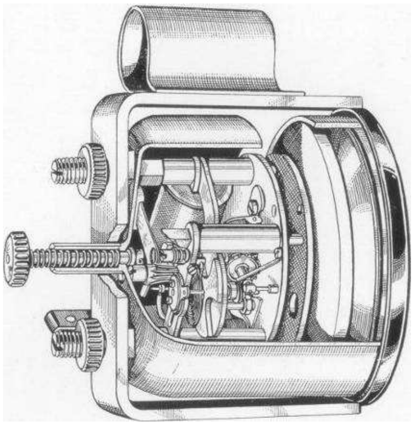
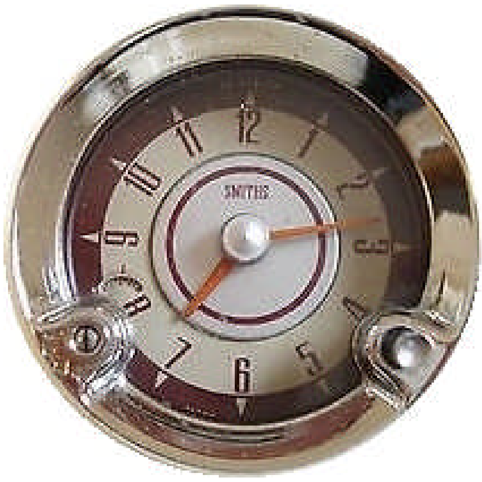
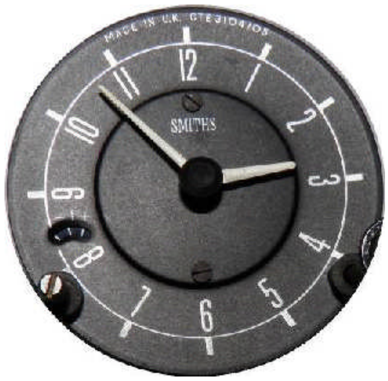
CLASSIC BRITISH ELECTRIC ANALOGUE CAR CLOCKS

(as fitted to "Classic" cars up to the late 1970s)

Part 1 Smiths electric car clocks







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Contents

1. INTRODUCTION:

These documents, Part1 - Smiths and Part 2 - Kienzle are aimed at those who may want to know more about or to repair car clocks they may own.

I'm assuming most readers will have some basic mechanical and electrical "nous". For the most part these skills are necessary to carry out repairs to these clocks. A basic knowledge of electronics is also required for the later "transitorised" impulse clocks.

If working on any type of clock, do not allow the hairsprings to be distorted. The coils of a hairspring must not touch each other as the hairspring contracts. If this happens, timing will be affected and it may prevent the clock from running.

I would like to mention the assistance of Rocky Hamilton, of the Triumph Owners Club in Christchurch, New Zealand, for kick-starting me on this project and providing some of the clocks I have used for photographs here. I also want to acknowledge Roger Lusby of Richmond, New Zealand for introducing the earlier, electrically wound, Smiths car clocks to my attention.

2. ELECTRIC/ELECTRONIC CAR CLOCKS OPERATION:

Smiths, and others, have produced car clocks for cars since the early 1900s. The earliest clocks were clockwork, basically domestic clocks with special mounting brackets. Later on, clocks designed specifically for mounting in cars were produced but still needed regular winding.

The clockwork mechanism comprises a "motor", usually a coiled spring or weights, coupled through a gear train to the hands and dial to display the time. The speed of the clock is regulated by an escapement controlled by a mechanism that has a fixed, periodic quality, either a pendulum or a balance assembly. The balance assembly is essentially a flywheel and hairspring combination. But instead of constantly rotating like most flywheels, the balance assembly oscillates with a fixed time period.

To "electrify" the clockwork mechanism, two common methods were used. One simply retained the clockwork mechanism and rewound the clock spring electrically. Early Smiths branded clocks used this method but their application was primarily in "high-end" cars such as Rolls Royce.

Another method was to use the balance assembly as both a time regulating device and as a source of energy to drive the clock. The Kienzle electric rewind clock described in part 2 is an example of the first method and the Smiths "CE" clock described here is of the second.

Later on "quartz" clocks were developed. These employed an electronic circuit to drive either a synchronous or a stepper motor which moved the hands of the clock through a gear train. A quartz crystal was used to provide an accurate frequency reference to drive the motor which turned at a speed proportional to the driving frequency. The motor provided continuous, constant speed, drive for the clock – the oscillating balance wheel was no longer required. The current line of Smiths clocks from Caerbont are of this type.

Smiths did briefly market a quartz car clock in the early 1980s – the CQB.3703/00 as fitted to the Volvo 343 Luxe and De Luxe and 345 cars and the CQB/CQJ.3701/00 and CQB/CQJ.3707/00 fitted to Austin Allegro cars are some examples. CQB clocks are branded "Smiths", CQJ are branded "Jaeger". The quartz movements for these clocks were, I understand, sourced from Seiko in Japan.

The down side of these "advances" in car clock technology, is that the later clocks are seldom reasonably repairable.

3. SMITHS ELECTRICALLY WOUND CAR CLOCKS:

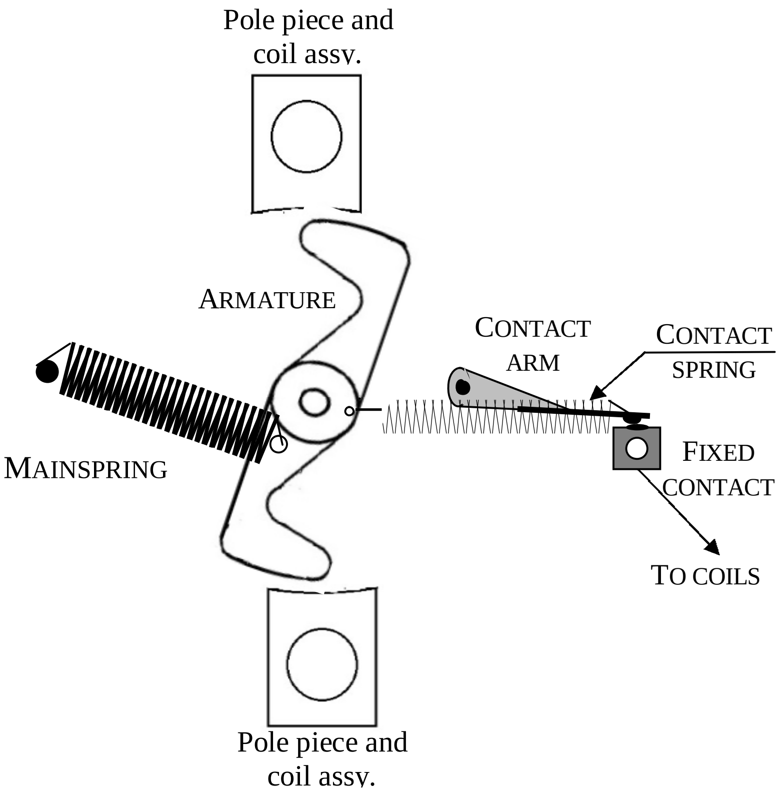
These clocks, which I have only recently become aware of, were manufactured by Smiths from 1932 to about 1939. They were originally manufactured by English Clocks and Watch Manufacturers Group (ECWM) under the brand name "Empire". Smiths acquired ECWM in 1932. (*Photograph at right.*)

There is nothing in the way of service information available (to me) for these very early Smiths car clocks. They are obviously based on the "Dr. Hermann Aron" electric clock movement developed in the late 1880s for electric power consumption meters and later clocks of his design.

To date, I have only had a chance to briefly examine a single example of this type of clock. The clock is driven, via a ratchet and pawl, by energy stored in a helical spring. The spring is "rewound" by an electric actuator that is energised as the spring tension reduces.

This same method is used in the Keinzle type 607 clock as described in the document "Classic British electric car clocks - Pt 2_Keinzle".

The construction of the actuator in this clock though is quite different to that of the Keinzle actuator despite both performing the same function. *Fig. 3.1* shows the main components of the ECWM/Smiths clock actuator and their operation.



The sketch at left shows the armature in its rest position with the contacts closed. When power is applied, current flowing through the coils will cause the armature to rotate anticlockwise, re-tensioning the main spring and drawing the contact plate assembly away from the fixed contact as the line of action of the contact spring moves to the other side of the contact arm pivot point.
The relative locations of the hairspring anchor on the armature (a stout, hooked wire) and the contact arm pivot are critical to the operation of this clock. The contact must operate before the armature meets any fixed part of the clock assembly and the contact plate must pull clear of the fixed contact before the armature achieves its point of maximum travel.

Figure 3.1: Schematic drawing showing the control elements of the rewind mechanism.

Fig.3.2 below is an annotated photograph of the internal mechanism and *fig. 3.3* is a drawing and brief description of the electrical circuit of this type of clock.

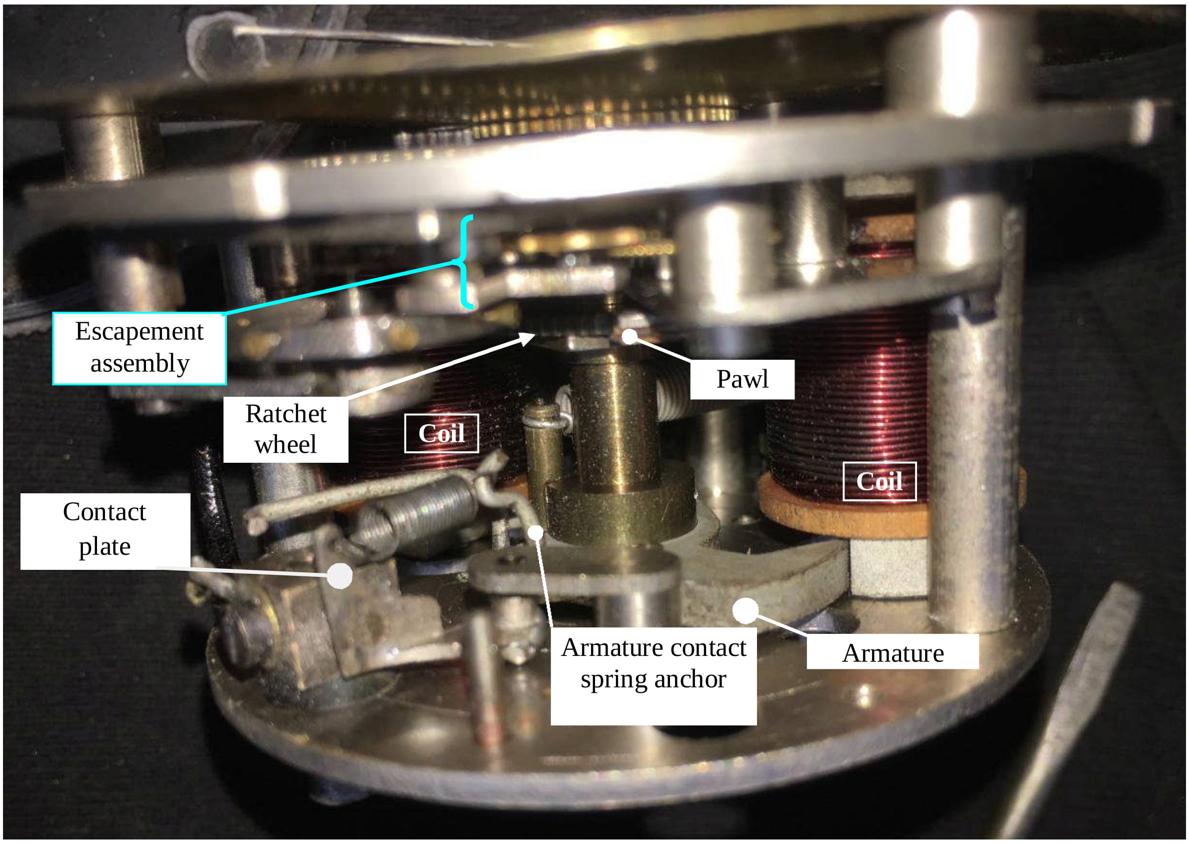
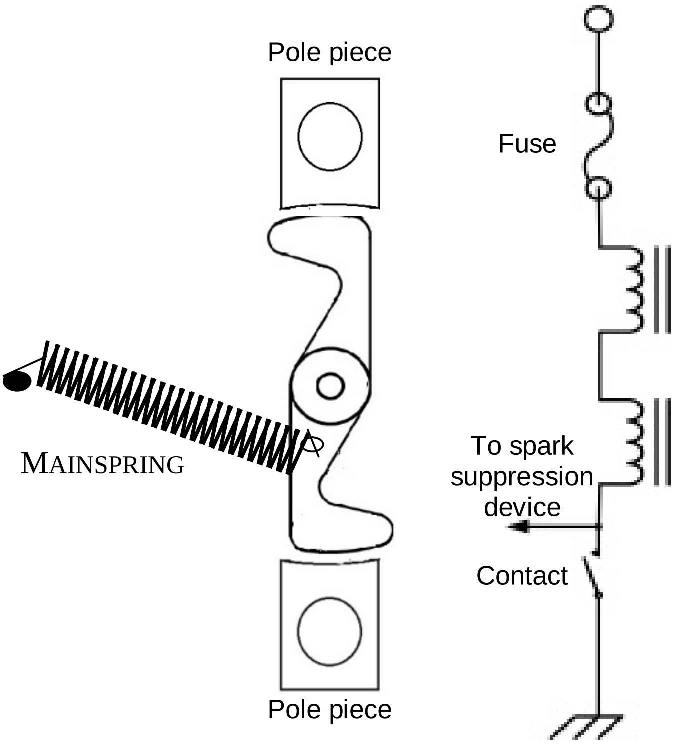


Figure 3.2: Showing additional detail of this clock's actuator mechanism. The actuator armature is in its rest, or "unwound", position here.



Sketch shows armature in its operating position, where the mainspring is under extended and the contacts are open removing power from the coils.

Current drawn by the coils when energised is something over 3 Amps but the contacts only close for a small fraction of a second so the average current drawn is very low.

The connection shown to a spark suppression device is comprised of a conducting metal strip between the point shown and the cap of the fuse holder. A loop formed in the end of this metal strip sits below and is held by the fuseholder cap with a disc of insulating material between it and the clock's baseplate. Originally, a disc of resistive material may have been fitted here.

Figure 3.3: Sketch of armature and pole pieces. Armature shown approximately in its "wound" position.

4. SMITHS "CE" ELECTRIC CLOCKS:

The Smiths "CE" type clock was timed by a balance wheel and hairspring. A spring mounted contact and a pin on the balance wheel energised a coil which provided power to the clock.

These early Smiths electric clocks were still essentially clockwork instruments. The "CE" clock was developed by Jaeger in the 1930s. This was a clever adaption of clockwork "technology". Previously the balance assembly and escapement in a clock performed solely as a regulator. Now they formed part of the power source to drive the clock as well.

These clocks were made in different styles and although basically the same, each style used slightly different components for some functions. I've covered those I have thought of but if you should find something "different" in a clock, something I have not covered or even mentioned here, then for the most part you should be able to work it out for yourself. If you are in the position of making one clock from several instruments, those differences described will need to be kept in mind. This should only be an issue if the clocks involved are significantly different in style or working Voltage.

"CE" electrical clocks had prefixes "X", "SK", "UC" and groups of digits such as "51-411-477-00" (Jaguar XK150 etc – now "CE 1106/00") but with the introduction of a new instrument naming format in the 1960s all prefixes for these clocks became "CE" ("Clock Electric") followed by the familiar "nnnn/nn" number sequence common to all Smiths automotive instruments at this time.

Accessory type "CE" clocks were marketed with "CFP" ("Clock Front set Positive" (positive earth)) or "CFN" ("Clock Front set Negative" (negative earth)) identifiers, "CRP/CRN" for clocks with rear controls and "CBP/CBN for clocks with bottom (stalk) controls. Earlier accessory clocks are listed as "CB" (Clock Black face) and "CS" (Clock Silver face) but the clocks themselves had "CE nnnn/nn" printed on the dial. *Smiths used various codes for accessory instruments as noted above. The code printed on the dial defines the type of instrument and it is these dial codes that are used when referring to clocks in this document.*

The "CE" clocks were superseded by the "CET" or "CTE" type clocks - "CTJ" for Jaeger branded instruments. These later clocks are adaptions of the Smiths "Sectronic" range of battery operated clocks. Here a large diameter balance wheel assembly incorporated two coils which moved between the poles of a magnet. As the coils of the balance wheel moved between the magnet poles, a transistor was switched on providing a pulse to the coils to drive the balance assembly and ultimately the hands of the clock through a gear train.

Smiths "CE" clocks were produced in many of the same forms as other Smiths gauges: 3 inch round, 3 inch square, 2 inch round, 2 inch by 1 5/8 inch rectangular and the small inset clock that sat at the bottom of speedometers or tachometers in a number of several (usually upmarket or sports) vehicles. This inset clock was roughly equivalent to the "quadrant" gauges in gauge clusters and one of the first "CE" clocks, from the late 1930s, was a "quadrant" type instrument designed to fit in a gauge cluster (a.k.a. "Instrument Panel").

Note that not all "inset" clocks are electric!! Very early inset clocks, such as those incorporated into older Smiths speedometers such as the Jaeger branded SSC.55 instrument, are clockwork.

These "CE" clocks need a "kick" to start and this was provided as part of the time setting mechanism. Setting the time, or simply depressing the time-setting knob, started the clock which would then run until power was removed. Most clocks, round or square, had a knob on the front to set time with. Other clocks had a stalk that sat below the dashboard or at the rear of the clock case, operated with a flexible cable similar to the trip meter reset cable of a speedometer. Some very early models simply had a knob on the back so it was necessary to reach behind the dashboard to set the time.

A means of adjusting the timekeeping (regulation) of the clock was provided. This adjuster was located at the front of the clock on front time-set models, the rear of the clock for remote time-set clocks and required a small screwdriver for adjustment. Some early rectangular clocks had a lever mounted on the side of the case to provide regulation. (See *figs 5.1* and *5.2*.)

Shunts, later on diodes, were fitted in parallel with the coil to reduce erosion of the balance assembly pin contact which is a common cause of failure with these clocks. (Think "pitting" of distributor points.)

Later "CE" clocks, those fitted with diodes, are polarity sensitive and available to suit each of negative earth and positive earth vehicles. If you are looking to replace one of these clocks in a vehicle then you will need to ensure it is of the correct polarity. Early "CE" clocks will work on positive and negative earth vehicles, later ones will not. Also note that "CE" prefix clocks were made in 6 Volt and 12 Volt versions. A 12 Volt clock may not work in a 6V system but the coil in a 6V clock will be burnt out, sooner rather than later, when supplied with 12V. (Refer also to section n "Testing a Smiths "CE" car clock".)

<table>
<tr><th colspan="4">TABLE A: SMITHS "CE" CAR CLOCK CONTROLS LOCATION</th></tr>
<tr><th></th><th>Time set</th><th>Regulator</th><td rowspan="4">Key to table A:
"Front" means a knob (time set) or screw (regulation) accessible from the front of the clock but may be at the top or bottom of the clock.
"Rear" means a knob or screw located at the rear of the clock
"Bottom" means a stalk protruding from the bottom of the clock (time set only).
"Remote" means a cable operated time set control usually located in some convenient location below the dashboard.
"Side" means a lever mounted on the side of the clock (rectangular clocks only).</td></tr>
<tr><td>Round</td><td>Front
Rear
Bottom
Remote</td><td>Front
Rear</td></tr>
<tr><td>Rectangular</td><td>Front
Rear
Bottom
Remote</td><td>Front
Rear
Side</td></tr>
<tr><td>Inset/"quadrant"</td><td>Remote</td><td>Rear</td></tr>
</table>

5. Identification of Smiths "CE" car clocks:

As can be seen in *fig. 5.1* at right, four screws in a rectangular pattern secure the internals of these clocks to the case. And it is this mounting screw pattern that identifies a Smiths clock as a "CE" clock. Some clocks have nuts rather than screws but in the same rectangular pattern. The movement is generally mounted on rubber grommets, an earthing strip between one of the mounting screws and the case was provided on these clocks as shown here and no other reliable electrical connection between the clock internals and case exists for rubber-mounted movements. Some clocks do not have the rubber grommets, the mounting screws electrically connecting the movement to the case, so an earthing strap was not required. (Note that on some clocks only three screws are used but these still sit at corners of this "square" pattern.)

FIGURE 5.1: Rear view of a Smiths CE "rear adjust" car clock. The rectangular pattern of the mounting screws identifies the CE type movement.

Also typical for these clocks, the voltage is stamped on the rear of the case and the polarity is indicated – "FEED LEAD NEGATIVE" to the left of the blade connector in this example. See "Testing a Smiths "CE" car clock" later in this document for clock supply polarity details.

Note the screw above the remote setting cable stub in *fig. 5.1*. This is the regulator to adjust the timekeeping, not a mounting screw. The regulator may be found at the front, rear or side of the clock. See *fig. 5.2* for illustrations of regulator controls.

Early clocks identified the voltage by the colour of the insulating sleeve around the supply terminal: Red or Black for 6V and Green or Yellow for 12V. This however is not a reliable indication as some 6V clocks may have been upgraded with a 12V coil and shunt without this sleeve being changed. Later 12V clocks used Black insulating sleeves and do not use a shunt resistor but a diode assembly and such a clock will be damaged if connected to the wrong polarity. (Means of identifying polarity of these clocks is provided later in this document.)

Some clocks are connected to the power supply by a wire protruding through a rubber grommet at the rear of the case. In examples I have seen the wire is yellow (indicating a 12V movement) Most clocks have a blade or screw-clamp style terminal as seen to the right in *fig.5.1*.

Figure 5.3a is an exploded view of these clocks. Here the difference between 6V and 12V connecting bracket/shunts can be seen, the early 6V assembly is shown inset.

This same clock movement was also used in engine hourmeters such as the ATFC 268 series instruments. The movement in these have an additional coil to self-start and no time setting components are present. Regulation adjustment was internal in the hourmeter. These hourmeters were produced in 6 Volt (ATFC 268), 12 Volt (ATFC 268/1) and 24 Volt (ATFC 268/2) supply versions. (Refer *fig. 5.7*.)

Fig. 5.8 later in this document is the electrical circuit diagram showing options for all Smiths "CE" type instruments.

5.1. *Smiths "CE" type clock regulator*

The figures below show some of the different regulator locations on Smiths "CE" clocks. *Fig 5.1* shows a rear regulation, remote time setting clock.

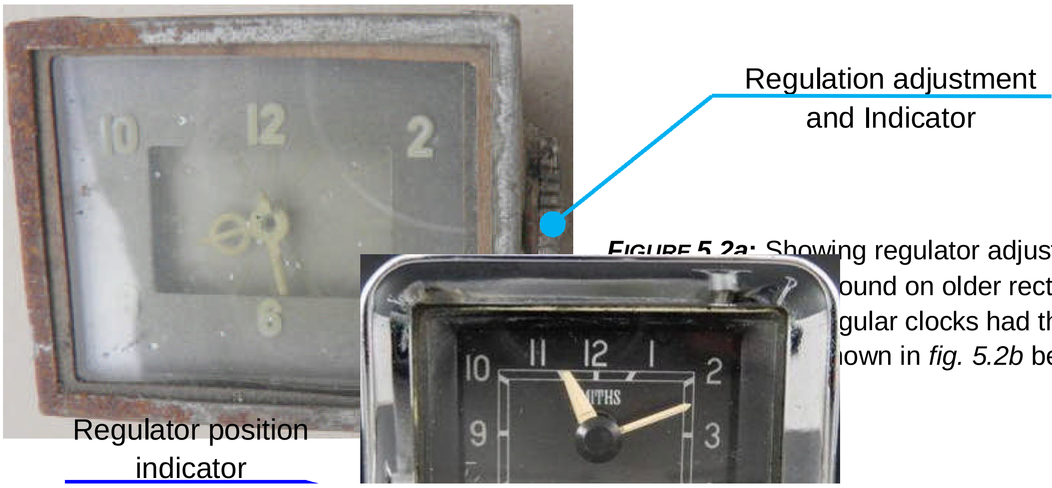


FIGURE 5.2a: Showing regulator adjustment on ...ound on older rectangular ...gular clocks had this control ...own in *fig. 5.2b* below.

Most clocks, other than inset type clocks, are provided with controls as shown in *fig. 5.2b*. Time set knob and regulation control screw are generally retained in the front "glass" as can be seen in *fig. 5.9* later in this document. Although the dial markings varied between clock models, the internal works are the same for round and rectangular dashboard mounted clocks. Some minor differences are found in inset type clocks such as found in Jaguar/Daimler vehicles

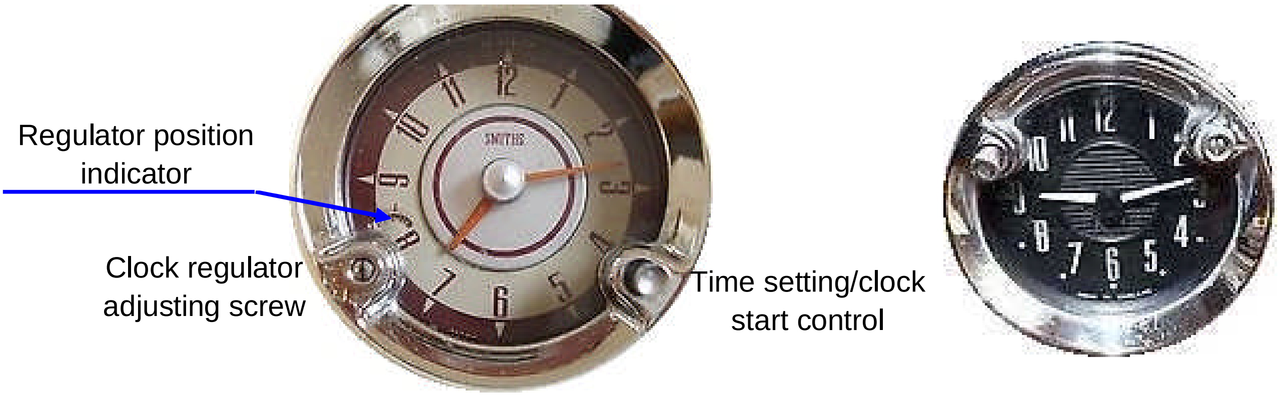
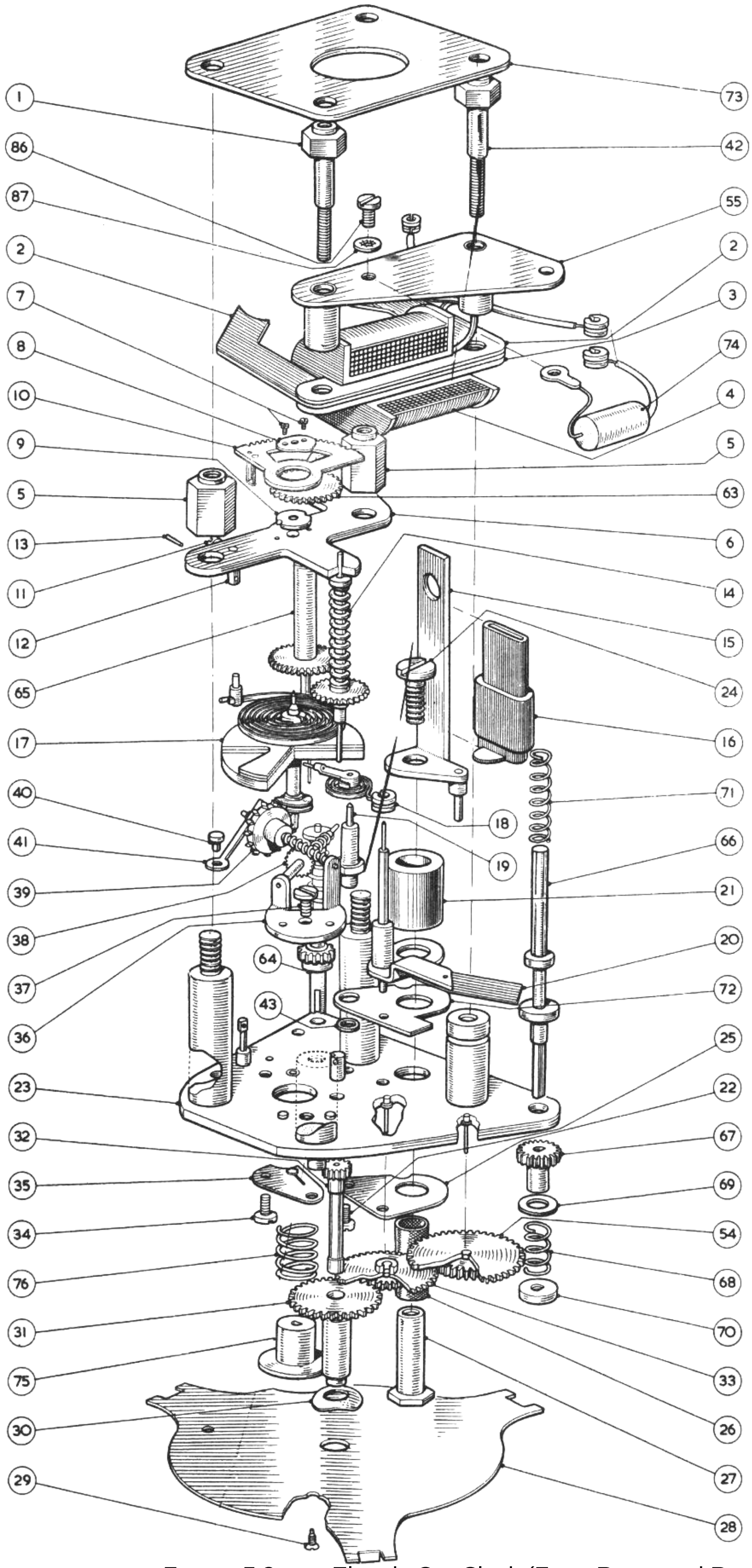


FIGURE 5.2b: Typical controls on front of clocks. Sometimes these controls were located at the top of the clock in some variants, such as the "CE 3101/01" shown on right.

“CE” clock exploded view



INSET: SHUNT ASSEMBLY FOR 6 VOLT MOVEMENT

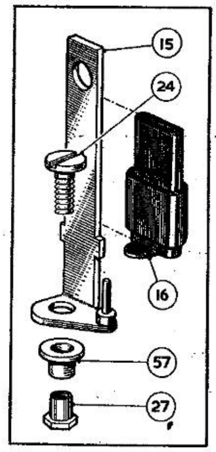


FIGURE 5.3a: Electric Car Clock (Front Reset and Regulation Types)
General Arrangement of Movement. (***See next page for key to part numbers***)

KEY TO *FIG. 5.3a*

1	Pole Piece Securing Screw	32	Cannon Pinion
2	Pole Piece	33	Minute Wheel
3	Pole Piece Spacer	34	Locating Plate Screw
4	Coil Complete with Collets	35	Locating Plate Complete with Steel Endplate
5	Balance Support Nut		
6	Balance Support Assembly	36	Double Support Plate
7	Top Endstone Screw	37	Double Support Plate Screw
8	Regulator Lever Washer	38	Transverse Wheel Assembly
9	Top Endstone Plate Complete	39	Escape Wheel Assembly
10	Regulator Lever Assembly	40	Friction Spring Rivet
11	Anchor Post Screw	41	Friction Spring
12	Anchor Post	42	Pole Piece Securing Screw
13	Taper Pin	43	Insulating Ring (for Contact Hairspring Pillar)
14	Centre Wheel Assembly		
15	Connecting Bracket and Pin	54	Setting Wheel
16	Insulating Sleeve (Red or Green)	55	Setting Support Plate
17	Balance Wheel complete with Timed Hairspring	57	Shunt Insulating Bush
		63	Regulator Wheel
18	Contact Hairspring Complete	64	Regulating Spindle Assembly
19	Contact Hairspring Pillar	65	Regulator Disc Spindle and Wheel
20	Shunt Bridge	66	Setting Spindle
21	Shunt Resistance	67	Setting Pinion
22	Insulating Plate	68	Setting Pinion Spring
23	Balance Platform Assembly	69	Setting Spindle Washer
24	Shunt Screw	70	Setting Spindle Collar
25	Screw (for Contact Hairspring Pillar)	71	Setting Spindle Return Spring
		72	Insulating Plate
26	Shunt Insulating Tube	73	Back Plate
27	Shunt Pillar	74	Suppressor Condensor (Optional)
28	Retaining Plate	75	Regulation Disc
29	Retaining Plate (or Sub Dial) Screw	76	Spring (for Regulation Disc)
30	Dial Washer	86	Screw (for Suppressor Condensor)
31	Hour Wheel	87	Locking Washer

Item #21 in the above table was replaced by a rectifier in later clocks. Two rectifiers were available – for each of positive (green encapsulation) and negative earth (white encapsulation) vehicles.

5.2. *Clock component variations:*

Fig. 5.4a & b below show some of the variations found in these clock movements. The hole marked "S" in *fig. 5.4b* is the rear bearing for the centre wheel assembly (14) and varied in diameter being larger on rear (remote) setting clocks. The hole marked "R" in *fig. 5.4b* may only be present on rear regulation clocks.

Clocks with bottom time setting controls had a pressed-on gear at the rear end of the centre spindle which sat above the support plate and had to be removed to fully disassemble the clock (refer to *fig. 5.11a* in "5.7.1 Dismantling the movement").

The regulator lever assembly (10), carrying the curb pins also varied between clocks, depending on regulator location.

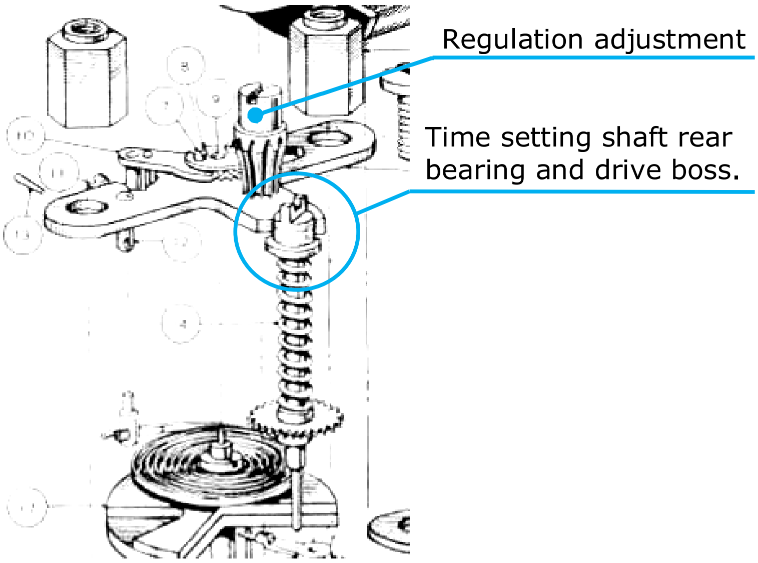


FIGURE 5.4a: shows details of clock with rear regulation and remote time setting. Note large diameter boss on centre wheel assembly (large diameter hole in support plate) compared with small diameter shaft shown in *fig 5.4b*. Also slotted pinion for rear regulation. This pinion is held in place by a dished washer below the support plate and was only supplied as an integral part of the balance support assembly.

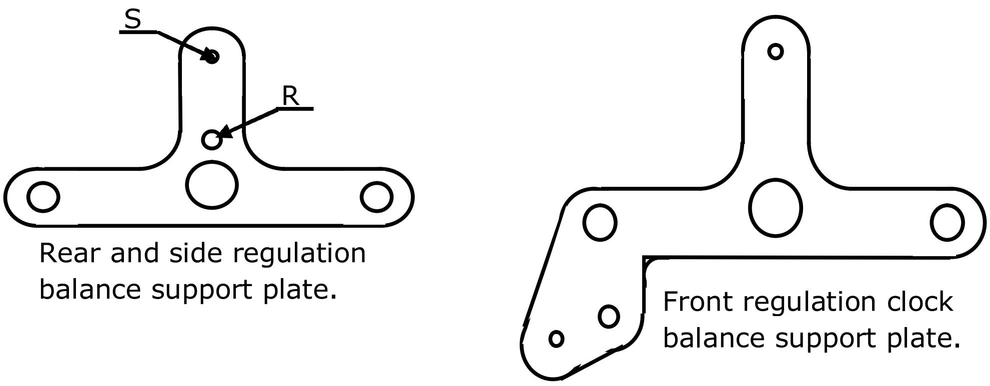


FIGURE 5.4b: Sketches of balance support plates found in various "CE" clocks.

For inset type clocks, a pin is fitted to the locating plate (front balance bearing) to take an intermediate wheel to drive the offset minute wheel and shaft. In other clocks this pin is a part of the balance platform assembly (23).

5.3. *Smiths "CE" clock internal works:*

The internal works of these clocks varied relatively little over the production period. The replacement of shunts with diodes was the only electrical difference of note, (The optional radio suppression capacitors had no impact on internal clock operation.) The physical difference between the shunt and the diode configurations did not require any change in the basic mechanism. This can be seen in *fig 5.5* below. (Note that the movement of *fig. 5.5a* is not complete.

FIGURE 5.5a: Partly dismantled Smiths 12V CE clock movement (Yellow insulation tape on coil) with black shunt resistor fitted. Note also the Black insulating sleeve on the input terminal bracket.

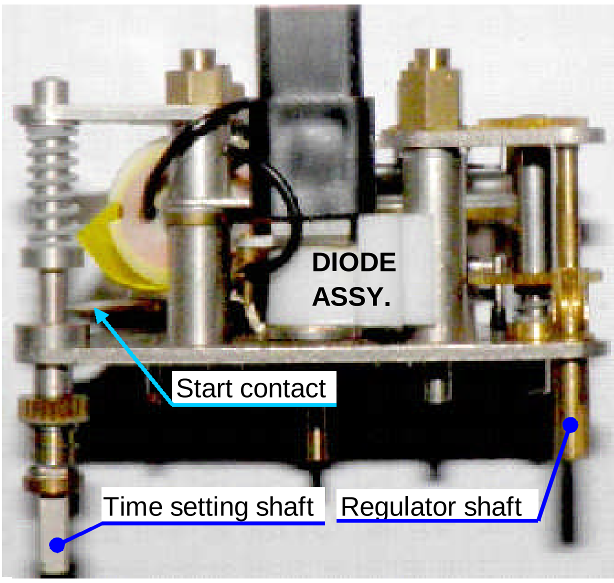


FIGURE 5.5b: Late model Smiths 12V CE clock movement with white diode assembly fitted. The white diode assembly identifies this movement as a negative-earth instrument. The positive-earth diode assembly is green.

Figure 5.6 below shows the internals of a later model clock that has been connected to a reverse polarity supply. Not a pretty sight, though damage is limited to two components and should be readily repaired. The only impediment to repair is the availability, or more correctly the lack of availability, of the contact hairspring assembly, Contacts from the destroyed diode plus an insulating bush and a common silicon diode (1N4004 etc) can readily and reliably replace the original no-longer-available diode assembly.

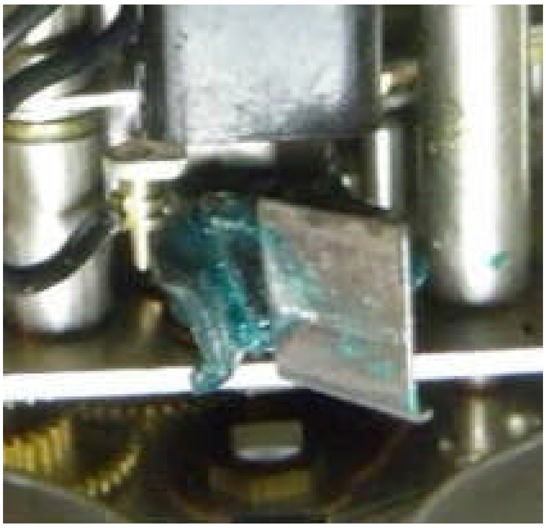


FIGURE 5.6: Later model Smiths 12V CE clock movement with green diode assembly (positive earth). This clock has been connected to a negative earth supply.

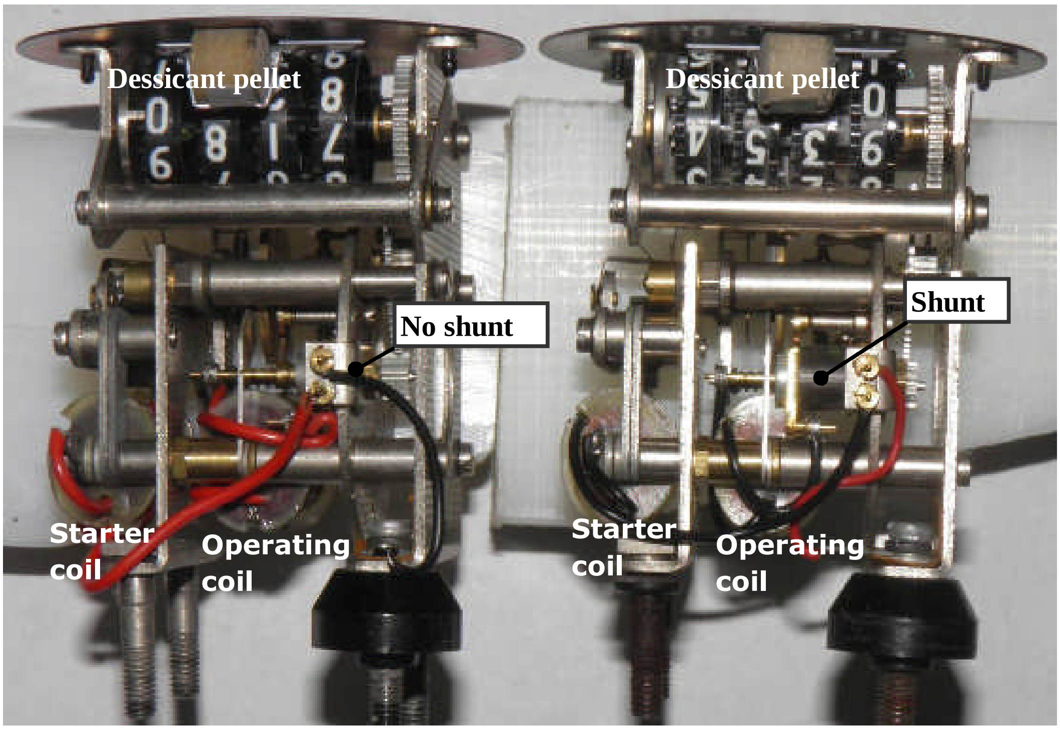
The contact hairspring and diode have been destroyed but this is the only damage to the clock – the balance hairspring survived.

The contact pin is in good condition and a contact hairspring and diode, salvaged from another clock, should have it running again.

Plus a clean and lube of course.

5.4. *Smiths "CE" type hour meters:*

Fig. 5.7 below shows two hourmeters removed from their cases which use the same basic mechanism as the "CE" clocks but placed "sideways", and with the addition of a starter coil assembly and no external regulation adjustment. Regulation has to be set as part of the repair process before fitting the hour meter into the case. The absence of the shunt resistor on the 6 Volt instrument can be plainly seen. These hourmeters can provide a source of spare parts to repair a failed car clock.



6V Instrument **12V** Instrument

FIGURE 5.7: ATFC 268 Hourmeters internal view

A word of explanation here. An hourmeter simply records how many hours a device has been capable of running – usually the time the ignition has been turned on. Service interval counters are based on the number of revolutions an engine has done or the distance a vehicle has travelled. These devices are often found on agricultural machinery and in some cases, cars for export to America. These service counters are driven by an engine or gearbox take-off and comprise a mechanical gear train and counter but no time-based mechanism.

5.5. *Testing a Smiths "CE" car clock:*

These clocks cannot be fully tested inside the case. Measuring the resistance across the terminals, using a digital multimeter, will check the coil/shunt/diode but not the contacts that make the clock operate. ***The time-setting mechanism must be pushed in while taking these measurement.***

The older clocks, fitted with a shunt resistor across the coil, are not damaged by connection to a supply of either polarity. This includes all unmodified 6V clocks and 12V clocks until about 1963. As you cannot be certain whether the clock movement is the original or replaced by a later type without removing it from the case, assume all clock have diodes. Smiths supplied complete clock movements as service spares and these later movements were fitted with polarity-sensitive diodes. S*ee fig. 5.5b* for a picture of such a replacement movement.

Resistance values given in Tables B & C "Terminal resistance" column below are those measured between case and supply terminal. If you measure the same value, 500 – 600 Ohms, when swapping meter leads, then there is a shunt installed and the clock is insensitive to supply polarity. Table C provides test data for clocks fitted with diodes.

TABLE B DATA FOR CLOCKS FITTED WITH NO OR INTERNAL RESISTIVE SHUNTS.				
SMITHS "CE" CAR CLOCK IDENTIFICATION – EARLY CLOCKS				
Insulator colour	Coil colour	Clock working Voltage	Shunt resistance	Terminal resistance
Black	Black	6	n/a	Not tested
Red	Red	6	n/a	81 Ohms †
Green	Green	12	1615 Ohms	565 Ohms
Yellow	Yellow	12	1208 Ohms 1450 Ohms 1583 Ohms	511 Ohms 528 Ohms 576 Ohms

† This value measured for 6V clock that had been connected to a 12V source so may be wrong

TABLE C DATA FOR CLOCKS FITTED WITH INTERNAL DIODES (RECTIFIERS).			
SMITHS "CE" CAR CLOCK IDENTIFICATION – LATER 12V CLOCKS			
Diode (Rectifier) colour	Clock (chassis) earth polarity	Terminal resistance case positive	Terminal resistance case negative
Green	Positive		
Meter on diode test range:		0.586 Volts	0.408 Volts
Meter on 2000 Ohms range:		879 Ohms	874 Ohms
White	Negative		
Meter on diode test range:		0.420 Volts 0.420 Volts	0.578 Volts 0.566 Volts
Meter on 2000 Ohms range:		866 Ohms 848 Ohms	869 Ohms 849 Ohms

As can be seen in Table C, resistance values are of little use when testing clocks fitted with diodes but the terminal resistance values are significantly higher than those for clocks fitted with shunt resistors. These resistance readings measure the combined coil + shunt resistance only. It is the voltage readings of the meter's "diode test" function that enable the polarity to be determined.

A resistance value greater than 800 Ohms is measuring only the resistance of a 12V coil. This value indicates the clock has a diode fitted in lieu of a shunt resistor. The lower resistance value, of c550 Ohms in Table B, is the combined parallel resistance of the shunt and coil. Using the diode check function on clocks fitted with a shunt resistor gives a value of c0.7V (Fluke model 37) to c0.9V (Digitech QM1548).

5.5.1. Clock polarity discussion:

The electrical circuit of early Smiths "CE" type car clocks is a coil and parallel resistance or shunt in series with a switch. There is nothing that is polarity conscious in any of these elements.

The balance wheel assembly is energised by magnetic attraction between the coil (think solenoid) and the soft iron, three lobed, discs that form part of the balance wheel assembly. The balance wheel is given a kick every time the pin touches the contact hairspring assembly irrespective of the direction of rotation of the balance wheel.

So clocks fitted with shunts can work on any supply polarity.

In fact, in Smiths Commonisation Tables (parts list) for the ATFC range of engine hours meters (shown in *fig 3.5*) based on the "CE" clock movement and fitted with a shunt resistor, is the statement "All instruments are suitable for Positive or Negative earth applications".

This is plainly not the case for those clocks fitted with diodes in place of shunts. A diode is a polarity sensitive device and to connect one the "wrong way round" across the power supply is to invite failure. It is only when a diode is added that supply polarity becomes an issue. Hence the need to know which clock configuration you are working with.

These clocks are also electrically noisy. In older cars, those without radios, this was not a problem. As in-car entertainment (I.C.E.) systems became more commonplace, this presented a significant problem and in some clocks a capacitor (aka "condenser") across the power supply connections was provided to reduce radio interference. Whether supplied as and external or an internal component, this did nothing to protect the contacts. If radio interference is a problem, a capacitor may be added externally

If you are repairing one of these clocks, the addition of a transistor to switch coil current would be a worthwhile improvement. This though would make the clock polarity sensitive as the diodes in the later movements did.

5.6. *Repairing a Smiths clock with the "CE" type movement:*

Numbers enclosed in brackets within this section refer to the parts numbers shown in fig. 5.3a. Names for the various parts are also those given in that diagram.

Before repairing one of these clocks, determine whether you may be better off to replace it. If you simply wish to have a "correct" looking clock in the dashboard then a new Smiths clock as sold by Caerbont Automotive Instruments may be the better option. These are suitable for positive and negative earth cars. If you wish to keep the clock original, have an inset type clock, a rectangular clock or one with a uniquely coloured dial, such as the maroon and cream faced clock shown in *fig. 5.2b*, then repair is the only option.

As noted previously, these clocks were in production for a long period with only minor changes. So making one good clock from several similar clocks is a viable option. Obviously 6V and 12V coils are not interchangeable but if making one clock from several, do not swap hairsprings on the balance wheel assembly. Use a balance wheel assembly complete with its original hairspring. Failing to do this may lead to significant timekeeping issues.

For later clocks fitted with diodes, positive earth diode assemblies can be identified by the GREEN colour of the plastic diode housing, Negative earth by WHITE. (Refer *fig 5.5b* – a negative earth replacement works.)

Fig. 5.8 below is the electrical circuit of the "CE" type clock. The circuit is the same for all these clocks, the shunt being replaced by a diode in later production clocks. Time-set contacts attached to the time setting mechanism close when the time is set manually to "kickstart" the clock.

Some clocks have a suppression capacitor fitted to reduce interference with car radios. A suppression capacitor may be mounted externally, held in place by a metal clip attached to the rear of the case, or internally. *Fig. 5.3a* shows an internal capacitor but these were only provided in later clocks.

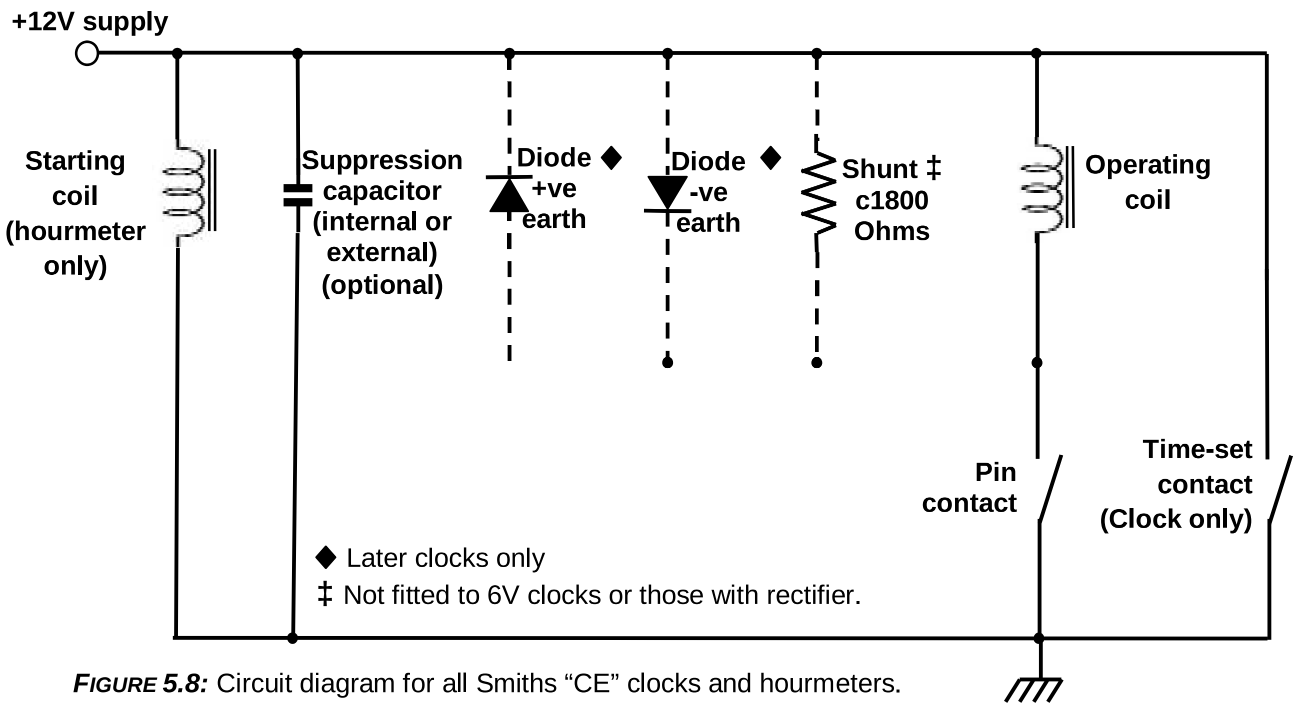


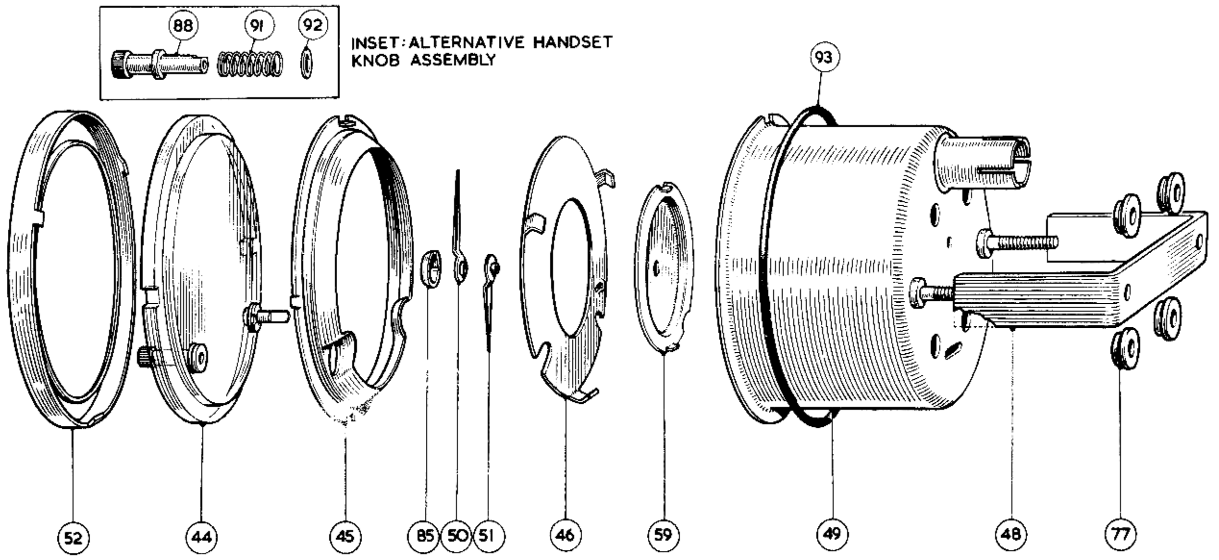
FIGURE 5.8: Circuit diagram for all Smiths "CE" clocks and hourmeters.

These clocks are not hard to refurbish and their repair is essentially a mechanical operation. Worn pivot holes can be re-bushed, a competent watchmaker should have little trouble here. Almost certainly the contact pin on the balance wheel will need attention. This contact pin (measured as 0.010" dia; 33 SWG/30 AWG) is the usual failure point in these clocks. Pin failure usually occurs before any significant wear occurs in the remaining parts. It may be possible to find a clock/watchmaker to replace this pin but costs could be prohibitive. As a minimum the pin and contact assembly will require cleaning.

CAUTION: When removing a rubber-bush mounted clock, always undo the earth strap screw on the case before removing the small screw on the tapped mounting screw. This strap is very thin and should the mounting screw turn with the earth strap screw, the strap can tear.

The internet is a good source of information on servicing these clocks so make use of it. Some useful or informative links have been included within these pages.

Repair starts with removing the movement from the case. (Refer to *fig. 5.9* below.) Rectangular clocks are similar.



44 Glass
45 Nest (or slip-ring)
46 Dial
48 Fixing strap
49 Case
50 Minute hand
51 Hour hand
52 Bezel
59 Sub-dial
77 Case grommet
85 Centre boss (for minute hand
88 Hand set knob
91 Hand set knob spring
92 Hand set knob washer
93 Rubber ring (external

FIGURE 5.9: "CE" 52mm car clock, front reset and regulation types, general arrangement of external parts.

Start by removing the bezel. The retaining tabs formed as part of the bezel need to be lifted up and this needs to be done carefully to avoid damaging the bezel itself. Do not try to fully straighten these tabs. Use a small blade screwdriver to lift/bend them. You will notice that the bezel rim will tend to move away from the case as you do this. Make use of this and only bend each tab sufficient to ease past the rim of the case. These formed lugs will break after being bent a few times. (No effective work-around for broken lugs has been found.) The time-setting knob is retained in the "glass" by a pressed-on boss and the regulator screw retained with a circlip. Once the bezel has been removed, the hands can be removed. Remove with a forked lever or similar tool taking care to ensure that force is applied to a supported part of the dial and using a piece of cardboard to protect the dial itself (*Fig. 5.10 at right*).

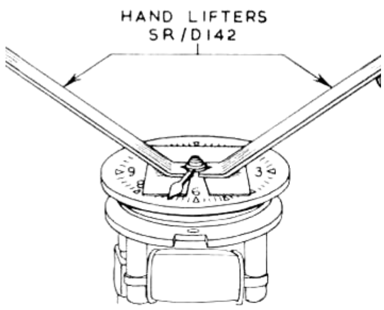


***FIGURE 5.10**: Hand Lifters.*

Remove trim plates, dial plates, retaining/cover plate and the hour-hand gears. For clocks with a screw clamp type terminal, remove the screw and clamp plate. Place the clock face-down on a flat surface and remove the clock from the case by undoing the rear screws bearing in mind the "CAUTION" above. Frequently the inner nuts/screws (1, 42, 5) of the clock will turn with the rear mounting screws. In this case just keep undoing the screws until the works are freed. Note that these items will need to be separated from the case and there is a small rectangular aluminium plate (73) that sits over the spigots on the nuts/studs. This plate must be replaced as it provides a land for each of the rubber grommets (when fitted) around the mounting screws. This plate fits over the spigots on the respective nuts/studs. (These spigots, turned on the brass nuts/screws, can be seen in *fig. 5.5b*.) The assembly of parts removed up to this point is pretty obvious and parts will only fit one way. From here on, note where everything fits grouping parts together and/or make some sketches or take photographs to show where parts fit to aid with re-assembly.

A comprehensive article on repairing these clocks by a professional watchmaker:
https://cjnwatch.co.uk/wp/2018/09/18/smiths-car-clock-as-used-in-jaguars-from-the-1960s/
Or you can download a pdf here:
https://cjnwatch.co.uk/wp/smiths-car-clock/

5.6.1. Dismantling the movement:

Taking the movement apart is mostly straightforward and should not give much trouble.

Apart that is from removing the cannon pinion (32). A special tool exists for removing this item which is either a brass gear (Rear remote time-set clocks) or a combined brass sleeve and gear pressed on to the centre wheel spindle (14). The official tool for this job, SR/D168 and is shown in *fig. 5.11a*.

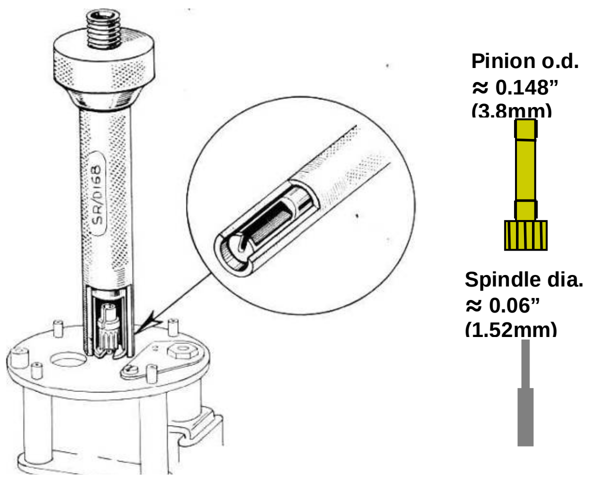


Figure 5.11a: Special tool SR/D 168 for removing cannon pinion from centre spindle assembly.

A dimensioned sketch of the cannon pinion and centre wheel spindle is also provided in *fig.5.11a*. The centre wheel spindle has a diameter of less than 1/16 inch and would be easily bent or broken. A tool similar to that shown is essential to successfully remove this component. It's not too difficult to make one up if you have access to a lathe. Without a suitable puller it will be extremely difficult to remove the pinion without bending the centre spindle.

Release the coil leads. These comprise split collets on a tapered pin. Use a "jeweller's" screwdriver to slightly spread the split collets and lift from their respective taper pins. Remove the two screws (1, 42) and remove the setting support plate and coil.

Be very careful with the balance hairspring. Loosen the screw holding the hairspring post to the support plate and free the hairspring. Remove the two top support plate nuts (5) and carefully lift the support plate and balance wheel clear from the rest of the clock. Remove the balance wheel, easing the hairspring from between the curb pins on the regulator lever assembly (10). You may need to spread the curb pins slightly to do this.

Take particular care with the jewel bearings (9, 35) as these are quite brittle and can be broken if dropped onto a hard surface. These should be cleaned in solvent with a small brush.

Continue dismantling the clock noting where everything fits. For bottom time set clocks, a gear is pressed on to the centre spindle and must be removed using a fixture similar to that shown in *fig 5.11b.* The punch to remove this gear has a flat surface. The clock will need to be substantially reassembled to refit this gear and a hollow punch and support for the bottom plate provided to refit.

Note particularly where insulating sleeves and plates fit. These must be re-assembled as they were. Failing to do this will allow components to short circuit. The clock will not run and fuses will die!

Later production clocks had a spacer below the coil's pole pieces. This must sit below the pole pieces, not between. Normally the pole pieces/spacer would not be removed from the coil. If the pole pieces have been removed from the coil, they must be replaced in the same position they were originally. These pole pieces are not interchangeable so mark the pole piece and the coil to ensure they are re-assembled correctly.

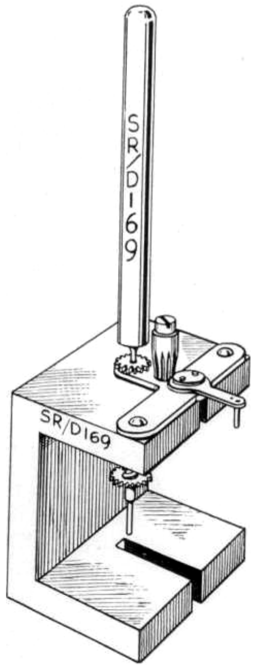


FIGURE 5.11b: Special tool SR/D 169 for removing setting gear from centre spindle assembly when fitted (bottom time set clocks).

Once the clock is dismantled, place the gears and metal plates in the ultrasonic cleaner and set it going…if one is available.

Failing that, the clock will need to be cleaned the old fashioned way. Place the metal parts in a metal container and cover with solvent - acetone, white spirit, methylated spirit or isopropyl alcohol. Leave to soak for an hour or two then use a small stiff brush.

If the parts are particularly dirty, soak for longer and start with a brass-wire brush to shift the bulk of the dirt.

Clean the contact pin on the balance wheel by lightly scraping with a sharp blade. Note the condition of the contact pin. It is common for the pin to be worn where the contact hairspring assembly meets it. In extreme cases, the pin may have broken at this point. If this pin has broken off, it may be possible to find a skilled watchmaker to replace the pin. Scrape the contact part of the contact hairspring assembly by more vigorous scraping. This needs to be clean and a small wire brush or even judicious use of a points file can be used if necessary.

Once all the obvious dirt has been removed, it is time to "peg" the pivot holes in the various plates. Use toothpicks or kebab skewers for this. Use "peg-wood" if it is available. **Refer to Appendix B: "PEGGING PIVOT HOLES".**

5.6.2. Re-assembling the clock:

Be very careful not to bend or distort any components when reassembling! A pair of needle-nosed tweezers should be used to hold parts while fitting in place. Fit the Escape wheel assembly (39), Transverse wheel assembly (38), Friction spring (41), Double support plate (36), Centre wheel assembly (14) and Setting spindle (66) to the baseplate, lubricating as you go.

Smiths recommend using a "high-grade" clock oil. In most cases, specialized clock oils will not be to hand. Use a brand-name sewing machine oil to lubricate. Do not use 3-in-1 or "handyman" type oils for this job! Lubricate using a needle to transfer oil to the parts. A very small drop of oil placed near the end of each shaft's journal is enough. The oil will be distributed over the length of the journal and the thrust face during assembly.

There are conflicting opinions as to whether the jewel bearings are oiled or not. Some say "yes", others say "no". If oil is used, a minute amount should be placed within the jewel bearing itself. Personally, I don't use oil on jewels.

Refit the top endstone plate (9) and regulating lever assemblies with a smear of silicone grease or petroleum jelly on the internal bore of the regulating lever. On no account allow grease to enter the jewel bearing!

Do not fit the coil to the clock until both the endshake and pin location of the balance has been set. Early production clocks used a fixed bottom bearing here so endshake is not adjustable. If the balance wheel assembly endshake is too great then the clock is unusable, though a later works could be used to overcome this. Later clocks had an adjustable bottom bearing and the balance wheel assembly endshake should be adjusted so that it is the minimum amount that allows free movement of the balance wheel.

Fit the contact hairspring pillar, insulating plates etc (22, 26, 43, 72) and secure in place. Using an Ohmmeter, check that there is no electrical connection between the hairspring pillar and the baseplate. Also check between the supply terminal and baseplate. If any electrical connection exists between the baseplate and contact hairspring pillar then determine the reason and fix it. If the shunt insulating tube (26) is damaged, cut a piece of heatshrink tube to slip over it and shrink in place.

5.6.3. Aligning balance contact pin:

Fit and align the contact hairspring. The contact arm should sit as shown in *fig. 5.12*. Ensure that the contact arm sits in line with the balance pivots before pushing the tail end collet home onto the connecting pillar of the shunt bridge assembly (20). This alignment can be affected if the hairspring is bent at the point marked "A" which is easily done.

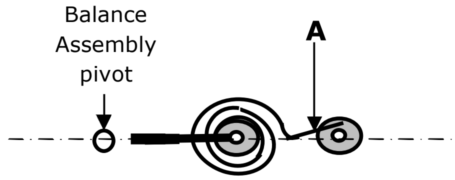


***FIGURE* 5.12:** Alignment of contact hairspring assembly

The electrical contacts of the clock need to be aligned and the means of doing this is shown in *fig. 5.13*. (Note the contact hairspring assembly is not shown in this diagram.) To align the pin and contact, a small jeweller's screwdriver (in lieu of the special tool shown) is inserted into the split collet of the hairspring and turned so that at rest the contact and pin are not quite touching.

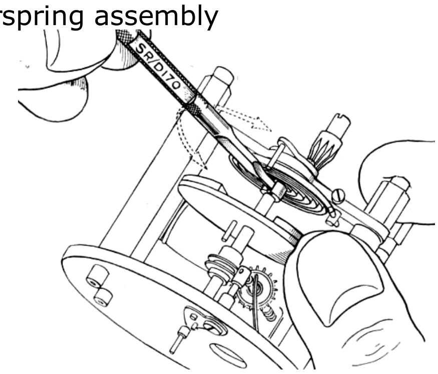


***FIGURE*.5.13**: *Align Balance wheel pin and contact assembly*

Note: Early Smiths service notes ("6 and 12 Volt clocks") state that:

> "*It is important, during this operation, that the balance should be positioned so that it comes to rest against one side of the contact arm (18). Should the pin in the balance not come to rest on the contact arm, steady the balance wheel and insert the blade end of the into-Beat tool SR/D 170 into the slot of the hairspring collet; turn gently in the opposite direction of the gap until the contact pin is lightly resting on the contact arm.*".

Later service information, states that the contact assembly should be offset from the centreline between the two pivot points so that they do not quite touch at rest as shown in *fig. 5.14* at right. This "later" method is the better way to set up these clocks.

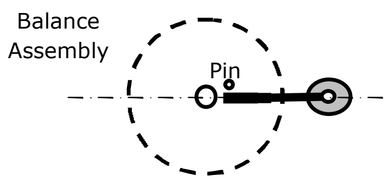


***FIGURE* 5.14:** Alignment of contact hairspring assembly (later method)

In order to minimise side loading on the balance wheel assembly, place the tool (screwdriver) in the collet and turn the balance wheel with your fingers rather than as shown here. Start the balance wheel oscillating using a finger and ensure the escape wheel (39) rotates. It may be necessary to increase tension in the friction spring, by bending, if the escape wheel rocks but does not rotate. Smear a little oil, light grease or molybdenum paste on the transverse wheel shaft beneath the friction spring to lubricate. Re-check action.

Ensure the insulating sleeve (16) is in place and fit the coil assembly in place. Tighten the securing screws finger-tight and adjust the coil so that the pole pieces are within 1 mm of the balance wheel but do not touch it. Spin the balance wheel to make certain that it does not foul on the pole pieces and fully tighten the coil securing screws. Re-check for fouling and re-adjust if required. Fit the collets on the coil leads to their respective pillars.

Re-assemble the gears driving the hands, the dial washer and retaining plate. Fit the dial components and hands. The clock should now be capable of running. Connect to a suitable power source to check. Set regulator arm to its mid-point and set time to the current time and run for 24 hours. The factory procedure is as follows:

> *Assemble movement to swivel mountings on test panel SR/D 179, making sure that the dial is in the vertical position, i.e. 12 at the top and upright on the panel. Connect leads A and B from test panel to battery, making sure that the relevant voltage is obtained, i.e. 6 or 12 Volts, Set hands to correct time. It is advisable, at this juncture, to observe the position of the index regulator lever assembly (10) in which the curb pins are incorporated. The teeth on the regulator pinion should be in the centre of the ratchet teeth on the regulator lever, This is to ensure that the maximum control is available to the customer, should it be necessary to make adjustments during its working life.*
>
> *Observe the reading of the clock after 24 hours when it should not indicate more than +1 minute of the correct time. Assuming the clock has gained five minutes over the period of 24 hours, check the position of the index or register lever, which should be central. If it is over to the plus side, move it back to the central position, but if the regulator lever is central, examine the action of the hairspring between the curb pins, where it should be breathing freely. If the movement is insufficient, open the inside pin so that the hairspring has a greater freedom of movement. Assuming the clock has a losing rate of three or four minutes, carry out the above procedure but, in this instance, close the curb pin and thereby reduce the hairspring movement.*
> *It will be obvious from the foregoing that these adjustments tend to increase or decrease the effective length of the hairspring. Should the above adjustments not bring the clock within the time control, we suggest that a new timed balance complete be fitted. After any adjustment has been made, replace the clock on the test panel and check for 24 hours until it keeps the correct time within the agreed tolerances.*

As noted earlier, the electrical working contacts in these clocks can erode to the point where the pin is gouged or breaks. This is caused by arcing at the contacts as they break the electrical circuit to the coil. This could be reduced by adding a transistor to the circuit so that the coil load is carried by a transistor and protective diode and a reduced, resistive, load is seen by the clock's contacts.

One means of achieving this can be found at:
https://www.sa.hillman.org.au/TT_SmithsClockPC.htm

This modification would only work where the contact pin on the balance wheel was still in serviceable condition.

TABLE D: "CE" CLOCK FAULTS: DIAGNOSIS and TREATMENT		
Fault.	**Diagnosis.**	**Treatment**
A. Stopped or difficult starting.	Dirty contacts	Clean contacts
B. Stopped or erratic timekeeping	Dirty contacts	Check movement train to ensure that there is working freedom ; if necessary adjust friction spring so that it will press lightly on the escape wheel spindle.
C. Stopped	*i.* Open circuit in coil or lead broken. *ii.* Wiper contact out of adjustment in relation to pin on balance. *iii.* Out of beat.	Repair lead or fit new coil Position spring contact so that it is in line and projects 1/4 to 1/2 of the diameter of the contact when the balance is at rest. See 6.4.2: Aligning balance contact pin.
D. Cannot start without shaking.	Time set contact not making.	Adjust easy starting spring, being sure that the tail of the spring makes contact on the shunt bridge pin.
E. Cannot start	Short circuit and insulation faulty.	Re-adjust lead. Check insulations.
F. Noisy	Excessive endshake	If fitted with latest type end plate, adjust end piece screw and reduce the endshake until there is only sufficient for working freedom. If old type end plate is fitted, exchange for new.
G. Bad time-keeping. Gaining.	Effective length of hairspring too short.	If regulator is in the slow position, open curb pin.
H. Bad timekeeping. Losing.	Movement dirty or binding. effective length of hairspring too long.	Dismantle, clean and re-lubricate. If regulator is in the fast position, close curb pin.

6. SMITHS CET – CTE CAR CLOCKS:

BE VERY CAREFUL WHEN DISMANTLING "CET/CTE" CLOCKS. THE HANDS OF THESE CLOCKS ARE MADE OF PLASTIC, ARE VERY FRAGILE AND ARE EASILY BROKEN. HANDLE THESE ONLY BY THE HUB WHERE THEY FIT TO THE CLOCK SHAFTS.

"CET" clocks were the first Smiths electronic car clocks and were powered by a small battery separate from the car's electrical system. The balance wheel assemblies used in these clocks could be damaged if the clock was dropped and it would soon fail from such impact damage.

"CET" clocks were used in Mk I Triumph 2000 cars, manufactured from October 1966 to December 1967 (CET 3501/01), and presumably other marques. These clocks were soon replaced by "CTE" clocks powered by the car's 12V battery.

Construction of the clock also changed, where most of the components were now made of plastic rather than the steel and brass used in the earlier "CE" clocks. This plastic construction required no lubrication and the balance assembly runs in jewel bearings which also need no lubrication. As always, the exceptions: The centre spindle bearing inside these clocks is a steel shaft running in a sintered brass bush which also houses the bottom balance bearing, If you have one of these clocks apart, a small drop of oil should be applied. A drop of oil on the time setting and regulator shafts where they pass through the balance assembly base plate is a good idea, though this is for corrosion protection rather than lubrication.

Like the "CE" clocks, these clocks need to be manually started. Unlike the "CE" clocks, the starting mechanism for these clocks is mechanical. When the time adjusting knob is pulled outwards, a tapered boss on the time setting shaft rotates the balance wheel, through a lever, away from its rest position. Releasing the adjusting knob allows the balance wheel to return to its rest position and in doing so the coils pass between the poles of the magnet assembly and trigger the transistor forcing the balance wheel to oscillate and the clock then continues to run for as long as power is supplied to it.

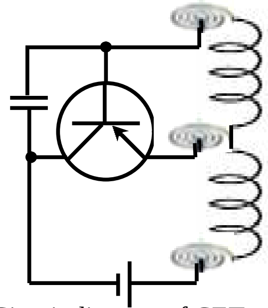
Each coil on the balance wheel is actually two coils – trigger and impulse (drive) coil. These coil assemblies are connected in "counter-series". When the balance swings in one direction, one trigger coil will switch the transistor ON, energising the associated impulse coil, the other trigger coil will try to turn the transistor OFF. When the balance swings in the opposite direction the action of each trigger/impulse coil pair will be reversed. The timing is dependent only on the mechanical characteristics of the balance wheel and hairsprings, the electronic circuit being a simple switch and not an oscillator. Coils will only have any effect on clock operation as they pass between the poles of the magnet assembly and not otherwise.

6.1. CET car clock

As noted earlier, "CET" battery operated clocks were used in several British vehicles. Their use seemed to be short-lived and corresponded with the change of vehicle chassis polarity from positive to negative earth. These clocks use an "N" size mercury cell with an open-circuit voltage of about 1.3 Volts. The life of the battery was 12 – 18 months. These clocks use essentially the same internals as Smiths Mk 2 "Sectronic" range of, battery operated, mantel and wall clocks.

Aside from requiring a separate battery, the "CET" clocks were internally similar to the later "CTE" instrument. From the late 1960s the "CTE" type clock (CTE 3501/00) was used in these cars and would be a good option to replace a failed "CET" clock. Similar options may be available for other marques.

The circuit of the battery operated "CET" clock is shown at right and is much simpler than the 12V CTE type. This clock was manufactured as a "positive-earth" instrument. Since the battery supplied only the clock this does not create an issue in negative-earth vehicles. **The transistor used in these clocks is a PNP type and not the NPN type shown in *fig.6.1.***



Circuit diagram of CET clock redrawn from Smiths document S-1347-8 "Care of instruments" dated April 1967

6.2. CTE car clock

The "CTE", or "CTJ" for Jaeger-branded, car clock was internally physically very similar to the "CET" clock. Electrically they were similar but some electronic component values differ. A simplified circuit of the later 12 V "CTE" clock is shown in *fig. 6.1* below.

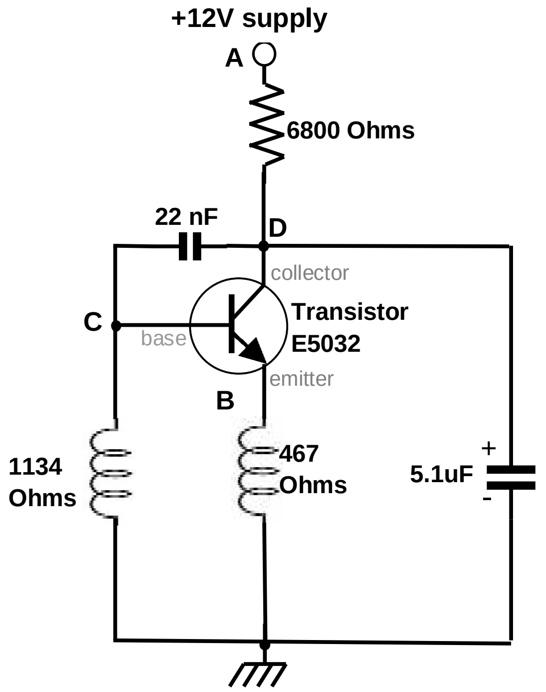


FIGURE 6.1: Simplified circuit diagram of 12V Smiths "CTE" type car clock. Coil resistances are as measured on a clock to hand.

The transistor is a general-purpose silicon NPN device. BC546/7/8 is a suitable substitute. Transistor terminals are identified with grey text.

The 5.1 uF capacitor is a tantalum capacitor and is also polarity conscious. It also may need replacing. If a 5.1 uF capacitor is not available, a 5.6 or 4.7 uF capacitor could be substituted.

See note re polarity of the CET clock in section 6.1 "CET CAR CLOCK" on previous page.

Letters on diagram identify the connection points marked in *fig. 6.5*.

"CTE" clocks should draw a peak current of <10mA from a charged battery. Usually 6mA. The average current draw will be much less than this value.

6.2.1. Inspecting Smiths "CET/CTE" type clock:

These clocks generally fail as a result of being dropped, whereby the coils partially or fully separate from the balance wheel, or by failure of the transistor due to reversed polarity supply. If the balance wheel/coil assembly has been damaged, repair is not practical.

Remove the clock from its case, the cases are similar to those for the "CE" clocks and inspect the movement. Note that the dial is held to the frame with screws and need not be removed for basic testing.

Inspect the movement for cobwebs or dust around the gears. If the movement is fouled in any way it needs to be cleaned. If it is clean, hold the frame of the clock firmly and pull the time-set spindle towards the front of the clock. This should rotate the balance wheel. Release the spindle and if the balance wheel does not swing freely between the magnet poles then the clock is unserviceable.

FIGURE 6.2: Damaged balance wheel assembly as removed from Smiths CTE clock.

To avoid damage, use the time-set spindle in lieu of fingers or other tools to swing the balance wheel while the clock is still substantially complete.

6.2.2. Repairing Smiths "CET/CTE" type clock:

Check for loose connections and short-circuits at the balance assembly and for obvious damage to electronic components. Also check for dry solder joints and re-solder any that look dull.

Connect the clock to a power source and observe operation. If the balance immediately rotates slightly so that one of the coils is drawn toward the magnet assembly then chances are the transistor is shorted, usually due to connection to a positive-earth power supply. If starting the balance wheel moving using the time-set shaft has the balance wheel swinging in ever decreasing arcs until it stops, a good balance will swing back and forth for up to a minute, the transistor is probably open-circuit. These are the usual faults in these clocks.

The good news is that the transistor can be replaced without further disassembly of the clock. The ends of the transistor's legs are bent and soldered inside the hollow posts to which they are soldered. Use a pair of metal tweezers to lift each leg away from its post as it is unsoldered. Use as little heat as possible to avoid damage to the plastic frame. *Fig. 6.3* shows the components and transistor terminal connections in a "CTE" clock.

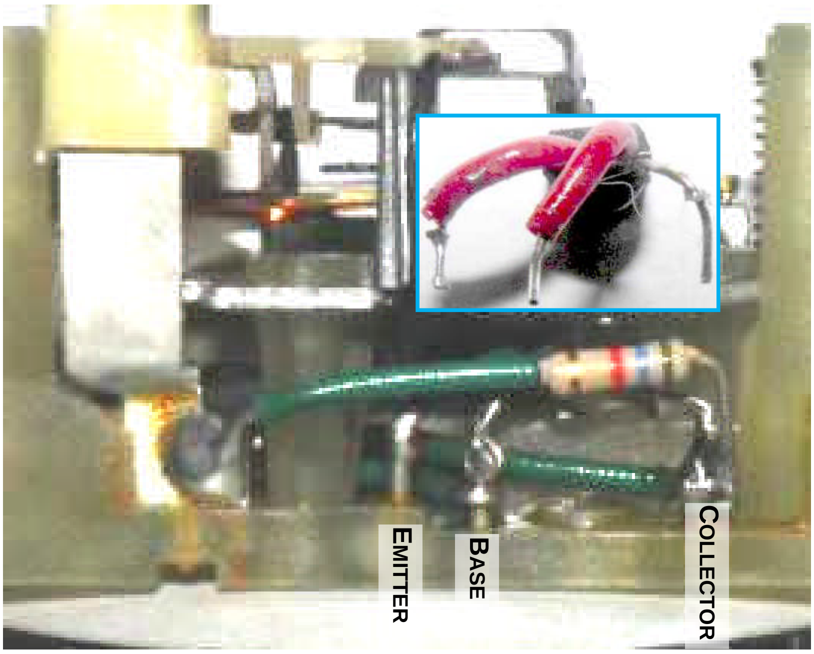


FIGURE 6.3: Showing the view of a clock removed from case with dial still attached.

Inset shows transistor as removed from another clock. Note how the legs are bent to fit.

The transistor is a silicon NPN type with an e-c-b pinout. The BC54x series are suitable replacements and have an e-b-c pinout which doesn't require any transistor leg to cross another!

This clock has been previously serviced as evidenced by the soldering on the posts.

If the clock movement is dirty or fouled, it may be cleaned as follows:

Place some warm soapy water in a bowl and swirl clock movement in the bowl. (It's a good idea to remove dial and hands first when doing this. Note what parts fit where.) Use a small soft brush to remove any obvious dirt as required.

Rinse well in fresh water – under a running tap works well. Shake off surplus water and dry with a hair drier or similar, on low heat or place in a warming cupboard overnight. The clock must be completely dry before applying voltage to it!

Connect to a suitable power supply and if it runs, allow it to run for several hours to be sure it will keep going.

THE REMAINDER OF THIS SECTION APPLIES ONLY IF IT IS NECESSARY TO FULLY DISASSEMBLE THE CLOCK.

In order to fully dismantle these clocks, the balance assembly must be removed which requires removing a boss and spring on the time setting control shaft. This shaft has a shoulder which prevents it being withdrawn towards the rear of the movement. F*ig. 6.4* shows this boss and associated spring.

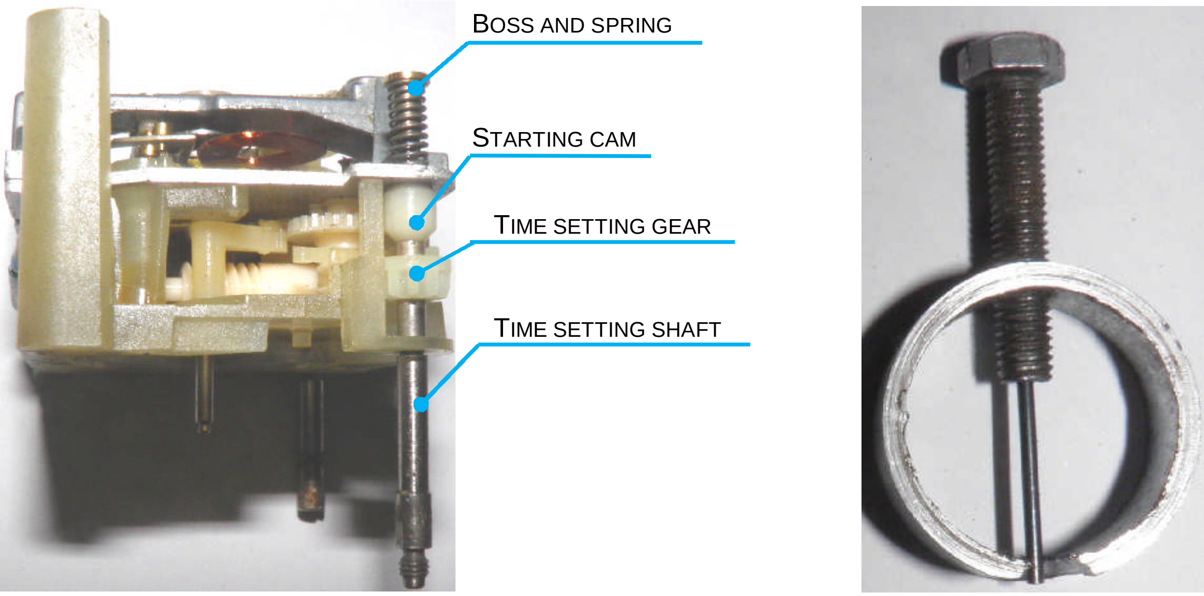


***FIGURE** 6.4*: Showing clock movement and boss and spring on time-set spindle. To the right is a home-made tool to do the job.

Pullers for the hands and Time setting shaft boss, a set of jewellers screwdrivers and a small soldering iron are required to service these clocks. A pair of narrow-tipped tweezers will make life a bit easier. The clock hands are very fragile. Hold only by the centre boss. Any flexing of the hands will break them!

Once the boss and spring have been removed, unsolder the wire shown in *fig. 6.5* and ensure it is clear of the post is attaches to.

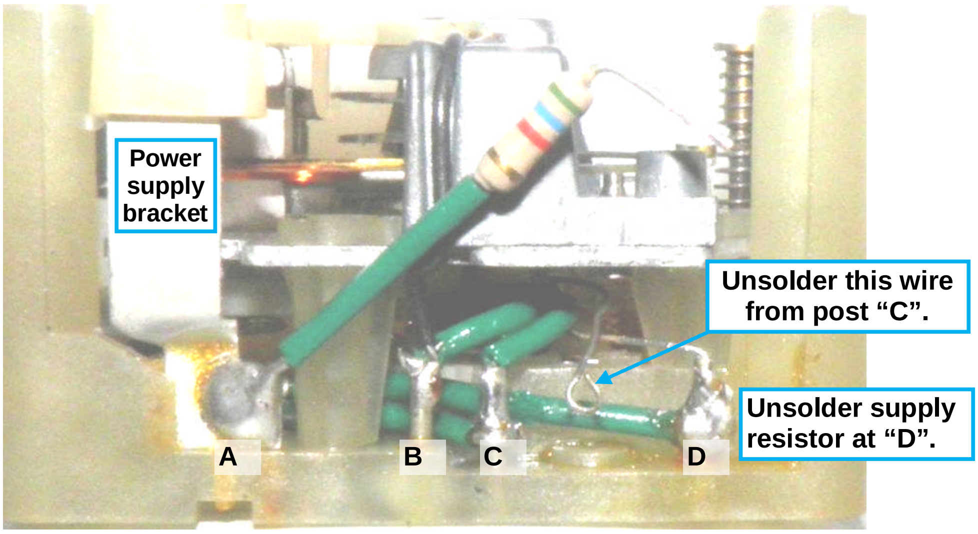


FIGURE 6.5: Unsolder power supply resistor from post "D" and move aside. Unsolder wire from post "C" and remove the transistor emitter and earth connections to free the balance assembly. Letters correspond to those on circuit diagram in *fig. 6.1*

Undo three slot-head screws to separate the balance assembly from the clock frame. Take care to avoid damage to the balance wheel assembly. The balance wheel itself is easily distorted. If the wheel rim has been bent slightly it will strike the magnets as it moves. If this happens, the wheel can be gently bent back into shape. The arms of the wheel and the mid line of the coils must all lie in the same plane within very close limits.

Removing the frame will also release most of the gear train components so separate the balance from the frame above a container so as not to lose any parts.

Fig 6.6 shows the top view of a complete balance wheel assembly from a Smiths "CTE" car clock Note the brass pin beside the regulation adjustment gear (circled near bottom at left). This is the earth connection for the electronics and a split collet is used for this connection as for the transistor emitter connection.

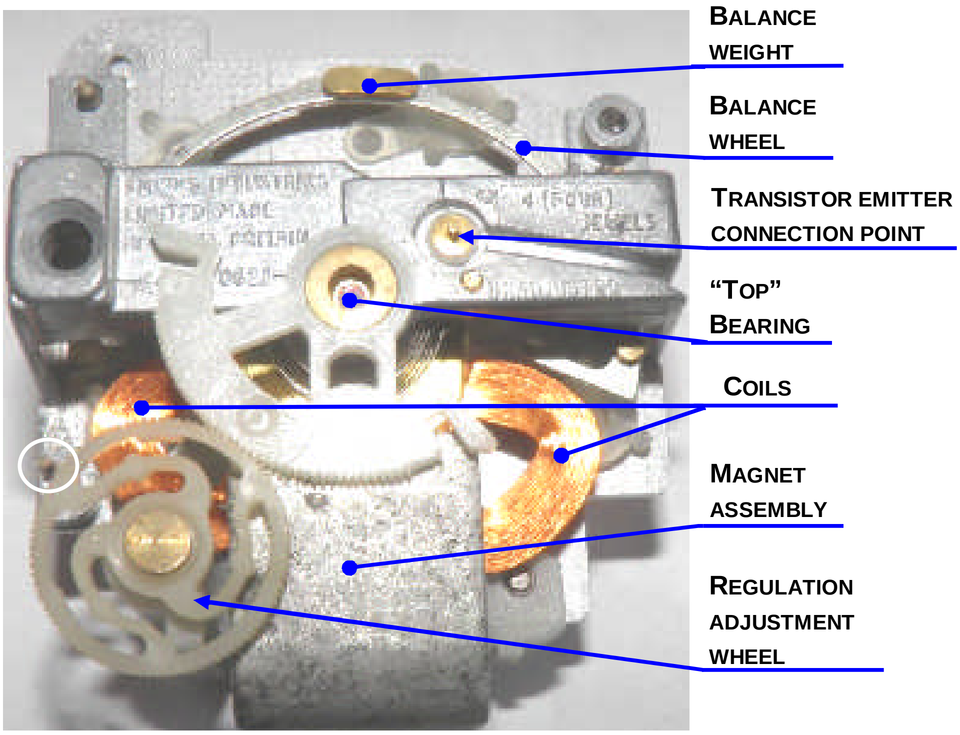


FIGURE 6.6: Marked-up view of ""top" of CTE" balance assembly.

Fig. 6.7 shows an underside view of the balance wheel assembly and identifies its major features. Note that the base connection of the transistor is soldered at the balance assembly and does not use a split collet as the two other connections to the balance assembly do.

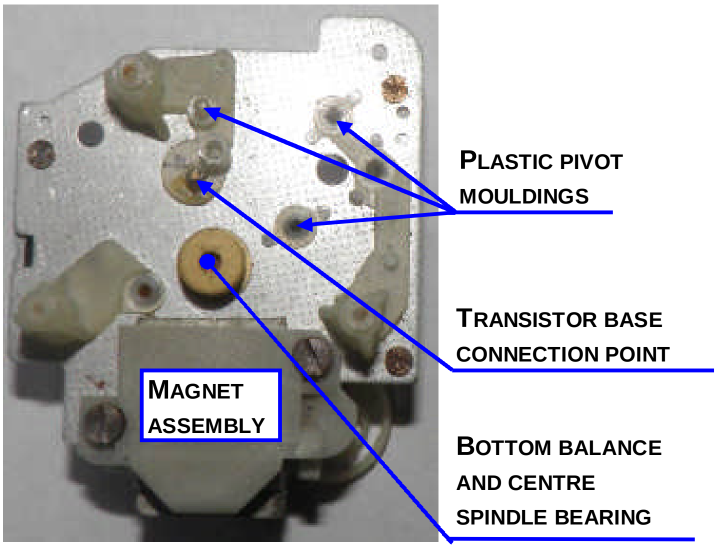


FIGURE 6.7: Underside view of balance assembly.
A slot in the side of the bottom balance bearing housing allows a rack to mesh with a small gear mounted on the balance wheel shaft, not visible, by which motion of the balance wheel is transferred to the remainder of the mechanism. The clockwork device's mainspring has been replaced by the electrical/electronic components and the car battery. The balance performs both the driving and regulating functions in these clocks.

6.2.3. Re-assembling the clock:

Re-assembly is fairly straightforward but "fiddly".

Fig. 6.8 shows most of the gear train components. The second gear and worm and the centre spindle assembly are retained in the frame as shown in *fig 6.9* below.

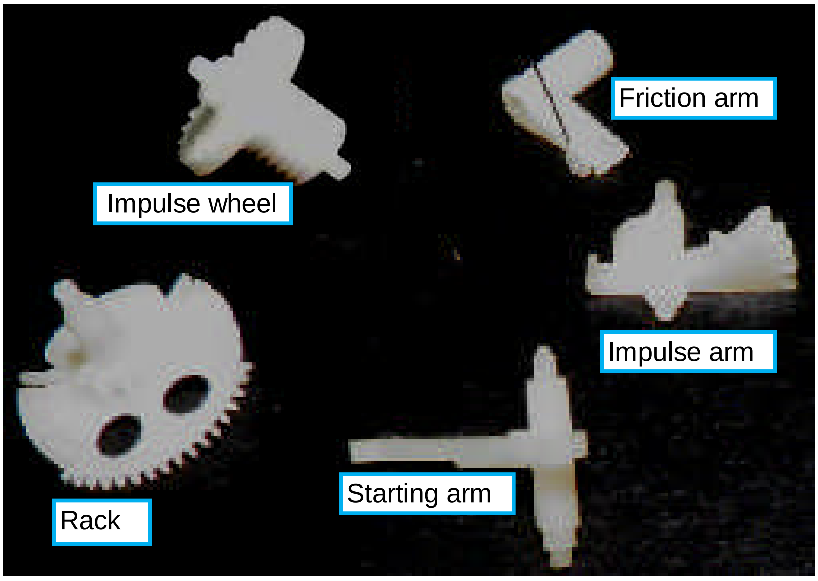


FIGURE 6.8: CET/CTE clock gear-train components.

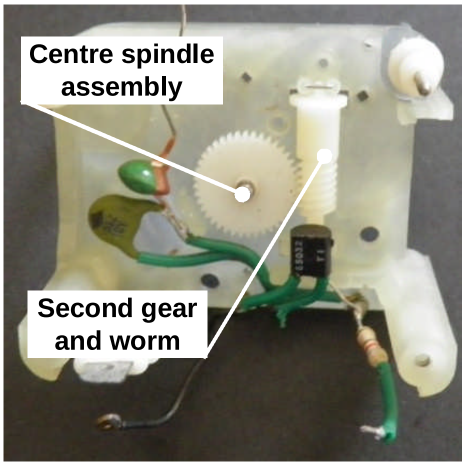


FIGURE 6.9: CET/CTE clock gears retained on frame.

Place the balance assembly on a flat surface and fit the rack and impulse arm. Ensure the wire soldered to the balance assembly is in place. Alignment is critical to operation so take a little time to get it right. With the balance wheel in its rest position fit the rack so that it meshes with the balance gear at its centre of travel (white dashed line). Fit the impulse arm assuring that it meshes with the centre of the teeth on a line between the two shafts (yellow dashed line). Fit the impulse wheel shaft into its bearing with the worm gear uppermost. Also fit the friction arm to its spigot Pay particular attention to the Friction arm spring. This is very fragile and easily distorted. It should lie parallel to the friction arm and bear against the vertical portion of the adjacent pillar. Fit the starting arm into place as shown in *fig. 6.10*. The starting arm has an extension that butts against a moulded post on the frame.

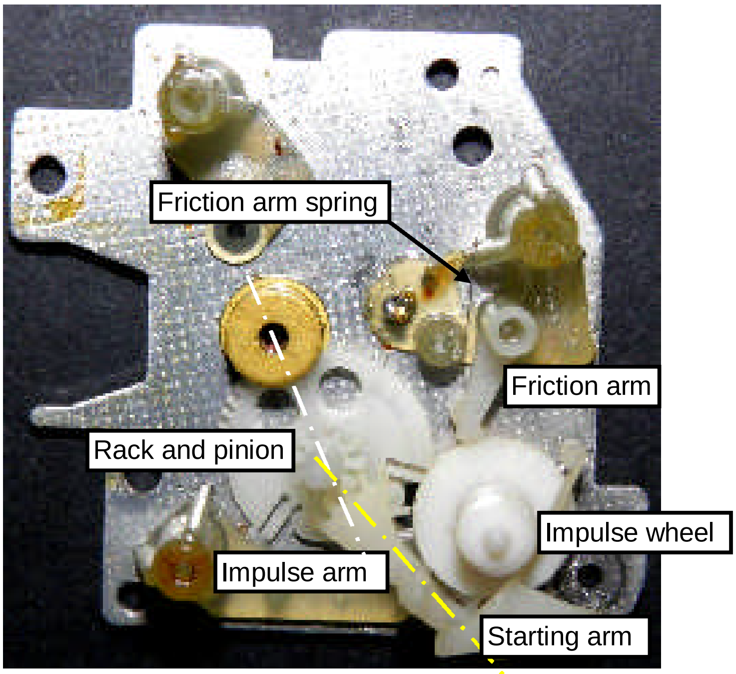


FIGURE 6.10: Showing gear train components fitted to underside of balance assembly.

Figure 6.10 shows the balance assembly base plate with the gear train components in their proper positions. Note particularly the location of the starting arm extension. This arm acts as a spring and bears against a moulded post on the frame.

Check that the Impulse wheel shaft is vertical and that the face of the friction arm bears against the Impulse wheel's rim. If the Impulse wheel shaft is not vertical the nub on the Friction arm to which the spring is attached can contact the impulse wheel which may cause problems when finally assembling the movement. Use tweezers to align shafts with holes when re-assembling.

Ensure the two wires that connect the electronics to the balance assembly are bent clear of the frame and place a small drop of oil on the centre wheel shaft. Carefully fit the frame to the balance ensuring that all shafts line up and fit into their pivots. Fit the three screws securing the frame to the balance assembly and do up tight. Secure with a drop of lacquer, or nail polish, applied to the side of the screw heads and frame. Refit the spring and boss to the time setting shaft.

Attach the electrical connections to the balance assembly and re-solder the transistor's base wire and supply resistor in place.

Fit the gears driving the hands and secure the dial plate in place with its two screws. Connect the clock to a 12 Volt supply – negative to balance assembly frame, positive to supply bracket and start the clock. It should now run. If it stops after a few swings of the balance wheel, check the position of the starting arm extension. It should lie between a moulded post on the frame and the impulse wheel worm (*fig.6.11*). It can be easily repositioned if needed. Start the clock again and it should run. Leave running for an hour or two.

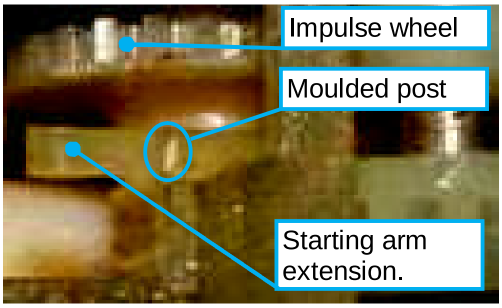


FIGURE 6.11: Correct position of starting arm extension.

Fig. 6.12 shows the layout of components behind the dial. Place the setting wheel in position first followed by the hour wheel. The retaining plate sits on top of the hour wheel, the flanges matching with moulded guides in the frame. The regulation disc engages with the regulation wheel.

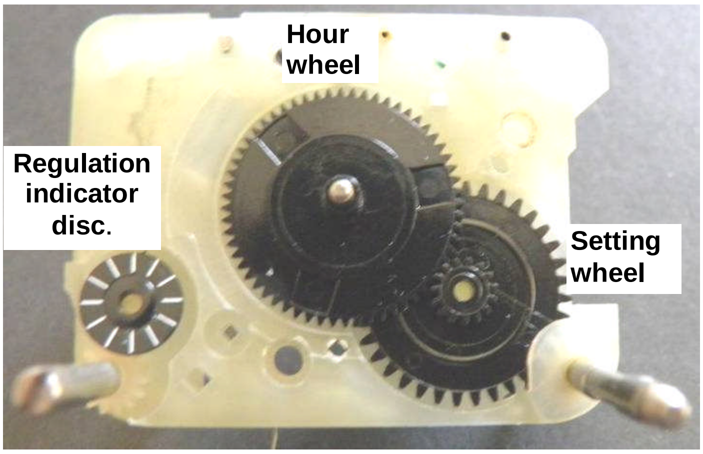


FIGURE 6.12: CET/CTE clock front works assembly.

Retaining plate

Once the clock has successfully run for an hour or so, fit the hour hand and time setting gears. Set the regulator lever to mid-travel and time the clock by running for 24 hours. Adjust the regulator if timekeeping is unacceptable and re-test. Fit clock to case and fit the dress plate, glass and bezel to complete the job.

Clocks can use either a metal or plastic slip ring behind the glass. Plastic slip rings have a moulded lip at the inner edge and are designed to take a glass with a raised ring formed on the inside. The steel slip ring takes a flat glass with no formed lip. (*fig. 6.13*)

Aluminium or plastic dress rings fit in the recessed holes around the spindles on the inside of the glass.

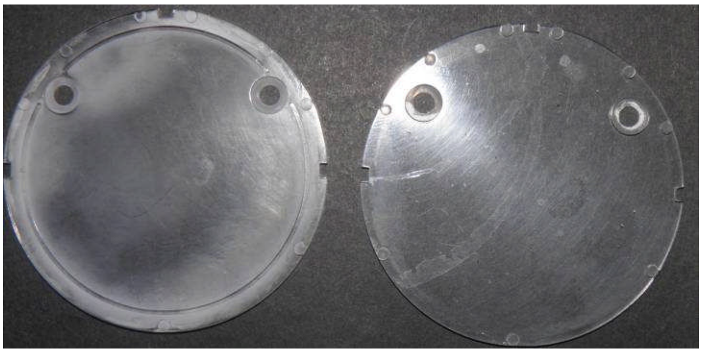


FIGURE6.13: showing partially polished clock glasses. Glass with raised ring on left. Plain glass on right.

APPENDIX A: LIST OF TOOLS REQUIRED TO SERVICE THESE CLOCKS:

The following is a list of Tools and Equipment necessary for the servicing of Smiths Electric Car Clock.

Common tools:

Set of jewellers screwdrivers (blade)

Small Phillips or posidrive screwdriver

Blade screwdriver (bezel removal)

Small vice (suction base – a suction base "hobby" vice is good)

Small parallel punches

Tweezers – needle-nosed

Magnifying glass/eye glass or similar

Small knife or blade (sharp)

Small hammer (tack hammer or watchmaker's hammer)

Digital Multimeter (Ohms, diode-check, Volts and mA)

Small soldering iron (<20W)

Special tools:

Hand pullers †

Balance support †

Cannon pinion puller

Consumables:

Peg-wood, skewers or toothpicks

Rosin-cored solder (18 SWG or finer.)

Clock or sewing machine oil

Silicone grease or petroleum jelly

Silicone oil

Replacement electronic components as required

Items marked † are readily made or substituted for.

APPENDIX B: PEGGING PIVOT HOLES:

Pegging is simply cleaning a hole with a wooden peg (or skewer, toothpick).as shown in *fig.B.1* at right. Sharpen the peg to a point, narrow enough to enter the hole you are cleaning. Dip the peg in the solvent of your choice (acetone is probably best if you have it) and rotate the peg while pressing firmly into the hole, approaching from the spindle side of the plate. ***Do not peg the jewel bearings.*** Press hard enough so that the peg passes fully through the hole. Take care to provide adequate support for bearing posts. Remove the peg and sharpen to expose a clean wood surface and repeat for each pivot hole until the peg comes out clean. When all holes are done, rinse the plate in clean solvent and allow to dry.

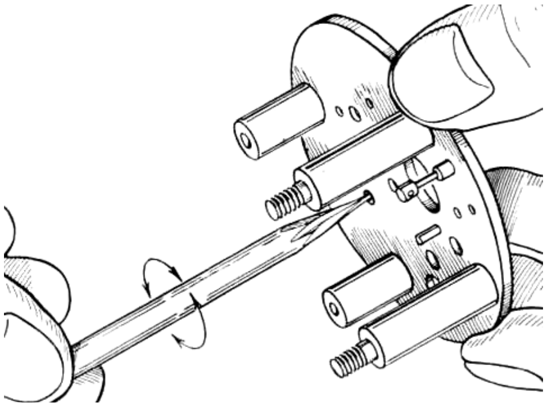


FIGURE.B.1: *Pegging Pivot Holes*

Polish the journals on each shaft. Use some manila card or craft paper for this job. This material is mildly abrasive and good for removing dirt but not metal. Cut into strips, fold lengthwise and dip into solvent. Lay the shaft between the fold and turn using a back and forth motion. Pinch the paper against the shaft with your fingers while you do this. **Do not use abrasive (emery) paper!!** Polishing compounds should be avoided unless you can guarantee that all traces of these abrasives, because that is what they are, are removed. Clean in solvent again and leave to dry.

Once all the parts are dry, you can start re-assembling the clock.

APPENDIX C: RANDOM THORTS:

Do not spray "CET/CTE" (or any) clocks with penetrating oil to get them going again!
It is possible that some penetrating oil formulations destroy the adhesive holding the balance wheel components in place. The balance shown in *fig 4.2* of the main body of this document was from a clock that had been so treated and such treatment is suspected in another clock where one of the balance coils had loosened. The above is not conclusively proven, but why take the risk?

On the subject of oils, many cheap "handyman" or "3-in-1" type oils do not handle elevated temperatures well. Consider that, in many localities, the inside of a car can get very hot in summer. These oils tend to break down and become "sticky" when subject to elevated temperatures over time, which defeats the purpose of using them. They probably work fine below about 30 degrees C but the temperature inside one of my vehicles, fitted with an air temperature gauge, can exceed 40 degrees C when left in the sun! And this is in a "temperate" rather than "tropical" climate.

Also, keep the dial screws with the movement frame they were removed from.
There appears to be two different diameters of dial screw used on these clocks. The possibility does exist that a previous repairer has stripped the original threads and fitted oversize screws. The larger diameter screws may be forced into the smaller diameter holes but not the other way round. Mounting holes in the dial plates also differ but this may not be as big a problem.

It may be that spare balance wheel assemblies for these car clocks can be sourced from domestic "Sectronic" wall or mantel clocks but this has not been fully investigated at this time. Such clocks would have to be of the Mk II type. The Mk I Sectronic movement was physically a very different beast. I'm assuming the same moulded frame pattern is used for all these clocks. In light of the comments earlier, regarding dial screws, these also would need to be kept with their respective frames.

When setting the regulator on these clocks, turning the regulator control clockwise slows the clock (lengthens effective hairspring length).

For any mechanical clock, clockwork or electric, endshake of the balance assembly is critical. In some cases, adjustment of this endshake (if provided) may be all that is necessary to "fix" a clock. Since the clock has to be removed from its case to make this adjustment, then it makes sense to clean and lube the clock while you're at it. Endshake should be the minimum that permits the balance to move freely. Just sufficient to be able to feel it when moving the balance with a finger - 0.002 to 0.004 inch should be about right. Clock construction should have metal spacers/studs supporting the bearing plates that have a similar coefficient of thermal expansion as the balance staff itself. That is to say that there is no change in the amount of endshake with temperature. Many clocks use jewel (synthetic sapphire or ruby) bearings for the balance assembly. When these are left unlubricated, change in the viscosity of oil won't be an issue.

APPENDIX D: AMERICAN JAEGER CAR CLOCK:

Photographs below show a Jaeger clock similar to the Smiths "CE" clock. The original patent for these clocks was issued to Jaeger in the 1930s. With licencing arrangements and the later purchase by Smiths of Jaeger's interests in the United Kingdom, Smiths had the right to produce the CE clocks. The unit shown here is an American manufactured Jaeger clock movement – The lettering on the coil reads "JAEGER WATCH CO., NEW YORK, U.S.A.". This clock uses the same style pin and triple pole piece balance structure as the Smiths unit to operate the clock. However, instead of a hairspring mounted contact, this clock uses a long strip of metal, almost the full width of the movement, to provide the electrical contact to the pin.

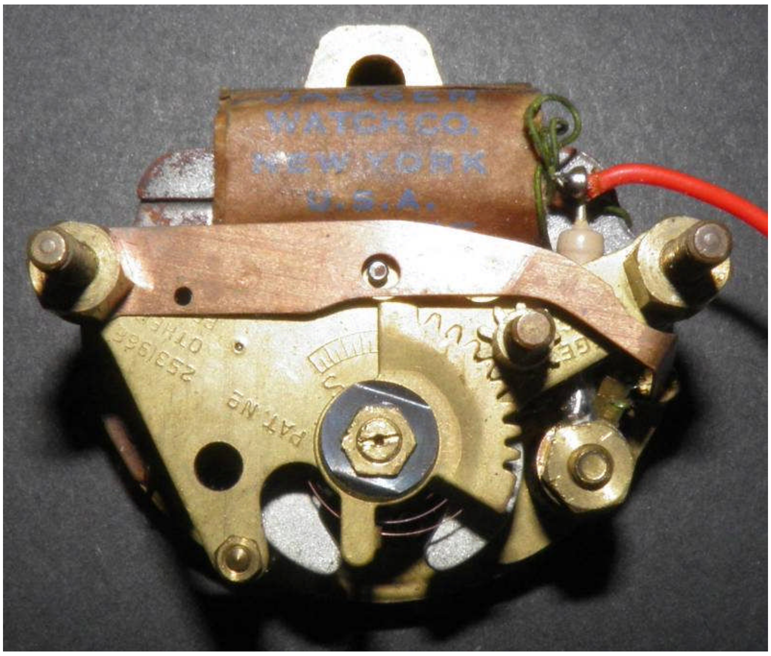


FIGURE A.1: Rear view of an American Jaeger car clock. The toothed segment visible in this picture is part of the clock regulation system.

An interesting aspect of this clock movement is a single slotted disc output which connected to an arm on the dial assembly, which also incorporated the required gearing between the minute and hour hands' wheels.

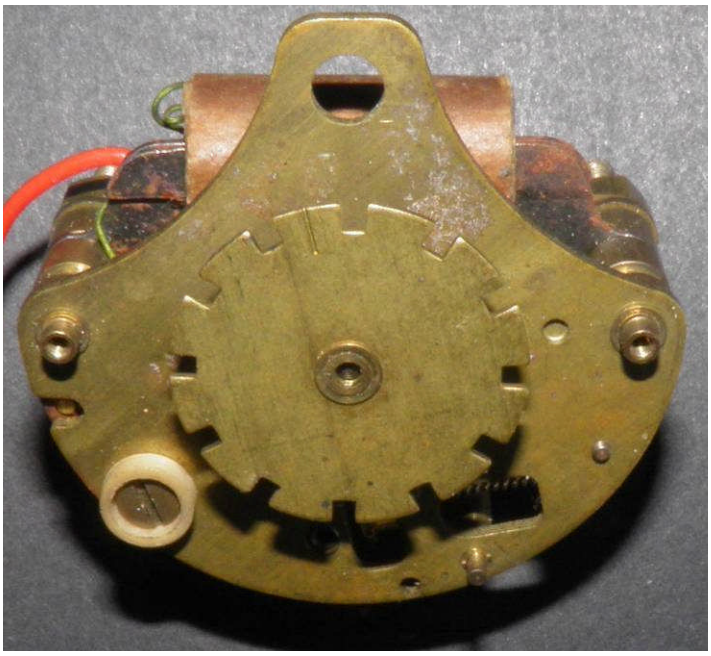


FIGURE A.2: Showing the slotted-disc connector between the clock mechanism and the dial assembly of the (American) Jaeger clock. Connection between the two assemblies was by means of a pin on a crank fitted to the dial assembly that entered one of the slots on the disc seen here.

This clock mechanism itself was housed in a pressed steel case that attached to the dial assembly, which included the front portion of the case, with a three pin bayonet style fitting. The clock mechanism itself could be swapped out in very little time and any Jaeger mechanism could be fitted to any other Jaeger dial assembly.

There is no date code visible on this clock but its determined application dates it from the early 1950s.

The similarity in design of the balance wheels can be seen in fig. A.3 below. Smiths "CE" clock design was based closely on the French Jaeger unit and production of these electric car clocks, by Smiths, Commenced in 1937.

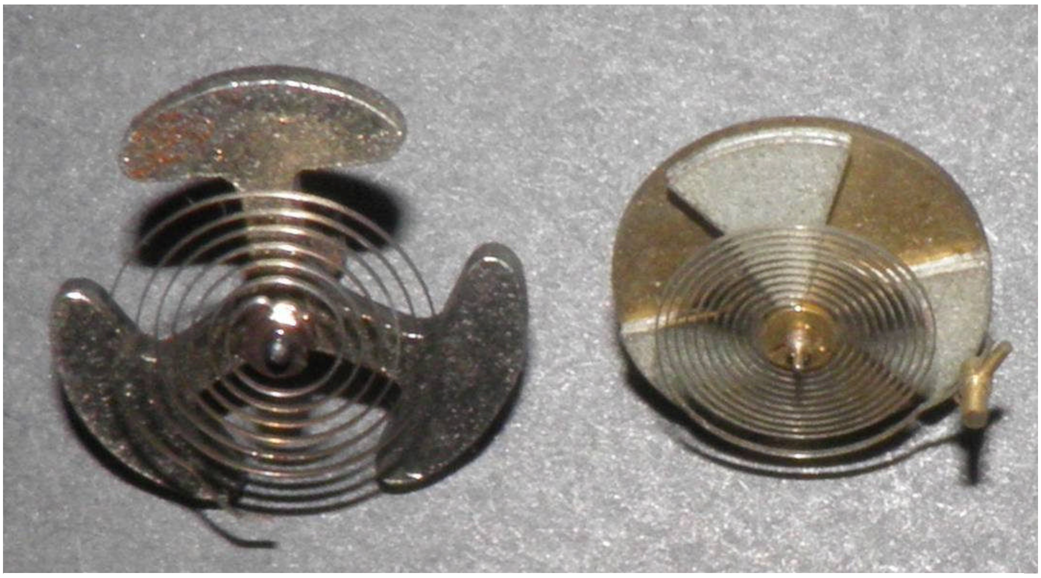


FIGURE A.3: Showing the balance assembly from an American Jaeger clock on the left and that from a Smiths/Jaeger "CE" clock on the right.

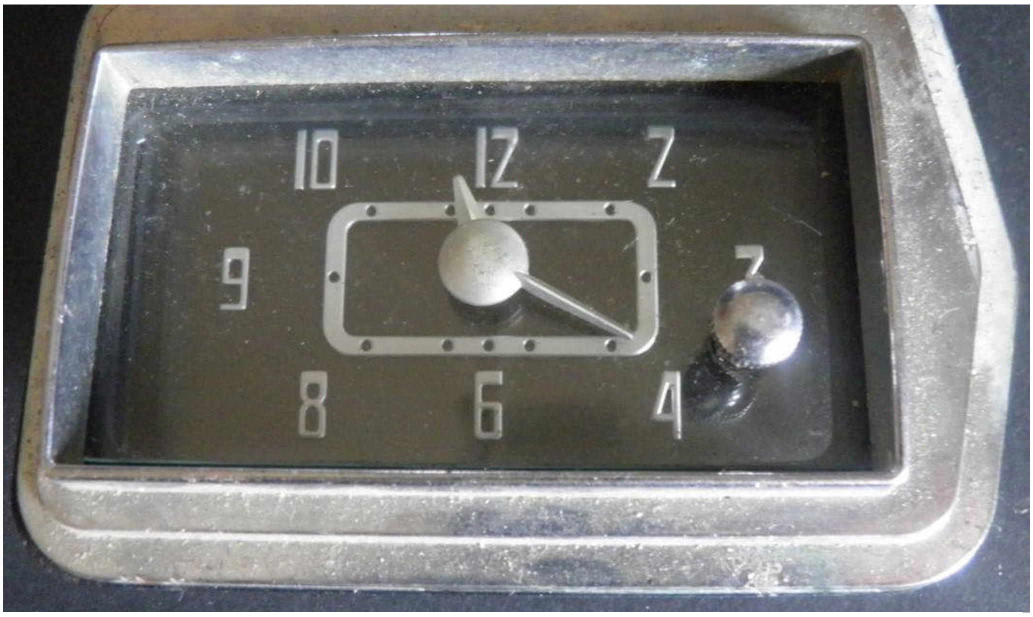


FIGURE A.4: Dial of American Jaeger clock to hand. It appears to be from an early 1950s Plymouth and is a 6 Volt unit. (Voltage marked on coil.)

So although there are obvious differences between this unit and the Smiths version, the information provided here for repairing "CE" clocks will substantially apply to this unit.

The Smiths unit is designed with repair in mind where the American item seems to be "disposable", the clockwork module to be replaced rather than repaired.

APPENDIX E: REPLACEMENT BATTERIES FOR SMITHS CET CAR CLOCKS:

The original battery for these clocks was a Mallory RM-1N or RM-1R mercury battery, Stanpart No. 146588 - Smiths number 40-688-340. These batteries had a nominal voltage of 1.35V and were commonly used in photographic equipment. Mercury batteries are no longer manufactured but this battery may be replaced by an LR50/PX1A/1A/A1PX/1100A/PC1A. alkaline battery. Alkaline batteries have a nominal voltage of 1.5V but the slight increase in voltage should not prove to be a problem though it may affect the timing of the clock which can be brought back to original using the regulator adjustment of the clock.

LR50 cell (battery)

The battery dimensions are:

diameter - 15.6 mm (0.61”).
length - 15.6 mm (0.61”_.

APPENDIX F: CAERBONT SMITHS CAR CLOCKS:

Caerbont Automotive Instruments still sell “Smiths” branded car clocks with modern internals. These are produced in both 52 and 60 mm diameter models. These clocks have a “CA” prefix and the internal works are isolated from the case - separate positive and negative terminals are present on the rear of the case allowing these clocks to be fitted to cars of either chassis polarity. The polarity of the connections must adhere to the markings on the rear of the clock.

These clocks typically have a single knob on the front of the clock for setting time. A remote-setting option is available on some clocks. See Jaguar E-Type clock below.

Caerbont also market clocks with “CE” (Aston Martin DB5) and “CTE” (Jaguar “E” Type) prefixes, though I suspect that the internals may be more modern.

This range of clocks has no facility for the user to adjust the timekeeping (regulation).The timebase is a quartz crystal and regulation is set during production. Motive power may be either a synchronous motor or stepper-motor.

It is assumed that these modern clocks are non-serviceable.

Two examples of current Smiths car clocks (From Smiths Instruments website)

SMITHS Classic Electronic Analogue Time Clock

Black dial and white print. white minute and hour hand. Chrome 1/2 v or IVA bezel.

Available in 52mm and 60mm variants.

1/2 V bezel	IVA bezel
52mm Clock CA1100-01C	CA1100-14C
60mm Clock CA2-1032-00C	CA2-1032-02C

Also available in Magnolia.

Jaguar E-Type Time Clock

Smiths 60mm analogue time clock with remote reset. Black dial, white print and white pointers. With black half round or half 'V'

Part Number	Bezel
CTE3107-01HR	Half Round
CTE3107-02HV	Half 'V'

Change log

Date	Version	Change list
December 2021	1.0	Initial document
April 2024	2.0	"The Lusby update". Added earlier (pre-CE) clock information and re-write text as needed.