helping Hands' tool that comes with arms that have adjustable crocodile clips etc. If you cannot achieve a neat connection, especially on the joint between the transistor and the capacitor, the joint will not fit into the groove in the body.

Transistor selection

If you are unable to purchase a Germanium PNP transistor, they can normally be cannibalised from old circuit boards. To avoid frequent interference with the module, solder three coloured wires to the transistor connection points and bring these out through the holes in the base. Terminate the leads with electrical screw connectors. You can then experiment with different transistors without having to reassemble the module or even disturb the clock each time.

Testing the clock

Reassemble the module and fit into the base. Be sure that the card gasket is replaced as this acts as an insulator between the components and the body. The body is grounded, so exposed leads could short out. Carefully adjust the clock levelling screws so that the bob, when stationary, is within the printed circle. Adjust the screw securing the suspension bracket so that the amount of swing either side is equal. If more energy is needed to swing the pendulum in one direction than the other, it will stop.

Give the pendulum a generous push, sufficient for the magnet to cover the majority of the cutout in the base. If all is well, the pendulum will continue to swing.

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