Servicing the Jaeger electric clock as fitted to the later DS

Overview

It is quite within the skills of most D owners to service the clock mechanism - cleaning and oiling, which is what most of these require to get them going again. Skip the next three sections if you like, and go to **Tools and Materials**. Before you do, though, read this:

Do not be tempted, either to 'oil' the clock, or immerse it in solvent to clean it without reading the appropriate paragraphs.

Terminology

Firstly, clocks do not have 'cogs'. Old mangles have cogs. Clocks have **wheels** and **pinions** - referring to them as 'cogs' must surely make all the skilled craftsmen that have made clocks since 1300 AD or so from Giovanni DeDondi to M Favre-Bulle turn, nay, rotate at a fast idle, in their graves.

Wheels have **teeth**, pinions (an arbitrary name for wheels with less than 20 teeth, have **leaves**. They are mounted on **arbors**; the arbors have **pivots** that run in pivot **holes**. Sometimes these are made from synthetic ruby, and are called **jewel holes.**

Holes are sometimes in the plates of the movement, or sometimes in separate small plates, called **cocks** if attached to the movement at one end, or **bridges** if attached at both ends.

The timekeeping device in a small clock is called a **balance**, and is mounted on a balance **staff**, and controlled by a balance spring, more popularly called a **hairspring**.

The wheels that drive the minute hand at 1 rev per hour are called the **train**. There is also a 12:1 reduction to drive the hour hand - this is called the **motion work**, and is connected with the train by a friction clutch to allow the hands to be set to the correct time.

What is a clock?

A clock, in this context, has a means of measuring time (balance, pendulum, or quartz crystal) and a power supply to keep it oscillating (weight, spring or electric supply).

The balance and the pendulum are really the same sort of thing; one uses a spring to return it to the centre, the other uses gravity. In a domestic clock, the weight or spring supplies power to the train, and an escapement performs the dual function of impulsing the pendulum or balance to keep it moving, and allowing the train to run down at a rate controlled by it, thus visibly measuring time.

Some of these spring driven clocks are electrically rewound.

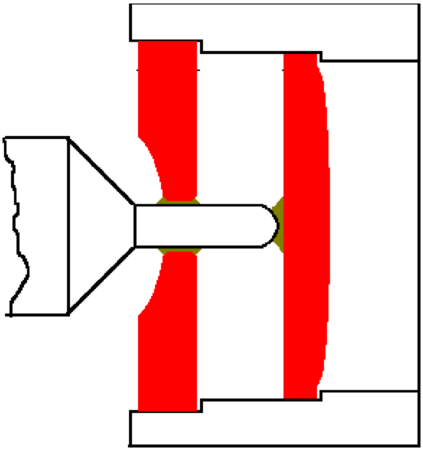
Car clocks

The first car clocks were spring-driven clocks not dissimilar to a high quality domestic clock. These were followed, in the 1950s, by clocks operated from the car battery. Virtually all British cars (including Slough-built DSs) used a unit made by Smiths, which had a balance. The balance was kept oscillating by a small electromagnet switched by a pair of contacts operated by the balance.

A car clock operates in extremes of temperature, is subject to vibration, and a varying supply voltage.

A balance or pendulum should, in theory, maintain an exact period irrespective to the arc of swing. This is not strictly true - longer arcs take a slightly longer time. This is known as 'circular error' because if the path was a cycloid, not an arc of a circle, the period would be the same irrespective of arc. Also, temperature changes the elasticity of the hairspring making the clock gain in lower temperatures. This is compensated for by making the hairspring from an alloy such as Elinvar. Keeping the arc of swing fairly constant overcomes circular error, but the varying supply voltage makes this difficult to achieve.

Another error is positional error, but this is less of a problem in a car clock than in a watch, unless you make a habit of driving up steep gradients, very adverse cambers, or turn cars over frequently.



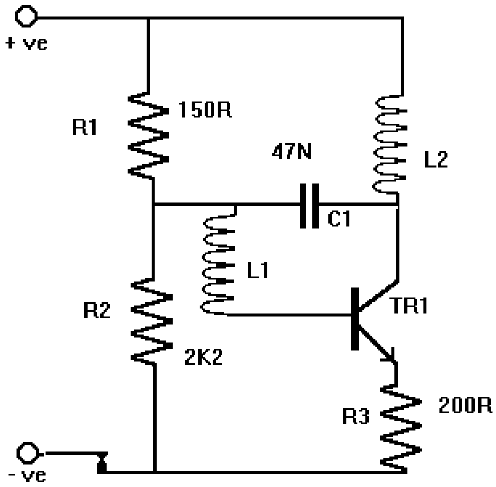
Positional error is caused by variations in arc due to varying pivot friction and errors of poise; as you can see it is really circular error. If the balance had conventional pivots, the friction due to the pivot shoulders would be excessive when the staff was vertical, causing the clock to gain. Balance pivots have endstones (see pic) to reduce friction when the staff is other than horizontal.

The clocks with mechanical contacts have several shortcomings:

1. The contacts wear
2. The contacts tarnish
3. There is always a compromise between sufficient contact pressure and too much interference with the balance, affecting accurate timekeeping

The Jaeger clock replaces the contacts with an electronic switch.

How the clock works



This clock uses a design with a rather interesting history. In 1924, Leon Hatot invented a battery-driven domestic clock, and formed the ATO company. ATO clocks are now collectible antiques. In 1953, they filed a patent to use a transistor in a clock for the first time. The design was used under licence by many manufacturers, including Jaeger le Coultre, in their car clocks. Look at the bottom left corner of your DS clock dial for the words lic.ato.

The Jaeger clock has a balance impulsed by a coil some 10mm in diameter and 2mm thick. The coil (L2 in pic) is mounted in a hole in a PCB that carries the other electronic components. Embedded in L2 by interleaving the windings is the trigger coil L1. The balance has a soft iron arm carrying two magnets that swing over the coils. To complete the magnetic circuit, there is an iron segment attached to the balance that passes under the coils.

TR1 is given a small standing base current with R1 and R2. This has a current superimposed on it from L1, as the magnets pass over the latter. TR1 amplifies the base waveform, feeding L2, which impulses the balance. C1 provides a small phase shift, R3 gives negative feedback to stabilize against supply variations to some extent.

Mounted in line with the coil, but diametrically opposite it, is a copper bar. This is to limit the swing of the balance - if the magnets swing over it, they induce a current whose field opposes that of the magnets, limiting the arc to some 220 degrees. The copper bar is, in effect, a coil that is shorted out.

As it stands, the clock is not self starting - the balance needs to be given an initial swing. This is done by the standing base current due to R1 pulling the balance off centre when the supply is connected. A switch on the handset knob breaks the negative side of the supply, so the balance is freed. A push or two on the knob will start the clock.

Up to now, we have a swinging balance, but nothing else. A nylon gathering pallet on the staff pushes the first wheel of the train around, half a tooth per swing. This is a **contrate** wheel, called so because the teeth are axial, not radial. The train has five wheels in total, all made of nylon, the last one rotating once an hour and driving the motion work.

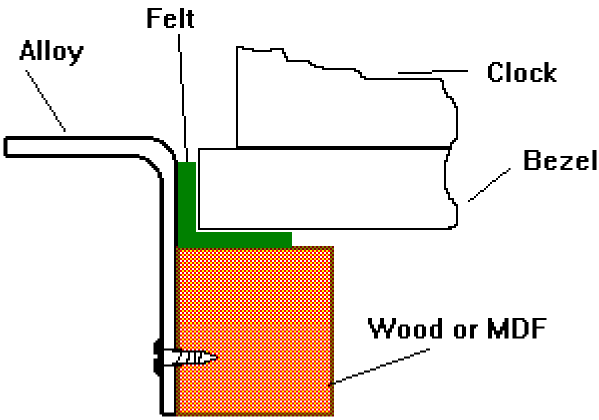
The contrate wheel has a small friction spring pressing on one pivot to ensure that it only moves when propelled, and not by inertia or vibration.

Tools and materials required

Essential: small screwdrivers, clock oil, small pliers, small childs' paintbrush with shortened bristles for cleaning, tweezers, loupe (jeweller's eyeglass) about x3 magnification
Desirable: oiler (small sewing needle softened and flattened at end), pegwood (or sharpened cocktail stick) Artery forceps or small circlip.

Examining, dismantling and cleaning

OK - here we go! First - do not start repairing a small clock if you have just lifted an engine out, or done similar heavy work. Your manual dexterity will be impaired. Sort yourself out a clean table and some good light, and no disturbances. Listen to some Sibelius if you have it.
The first thing to do is pull off the hand set knob, then remove the bezel. This latter is held on by the rather crude method of turning the edges over on all four sides. Make a couple of vice soft jaws (see pic) and grip clock lightly. Carefully turn three of the edges back using an old knife with the end of the blade cut at 90 degrees and sharpened like a chisel.. Once you have done this, the bezel and glass (actually acrylic) will come off. Remove the illumination bulb, and th4e two screws retaining the movement in the case. The movement should pull out - the rubber gasket may stick a little.



Soft vice jaws for removing bezel

Warning: The balance pivots in these clocks take no prisoners. Be **very** careful not to knock the balance or staff, or let any tools slip, or to bend the magnet arms. If you break a pivot - that's it. If you have the skill to turn a balance staff, all well and good, but you probably would not be reading this.
Remove the black washer and spring from the set-hand arbor, then carefully pull off the minute hand - use your fingers to do this, no tools. The hour hand will probably pull off its collet - if the collet comes off with it - fine. If not, take the dial screws out, and from below the dial, place two screwdrivers under the hour hand collet diametrically opposite, and twist them in opposite directions to lever the collet off. The dial can now be removed, together with the set-hand pinion.
At this point, you ought the put the clock across a battery and diagnose the problem.
It will probably be one of the following:

1. Oil
2. Ferrous debris stuck on magnets
3. Starting switch not making contact
4. Broken balance pivot (s)

1) Any visible oil is too much - the clock will need cleaning if you can see oil.
2) You may be able to get away without dismantling
3) You will need to remove the top plate and retension the switch
4) Not much hope, unless you can find someone to turn a new staff. You should be able to adapt a quartz movement (I hate the things!) and maintain the original hand setting knob (see later for suggestions and tips)

If you are not too confident in your ability to handle small mechanisms, do not worry - you should be able to split the movement to clean it, even if you do not remove the balance. First, you need to lock the set-hand arbor in place. If you push it, as if setting the hands, you will see a groove in the extremity beyond the back plate. This is to put a circlip in to lock the arbor, but if you haven't got one, use some artery forceps or similar. Remove the two screws that hold the movement together, and carefully separate the plates. This will require a small amount of force to (1) free the lug on the balance bridge, and to free the copper shunt from its clip. Once apart, you can wash the plate with the train in petrol (gasoline) and spin the wheels whilst immersed, and to dry it. This is not an ideal way to clean, but further dismantling of the train is precluded by the plate being rivetted on.
Flush out the balance pivots with petrol to remove gummed oil, and brush petrol around the gathering pallet.
If you are really brave, you can remove the balance, but do not attempt this if you have any doubts as to your ability. To do this, look at the hairspring - its end is secured by a brass wedge in the **stud**, which is adjustable, and passes through the regulator index. Mark the position of both the regulator and the stud with a scriber. Remove the wedge and lift the hairspring carefully with tweezers so it passes through the wide gap in the regulator index. To remove the balance you need to unscrew the pivot screw at the magnet end. It may be locked with threadlock - a drop of thinners will soften it.
Sharpen a piece of pegwood and carefully peg out the jewel holes; wash off the balance.
Leave everything for 12 hours or so to dry.

Reassembly and setting up

If you removed the balance, replace it by carefully screwing up the pivot until there is only just discernible endshake. Oil the pivots - the correct amount is shown in the pic. Only use clock oil - nothing else will do. To make an oiler, flatten the end of a piece of #24 wire.
Pass the hairspring through the regulator index and anchor it with the wedge. Put the index and anchor back in the marked positions - if these were correct, the balance should be at the centre of its swing.
Place the copper bar in position and check the starting switch is not bent, and the part of the front plate it contacts is clean and bright. Carefully fit the PCB, making sure the starting switch goes over the set-hand arbor. Offer up the front plate, locating the PCB and copper bar, and fit the two screws.
At this point, the balance should swing freely - you will probably find that it does not. Look at the engagement between the contrate wheel and the gathering pallet. There should not be a tooth in the groove on the pallet - if there is, it can be eased out with tweezers - the teeth are quite flexible.
Test the clock across a battery.
The set-hand arbor can now be released - take off the clip or forceps. Fit the black pinion so the sleeve is innermost, replace the dial and hands. Line hands up on an hour - 6 or 12 o'clock. If the hour hand came off its collet on dismantling, it just presses on. Lay hand face down on a flat surface and push collet into it.
Fit spring and plastic washer on set-hand arbor, refit case and bezel. The case has a removable cover to expose the regulator, which is adjusted by a tool with a pinion on a handle, like that used for a voltage regulator. Turn the index clockwise to make the clock gain.

If all else fails

There should be room in the case for a small quartz movement. With the back plate removed, the centre arbor which is brass projects about 3mm rearwards, so it should be possible to connect the centre arbor of the quartz movement to this, so retaining the original motion work and hand setting knob. If the movement is a domestic one, it probably runs off 1.5 volts, so we need some sort of a power supply. Two small diodes (1N 4001) in series could act as a 1.2 volt 'zener' and we need to supply them from, say, 14 volts, with about the same current as the clock - say 5ma. R = E/I (14-1.2)/(5+5) Headache yet? OK - you will have to take my word for it that you need a 1.5 k resistor connected between the supply and the positive side of the new movement, two 1N4001 diodes in series between this terminal and earth (with the striped ends on the earthy side) and a 10mfd 25 volt capacitor across the diodes - negative side to earth.
Another idea would be to get a Jaeger clock from a GSA Special or Club dash - these, once removed from their case and the dial taken off, have the same position for the set-hand arbor and dial screws, and will fit in the original case. They are quartz, and have a seconds hand. You would need to enlarge the hole in the original dial, and make holes in the case for the supply connector and bulb, and as the hands project further, you may have to leave the seconds hand off.